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UNIVERSITY of OULU

CeHRes Roadmap utilization in development of eHealth Technology solutions: A Scoping review

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Mari Palokangas
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Abstract

eHealth can be defined as health care field that is using Information and Communication Technologies. There is variety of different technologies that can be used in eHealth and the field is evolving via new inventions. Users in eHealth are coming from several user groups from health care professionals to patients and external users. Development of eHealth technology solutions can fill increasing demands of health care field that are caused by longer life expectancy. Despite all the benefits that utilization of eHealth technology can bring for health care sector, it has also some barriers that are delaying adoption of eHealth technology solutions. To overcome these barriers CeHRes Roadmap was created to support and guide eHealth technology development and it is meant for developers, researchers, policy makers, and for educational purposes. CeHRes Roadmap is visualizing Holistic framework and it is based on participatory development approach, persuasive design techniques, and business modelling.

Objective of this master's thesis is to identify, collect, and characterize all relevant research that is using CeHRes Roadmap in developing eHealth technologies published from year 2011 onwards. Research articles are analysed geographically, in terms of technology and medical domain, and characterizing and categorizing CeHRes Roadmap elements and attributes.

Research method in this thesis was Scoping review that is literature review method that aim to map rapidly relevant literature and is suitable for broad topics. Literature search was done from Scopus, Web of Science, IEEE, PubMed, and Cinahl. Due to multidisciplinary nature of topic search was done for databases that contain material from Information processing science and/or medical science. 26 studies were identified to be relevant for this research.

Results of this master's thesis indicate that usage of CeHRes Roadmap has been most common in Netherlands, but it has been recognized and referenced in hundreds of studies. As the roadmap is not restricting usage to particular technology area, variety of used technologies were wide and several different medical domains using CeHRes roadmap were found. When analysing CeHRes Roadmap characteristics, participatory development was found to be the key characteristic that was visible in almost every selected study. This thesis provides inventory of studies that have used CeHRes Roadmap in development work and give insight how it has been used.

Keywords
eHealth, development, CeHRes, Scoping review

Supervisors
PhD, Professor Harri Oinas-Kukkonen
PhD, Pasi Karppinen

Foreword

Health technology has interested me some time now. I wear activity meter on my wrist which measures my steps, my sleep and how much calories I burn daily. Originally, I bought it for exercise purposes to monitor heart rate and how fast I run but gradually it became part of my daily routines to wear it on my wrist and check have I been active enough and try reach daily activity limit. This is just simple example how health technology can persuade people to live healthier life and it has been interesting journey to familiarize myself with eHealth technology development and get more knowledge on that.

I would like to thank Harri Oinas-Kukkonen and Pasi Karppinen supervising and guiding me in my master's thesis process and giving me this opportunity. I would also like to thank my family for being patient and for giving support during my studies.

Mari Palokangas

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Abbreviations

BCSS	Behavior Change Support Systems
CeHRes	Center for eHealth Research and Disease Management
DSRM	Design Science Research Methodology Process Model
eHealth	Electronic health
ICT	Information and Communication Technologies
PSD	Persuasive System Design
STTBI	Sexually Transmitted and Blood-borne Infections

Contents

1. Introduction

eHealth is quite new research field and it is combining elements from several other research fields like computer science, information science, decision science, statistics, cognitive science, and organizational theory to health care field (Gray & Sockolow, 2016). Term eHealth has many definitions by different researchers. Eysenbach (2001) defines eHealth as health services and information that is delivered or enhanced through internet or related technologies. According to Mitchell (1999) eHealth refers to the combined use of electronic communication and information technology in the health sector (as cited in Della Mea, 2001). Van Gemert-Pijnen et al. (2011) defined term eHealth to be referring to all kinds of Information and Communication Technologies (ICT) that are used for supporting health care and promoting wellbeing and it can include wide spectrum of technologies such as internet, electronic health records, online portals, mobile applications and so on. For all the definitions, it is common that they include the theme health and technology either explicitly or implicitly (Oh, Rizo, Enkin, & Jadad, 2005). Term eHealth is expanding and refining the usage of telemedicine services (Matusitz & Breen, 2007). Telemedicine is defined as usage of telecommunication technologies in clinical healthcare delivery and exchange from long distances using services such as videoconferencing, telephones, and faxes for interaction between doctor and patient (Perednia & Allen, 1995; Turner, Thomas, & Gailiun, 2001). eHealth differs from telemedicine in that eHealth use advanced information and communication technologies (e.g. internet) to satisfy needs of citizens, patients, healthcare professionals, and policy makers (Eysenbach, 2001) and focuses wide range of services for example nursing, education, and medication prescription (Matusitz & Breen, 2007).

Van Gemert-Pijnen, Peters & Ossebaard (2013) categorized eHealth to three dimensions: users, technology, and context of use. User is the centre of eHealth technology development and there is wide spectrum of different users that can use eHealth applications. According to Van Gemert-Pijnen et al. (2013) intended user group and interactions between user groups are guiding development work in eHealth applications. eHealth application users can be classified as health care professional, patients, external users e.g. financial controllers, and other eHealth applications and systems which are sharing information. Interactions between user groups can be categorized as follows; from health care professional to other e.g. for inter-professional consultation; between health care professional and patient e.g. for electronic consultation; from patient to other e.g. online peer support; between patient or health care professional and external users e.g. for health insurance declarations; and between patients or health care professionals and other eHealth applications or systems, e.g. for medical decision making or virtual coaching (van Gemert-Pijnen, Peters, & Ossebaard, 2013). Krijgsman and Klein (2012) categorized technologies (as cited in van Gemert-Pijnen et al., 2013) as web-based applications; mobile apps; electronic health records or personal health records; health sensors, gateways, and wearable devices; domotics; video communication; robotics; health information exchange; business to business gateways; and business intelligence and big data solutions. Complex eHealth solutions can combine several of these defined technology variants together (van Gemert-Pijnen et al., 2013). Van Gemert-Pijnen et al. divided context of eHealth to eCare, eLogistics, and ePublic health. With eCare they refer to primary process of care e.g. tele-diagnostics, online-therapy, and remote monitoring. Procedures that support and simplify primary care processes such as electronic health records, purchasing, and online appointment tools are defined as eLogistics. With ePublic health is meant public education and prevention with help of technology such as populations screening and online provision of information. (van Gemert-Pijnen et al., 2013). Variants of eHealth technologies presented by Krijgsman and Klein has been used in categorizing used technologies in selected studies because those were clear and gave insight of how wide scope of technologies have been utilized in selected studies.

To improve the adoption of eHealth technologies researchers in University of Twente evaluated existing eHealth frameworks and created a new holistic framework for eHealth technology based on a participatory development approach, persuasive design techniques and business modelling. As a result, they presented CeHRes Roadmap which purpose is to serve as practical guideline to help planning, coordination and execution of participatory development process of eHealth technologies (van Gemert-Pijnen et al., 2011). Purpose of this study is to summarize and analyse what is known in literature about CeHRes Roadmap usage in eHealth technology development projects. CeHRes Roadmap is quite new roadmap and there is no earlier research available on its usage and adoption and thesis should provide answer where and how CeHRes Roadmap has been used.

1.1 Research method

The research method of this thesis is scoping review by Arksey and O'Malley (2005). Scoping review is literature review method that is aiming to map rapidly relevant literature and to address broad topics. Scoping review differs from systematic literature view in several ways. Search process in scoping review is iterative and it is not restricted to specific study design. Study selection inclusion criteria is not required to decide before search is started and it is possible design inclusion criteria post hoc as and when familiarity of literature is increasing. When presenting the results, scoping review tries to present overview of all material and does not try to aggregate findings from different studies. (Arksey & O'Malley, 2005).

According to Arksey and O'Malley (2005) scoping review can have two different purposes: it can be part of full systematic review or it can be independent research producing own publication but Grant and Booth (2009) disagree on using scoping review as final output because it has limitations on accuracy and duration and they suggest that it should always be used only as part of other research methods. Levac, Colquhoun and O'Brien (2010) argue that scoping review method by Arksey and O'Malley has several challenges: research questions are too broad, creation of scoping review purpose is missing from the stages, balancing with breadth and comprehensiveness of scoping review, study selection linearity is misleading, unclear study selection decisions, extraction of data from selected studies is unclear, collating, summarizing and reporting results stage has too many steps included, and external consultation usage lack clarity. Although research method has received critique the popularity of method has increased in past few years (Colquhoun et al., 2014). For example, Wildevuur and Simons (2015) have used scoping review method for identifying research gaps in usage of ICT interventions in chronic diseases. Strength of the scoping review method is that it can be used in rigorous and transparent way to map areas of research in relatively short time (Arksey & O'Malley, 2005). Due to the wide research topic and the purpose to get comprehensive coverage of all available literature scoping review is suitable research method for this master's thesis and therefore scoping review is used as independent research producing own publication despite the disagreement on suitability of scoping review method usage in producing final output of research. Scoping review has not been used in Oulu University Information Processing science discipline and this master's thesis is also providing information of suitability of research method on master's thesis purpose.

1.2 Structure

The structure of this thesis is as follows. Chapter 2 describes background of eHealth development, and Holistic framework and CeHRes Roadmap that was presented by van Gemert-Pijnen et al. (2011) and introducing reader to the subject. The following chapter, Chapter 3 describes used research methodology in this master's thesis and process steps of scoping review process in general. Chapter 4 gives detailed description how scoping review steps were conducted in this research. Chapter 5 presents results and findings regarding research question. Chapter 6 is discussion where an overview of research question and the findings are given, and implications and limitations of this work is discussed. Chapter 7 gives concluding remarks.

2. Background

Implementation of eHealth technology solutions are getting more interest when demands on health care field are increasing. This chapter describes background of eHealth development and evaluation, benefits that eHealth technology usage can bring to health care, and challenges that eHealth development has, and presents CeHRes Roadmap that was developed by van Gemert-Pijnen et. al (2011) to help eHealth technology development.

2.1 eHealth development and evaluation

Using ICT on health care sector is rather new and awareness of eHealth has grown among public since the turn of 21st century due to increasing usage of internet and web-based health and lifestyle solutions (Pagliari, 2007). eHealth is combination of health care field, computer science, and information science and it needs to correspond to requirements from all parallel science fields and therefore development is complex. Due to differing languages, cultures, and motives eHealth development can contain problems and solutions might not be what were expected (Pagliari, 2007). Health care differs from other sectors in management, in variety of customers, in number of variants, and in a usage of soft values as metrics (Avison & Young, 2007). Due to the nature of eHealth technologies it is not sufficient to consider only technological aspects but also people, organizations, and social issues should be reflected in eHealth technology development (Kaplan, Brennan, Dowling, Friedman, & Peel, 2001). When designing eHealth technology, it is important to understand the impact of new technology to the users, organizations, and to work processes (Karsh, 2004). Development of eHealth technology should be seen as possibility to create infrastructure for knowledge sharing, communication, and health care organization and as engine for innovative health care (van Gemert-Pijnen et al., 2013). Because nature of eHealth development is multidisciplinary several frameworks for eHealth development has been created aiming to facilitate complex development process. Frameworks have had different approaches and for example framework by Esser et. al (2009) propose user-centred approach to development and Pagliari (2007) propose using interdisciplinary collaboration between software designers and researchers, and iterative evaluation stages. eHealth development is tightly intertwined with ICT development that has also several frameworks and development methods such as Design Science Research Methodology Process Model (DSRM) by Peffers, Tuunanen, Rothenberger and Chatterjee (2007) or Agile methods which have been popular methods in ICT development in recent years.

Evaluation in eHealth technology is important because health systems contain sensitive data and can affect to people's health. Catwell and Seikh (2009) proposed comprehensive evaluation that promotes multidisciplinary approach and continuous systematic evaluations through lifecycle of eHealth technology. Lilford, Foster and Pringle (2009) suggest including both qualitative and quantitative evaluations in eHealth technology. Quantitative evaluation provides information of how eHealth technology works, and qualitative evaluation provides information of eHealth technology usage and how that fit for the purpose (Lilford, Foster, & Pringle, 2009). Generally, eHealth technology has several user groups that have different requirements and therefore information gathering for evaluation needs to be done in several levels for gaining adequate level of evaluated information. Both formative and summative evaluations are required due to the different natures. Formative evaluations provide timely feedback for current eHealth project and its feasibility and summative evaluations regard longer period of time and information is used more for future work and decision making (Lilford et al., 2009).

2.2 Benefits of eHealth technology usage in health care

Use of eHealth technology in health care has many benefits. It is enabling online consultation and treatment, medical education, and allows easier access to information for both health care professionals and patients (Mudur, 2004). Van Gemert-Pijnen et al. (2013) declare that eHealth can improve health care by increasing equity and improving access for health care for more people by enabling health care service to be available independent of time or place and reducing constraints of service delivery. It can help to save resources and improve efficiency by improving communication possibilities between patients and health care professionals or between health care professionals and reducing unnecessary visits to the hospital. By providing access to own medical records, eHealth can make health care transparency, and involve patients more in their own care, and increase the quality of health care (van Gemert-Pijnen et al., 2013).

As world population is ageing and people live longer due to improved nutrition, sanitation, medical advances, health care, education and economic well-being (UNFPA and HelpAge International, 2012), new solutions are required to meet increasing demands in health care field and development of eHealth technology solutions could be the answer for all the challenges. Potential of eHealth technology has been noticed also in European commission that has an eHealth action plan to promote eHealth adoption among European Union (EU). European commission believes that eHealth technology could respond to challenges of ageing population, expectations of citizens, and mobility of patients and health care professionals via innovative solutions and provide better and safer health care, more transparency and empowerment, a more skilled workforce, more efficient and sustainable health and care systems, better and more responsive public administrations, and new business opportunities which can improve European economy (European Commission, 2012).

2.3 Challenges in eHealth development

In addition to all benefits eHealth technology usage can provide, there are some challenges in eHealth technology development which affect to the development and adoption of developed solutions. Large investment costs in eHealth may cause lack of funding in infrastructure, equipment, and personnel and that leads to uneven possibilities to get treatment in some regions (Mudur, 2004). Poorly designed eHealth solutions can have functional errors, are unreliable, and not user-friendly and cause danger for patients and health service (Ammenwerth & Shaw, 2005). Most common barriers for adopting eHealth technology are insufficient knowledge and confidence in eHealth solutions among patients and healthcare professionals, lack of interoperability between eHealth solutions, missing evidence of the cost-effectiveness of eHealth solutions, lack of legal clarity and transparency of utilizing data collected via healthcare applications, high start-up costs and regional differences in accessing ICT services (European Commission, 2012). To overcome these barriers European Commission is concentrating on their plan to gain better interoperability of eHealth services, supporting research, development, and innovation in eHealth, facilitating uptake and ensuring wider deployment and promoting globally dialogue and co-operation on eHealth. Van-Gemert-Pijnen et al. (2011) analysed different eHealth technology frameworks and based on that developed CeHRes Roadmap that aims to facilitate eHealth technology development and adoption. eHealth technologies have potential to increase efficiency of health care field and improve quality of life. As technology is evolving also eHealth technology usage in health care field has become more common even it still is behind other sectors (Smadu, 2007).

2.4 Holistic framework for eHealth development

Van Gemert-Pijnen et al. (2011) composed holistic framework and presented CeHRes Roadmap to help planning, coordination and execution of eHealth technology development process. Framework is integrating participatory development approach, persuasive design techniques and business modelling (van Gemert-Pijnen et al., 2011) which are essential elements of framework. Framework has six principles that promote development of eHealth technologies:

1. eHealth technology development is a participatory process.
2. eHealth technology development involves continuous evaluation cycles.
3. eHealth technology development is intertwined with implementation.
4. eHealth technology development changes the organization of health care.
5. eHealth technology development should involve persuasive design techniques.
6. eHealth technologies development needs advanced methods to assess impact.

Participatory process principle underlines co-creation with the users and listening their requirements. Participatory approach in system design emphasize designing systems that are useful (Gould & Lewis, 1985) and in framework presented by van Gemert-Pijnen et al. (2011) it is enabling fulfilling goals of eHealth technology by receiving input from stakeholders. eHealth system acceptance problems are largely caused by lack of end user perspective in system design which produce solutions that does not meet user requirements and therefore development should be done with end users instead of designing for end users (van Gemert-Pijnen et al., 2013).

Evaluation is important for ensuring that created eHealth technology is responding to the user requirements and it has been understood. Evaluation is cyclic and continuous activity that is along in every stage of the development without agreed finish (van Gemert-Pijnen et al., 2011). Involvement of users provides information of usage, how developed solution fit for the purpose, and possible improvement points (van Gemert-Pijnen et al., 2013). Sixth principle of methods to assess impact of eHealth technology development refers to summative evaluation that is performed at the end of technology development. Summative evaluation estimates the added value of eHealth technologies for health care and society (van Gemert-Pijnen et al., 2011) and should not focus only for effectiveness but consider also how and why technologies contribute to this effectiveness (van Gemert-Pijnen et al., 2013).

Implementation should be considered already from the beginning to avoid surprises when it is time to take system into use. By identifying potential implementation issues already from the beginning throughout whole development process it is possible to avoid pitfalls of stakeholder disregard (van Gemert-Pijnen et al., 2011). Implications that developed health technology has for individuals, health care and society should be observed from the beginning for ensuring successful implementation (van Gemert-Pijnen et al., 2013)

eHealth technology development can cause changes in organization or work processes and therefore change management is important for ensuring fluent adoption of developed solution. Using co-creation process in eHealth development and involving stakeholders from different backgrounds and different interests enables creating trust, commitment, ownership, and organizing resources and capacities for development work (van Gemert-Pijnen et al., 2013).

Persuasive design techniques in development process assure that there is no misconception in actual use of system related to intended use. Oinas-Kukkonen and Harjumaa (2008) defined persuasive systems to be "computerized software or information systems designed to reinforce, change or shape attitudes or behaviours or both without using coercion or deception". Persuasive system design model explain process of designing and evaluating persuasive systems (Oinas-Kukkonen & Harjumaa, 2009). It has three steps: understanding fundamental issues behind persuasive systems by addressing seven postulates concerning users, persuasive strategies, and system features; analysing context of persuasive systems; and design and evaluation of persuasive system features. Persuasive design techniques in framework provide understanding of behavioural change influence that eHealth technology might have on users, how it fits on the needs of users and how new structure for health care delivery can be created (van Gemert-Pijnen et al., 2011).

Business modelling makes development value-driven and introduces research activities before actual technical design providing value drivers for decision making in development project (van Limburg et al., 2011). Business modelling in framework is considering economic, behavioural, and psychological values and identifying critical factors for implementation (van Gemert-Pijnen et al., 2011). Business modelling can be divided to three levels of detail: business model, business case and business process model. First level, business model includes strategic decisions for implementation and it can change during development when knowledge of technology is increasing. Second level, business case contains more detailed information, mainly financial information. And third level, business process models describes activities that employees do, and level of details can vary by organizations (van Gemert-Pijnen et al., 2013).

Framework is not focusing to any specific eHealth technology and it is applicable for wide spectrum of technologies. It is meant to be used by developers, researchers, policy makers, and for educational purposes and it is convenient to be used as analytical instrument for decision making (van Gemert-Pijnen et al., 2011).

2.5 CeHRes Roadmap

CeHRes Roadmap presented by van Gemert-Pijnen et al. (2011) has six development and research activities and those are presented in Figure 1.

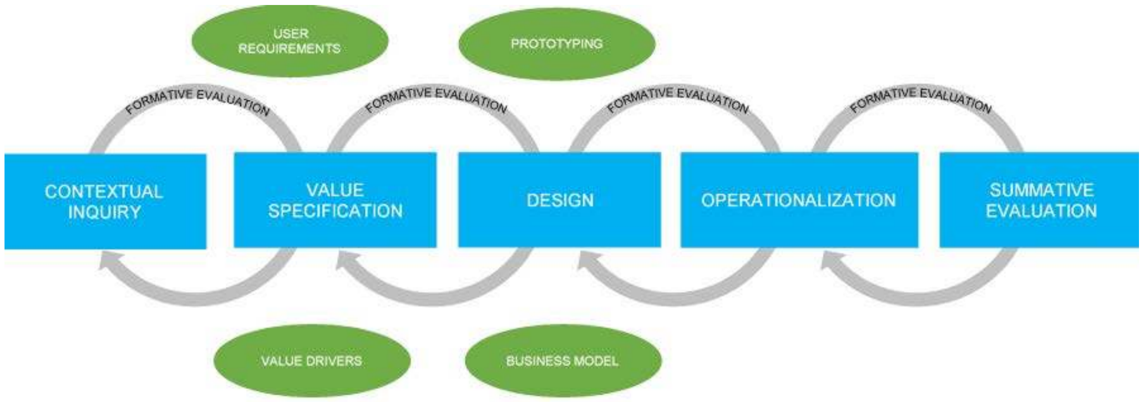


Figure 1 CeHRes Roadmap (van Gemert-Pijnen et al., 2011 Originally published in the Journal of Medical Internet Research)

Development process should start with multidisciplinary project management even that is not presented in Figure 1. Purpose of multidisciplinary project management is to facilitate co-operation between designers and users. Actual development steps are contextual inquiry, value specification, design, operationalization, and summative evaluation. (van Gemert-Pijnen et al., 2011)

Contextual inquiry collects information of intended users and environment where eHealth technology is used. Different methods, such as field observations, interviews, literature review, workshops, persona, and scenario creation can be used in this phase to identify problems, needs and goals that eHealth project has (van Gemert-Pijnen et al., 2011). In this phase, whole eHealth project is planned and prepared and decision is made that is there need for eHealth solution in a first place and is project needed or not. Outcomes of Contextual inquiry phase are categorization of expectations, identification of key-stakeholders and intended users and these outcomes are used as inputs in value specification phase (van Gemert-Pijnen et al., 2013).

Value specification elaborates data from contextual inquiry and stakeholders economic, social, and behavioural values are determined. Values are ranked based on importance and creating user and organizational requirements for the eHealth technology (van Gemert-Pijnen et al., 2011). Key-stakeholders explore required changes and how those fit to defined values. This information is used for business model creation and ensure infrastructure for developed eHealth technology (van Gemert-Pijnen et al., 2013).

Contextual inquiry and value specification together are providing functional requirements for the desired eHealth technology. In design step, functional requirements are translated into technical requirements. Prototypes, mock-ups, or storyboards are created to visualize requirements and how those are fulfilled. Process is iterative and intended users are testing and giving feedback whether prototypes match expectations (van Gemert-Pijnen et al., 2011). Design applies persuasive design techniques to motivate users to use system and prototype evaluations ensure ease-of-use of the system (van Gemert-Pijnen et al., 2013).

Operationalization takes eHealth technology in daily use and it enables and reinforces activities and organizes training, education, and deployment of eHealth technologies (van

Gemert-Pijnen et al., 2011). Created business model defines resources, required skills, and expected cost-benefit of implementation. Action plan for taking new system into use help to introduce new system for users and usage of system later (van Gemert-Pijnen et al., 2013).

Summative evaluation evaluates actual uptake and impact of eHealth technology. Outcomes are measured in different levels: the usage of the technology and the effects on performance criteria for high-quality care (van Gemert-Pijnen et al., 2011). Different methods for evaluation can be used like surveys, usability tests, clinical trials etc. to determine the effects of developed eHealth solution (van Gemert-Pijnen et al., 2013).

3. Research methodology

Used research methodology to conduct this research is scoping review. Mays et al. 2001 defined scoping review (as cited in Arksey & O'Malley, 2005) as “aim to map rapidly the key concepts underpinning a research area and the main sources and types of evidence available, and can be undertaken as standalone projects, especially where an area is complex or has not been reviewed comprehensively before”. This section explicates the overview of scoping review and how it differs from systematic review method and different stages of scoping review process.

3.1 Overview of scoping review

Popularity of scoping review as research methodology has been increasing in past few years (Colquhoun et al., 2014). Definition of scoping review underline conducting a comprehensive coverage of available literature in the field of interest however different purposes of a review affect to the depth of the coverage (Arksey & O'Malley, 2005). In framework published by Arksey & O'Malley (2005) four different reasons for scoping review usage were identified: to examine the range of available material of research topic, to define the value of starting a full systematic review, to summarise and disseminate research findings, and to identify research gaps in the existing literature. These four reasons reveal two different intentions for a scoping review: scoping review can be involved as one part of an ongoing review for producing a full systematic review or scoping review can be independent research that is published (Arksey & O'Malley, 2005).

Arksey and O’Malley (2005) state that strength of scoping review is that it can be used in rigorous and transparent way to map areas of research and it enables reviewers to adopt the field of interest in terms of the volume, nature, and characteristics of the primary research in relatively short space of time and facilitate exploiting of findings for policy makers, practitioners, and consumers. Limitations of scoping review are that it does not appraise the quality of evidence and quantity of generated data can be considerable high (Arksey & O'Malley, 2005). Grant and Booth (2009) state in their research that scoping review cannot be regarded as final output because it holds potential for bias due to its limitations in accuracy and duration but Arksey and O’Malley claim that scoping review can be used as independent research method, if process is documented sufficiently and replicable by others.

Comparing scoping review and systematic review types reveal differences in literature search and selection, quality assessment, and how research is presented and analyzed. Scoping review use broad criteria identifying relevant literature and does not restrict used study design (Arksey & O'Malley, 2005) and does not limit search completion with time and scope factors (Grant & Booth, 2009). Study selection exploit inclusion and exclusion criteria post hoc based on increased familiarity of the literature and does not include quality assessment for selected studies in research process (Arksey & O'Malley, 2005). Presentation is tabular with narrative commentary and analysis concentrates on characterizing relevant literature with key features (Grant & Booth, 2009) and presenting overview of all material reviewed (Arksey & O'Malley, 2005). Systematic literature review focuses on narrow topic that has clearly defined question and in advance identified study design (Arksey & O'Malley, 2005) and aims for exhaustive, comprehensive searching (Grant & Booth, 2009). Study selection is done using inclusion and exclusion criteria with quality assessment (Arksey & O'Malley, 2005). Systematic review typically utilizes narrative format that is supplemented with tabular format (Grant & Booth, 2009) and in analysis, systematic review aims to combine evidence and findings from different studies (Arksey & O'Malley, 2005). Mapping review/systematic map research method is like scoping review method but according to Grant and Booth (2009) difference is that mapping review research method may identify need for further review work or primary research and the outcome is not known beforehand.

3.2 Process of scoping review

Scoping review framework by Arksey & O'Malley (2005) proposes to use five stages in a scoping review process and optional consultation exercise in the end to inform and validate findings. In this study consultation exercise is not used and only five stages of scoping review are carried out. The process is iterative and allows repeating steps for ensuring covering literature in comprehensive way. Stages of scoping review process are described in Table 1.

Table 1. Overview of Arksey and O'Malley (2005) framework stages.

Framework stage	Description
1. Identifying the research question	Identifying research question and relevant aspects of the questions guides the search strategy creation. For ensuring breadth coverage of literature, research question is wide in nature.
2. Identifying relevant studies	Identifying relevant studies requires decisions of search sources, time span and language. Sources include electronic databases, reference lists, hand-searching of key-journals, and existing networks, relevant organizations, and conferences. Cost, time, and personnel resources are possible limiting factors that can affect to the search.
3. Study selection	Study selection is done using inclusion and exclusion criteria like systematic review method but criteria is constructed afterwards based on increasing familiarity of literature. Initial selection is done based on abstract and final selection after reading whole document.
4. Charting data	Data charting form is created to extract key items and themes from studies using narrative review or descriptive-analytical methods. Requires decision of what information is recorded and how comparison between studies is implemented. Collected data forms the basis of the analysis.
5. Collating, summarising, and reporting the results	Analytical framework or thematic construction is used to present an overview of existing literature. Numerical analysis of extent, nature and distribution of studies is presented using tables and charts. Clarity and consistency in reporting the results is required.
Optional: Consultation exercise	Involves three groups of stakeholders: representatives from national statutory and voluntary bodies, managers and practitioners from local organizations, and key informant carers. Can provide additional references about potential studies and insights of issues.

According to Levac, Colquhoun and O'Brien (2010) scoping review process defined by Arksey and O'Malley has several challenges: research questions are too broad, creation of scoping review purpose is missing from the stages, balancing with breadth and comprehensiveness of scoping review, study selection linearity is misleading, unclear study selection decisions, extraction of data from selected studies is unclear, collating, summarizing and reporting results stage has too many steps included, and external consultation usage lack clarity. Despite all challenges that Scoping review framework by Arksey and O'Malley has, it is most used method of its kind. Scoping review method was selected for this study due to broad nature of research question and novelty of the subject. Use of scoping review as research method in master's thesis allowed to scan the key concept of CeHRes Roadmap usage in eHealth technology research.

4. Scoping review

The scoping review in this study follows the guidelines proposed by Arksey & O'Malley (2005). This chapter describes process of utilizing scoping review framework and it stages.

4.1 Identifying the research question

Starting point for study is to identify relevant research question which will guide search strategy building and it is important to reflect which aspects are major. In scoping review, research question should be wide in nature for ensuring adequate coverage of literature. In some cases, research question might require parameter definition to clarify inclusion and exclusion criteria of relevant articles, but decisions of parameters can be done after understanding of volume and general scope of the field has been received. (Arksey & O'Malley, 2005)

Scope of the study was to explore CeHRes Roadmap adoption in generally and based on this following research question was formulated:

What is known in literature about CeHRes Roadmap utilization in development projects in eHealth technology area?

CeHRes Roadmap is not focused to any specific technology and the scope of usage is broad and it is based on participatory development approach, persuasive design techniques and business modelling, and it is meant for developers, researchers, and policy makers and for educational purposes (van Gemert-Pijnen et al., 2011). As the possibilities in CeHRes Roadmap usage in eHealth technology are wide, aim of the research question was to clarify how widely in technologically and in geographically CeHRes Roadmap has been applied and which medical domains have used CeHRes Roadmap and how CeHRes Roadmap characteristics and categories were utilized in selected studies. Although study location and used technology were used in reporting the results those were not used as search criteria because there was no need to restrict it for certain geographical area or technology and purpose was to get wider sight of CeHRes Roadmap usage.

4.2 Identifying relevant studies

Several different sources e.g. electronic databases and reference lists can be used to comprehensively identify primary studies that answer the main research question (Arksey & O'Malley, 2005). Because CeHRes Roadmap is created especially for eHealth technology, both ICT and medical fields needs to be covered in database search. Therefore, database searches were carried out in Scopus and Web of Science that are multidisciplinary reference databases and in IEEE, Pubmed and Cinahl databases for getting separate view for ICT and medicine fields. Search query was composed of "eHealth" and its synonyms and different types of spelling combined with "user-centred" "participatory development", "persuasive design", and "business model" and their synonyms. Search words were identified based on CeHRes Roadmap description and by using synonyms and searching keywords from relevant articles. Used search queries in different databases are presented in table 2. Same search query was used for Scopus, Web of Science, Cinahl, and PubMed but due to restrictions in IEEE database search, search query was formulated differently for IEEE database. Searches were conducted during

January to March in 2017. Even scoping review doesn't set limitation to search completion it was decided that no new studies are added after March 2017 to selected studies to get Master's thesis finalized on time.

Table 2 Used search queries by databases

Database	Search query	Number of studies
Scopus Web of Science Cinahl Pubmed	(mhealth OR telehealth* OR telemonitoring OR ehealth OR e-health OR telemedicine OR "health system*" OR "health care information system*" OR "health informat*" OR "electronic health" OR "medical informat*") AND ("user-cent* design" OR "user cent* design" OR "holistic approach" OR "participatory design" OR "participatory development" OR cehres OR "persuasive design" OR "persuasive technology" OR "business model*"))	695 359 32 443
IEEE	((mhealth OR telehealth* OR telemonitoring OR EHealth OR E-Health OR telemedicine OR "electronic health") AND ("user-centered design" OR "user centred design" OR "user-centred design" OR "user centered design" OR "participatory design" OR "participatory development" OR "persuasive design" OR "persuasive technology"))	40

Only publications published from year 2011 onwards were included because that is the year when CeHRes Roadmap was published. The search was limited to articles in English because translating of material was not possible. Database search in Scopus, Web of Science, IEEE, Pubmed and Cinahl produced together 1569 articles and after duplicates were removed, 1004 articles were identified. Duplicate removal was done using Microsoft Excel. First duplicates were removed by using remove duplicates feature in Microsoft Excel. Due to small differences in spelling, automatic feature to remove duplicates did not identify all duplicates and therefore rest of the duplicates were removed manually by sorting table alphabetically by title and then manually removing duplicate rows. To identify additional relevant articles for this research, reference list of already selected articles was explored and citation search for article by van Gemert-Pijnen et al. (2011) was performed.

4.3 Study selection

To select suitable studies from search results requires defining inclusion and exclusion criteria (Arksey & O'Malley, 2005). In database search phase inclusion criteria of year and language were used and studies published before 2011 with other language than English were excluded. Addition to these, other inclusion criteria were required for first review of database search results to identify studies that answer research question. In first phase to review database search results, titles, and abstracts were screened and included only studies that were using CeHRes Roadmap. For all studies, it was not possible to detect CeHRes usage already in abstract and for promising publications also introduction paragraphs were screened. Eleven studies were identified from database search results to be relevant to this research. Study selection process is shown in Figure 2. Low rate of detected studies via database search was due to diversity of used keywords in studies. Studies from medicine area were using keywords related to concerned health field e.g.

diabetes or cancer and because health field was not used as search criteria those were not identified in database search. Reference and citation search of found studies revealed to be efficient method for identifying studies utilizing CeHRes Roadmap. Process of searching and identifying relevant studies is presented in Figure 2.

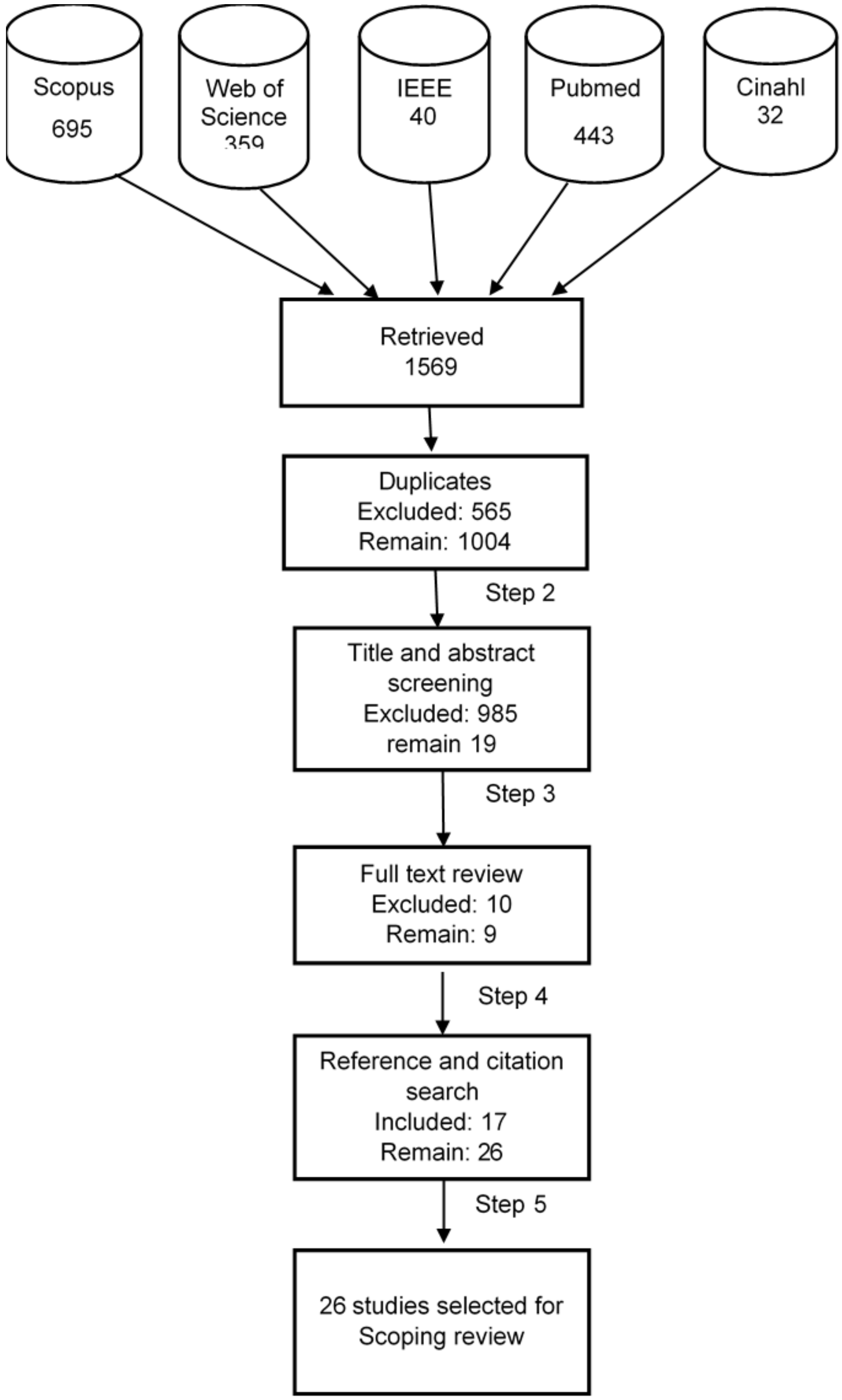


Figure 2 Process of searching and identifying relevant studies

4.4 Charting the data

To gather key issues and themes from selected studies data charting form creation is required (Arksey & O'Malley, 2005). The data charting form were created using MS Excel program. According to Arksey and O'Malley (2005) it requires decisions and consideration of what types of data is gathered from selected studies that data is useful for the readers. Data charting form included following information:

- Author(s), title of the study, year of publication, publisher.
- Study location, used technology, medical domain, and description of developed eHealth solution.
- CeHRes attributes (participatory development, persuasive design techniques, and business modelling), CeHRes Roadmap steps (Contextual inquiry, Value specification, Design, Operationalization, and Summative evaluation), and used methods.

General data was used to identify the studies. To understand how widely CeHRes Roadmap has been adopted information of study location, used technology, medical domain, and description of developed of eHealth solution were gathered. Because CeHRes Roadmap was not designed to specific eHealth technology, information of used technology variant was collected to get insight which technologies have been used in projects using CeHRes Roadmap. Technologies were categorized by using variants of eHealth technologies presented by Krijgsman and Klein (2012) (as cited in van Gemert-Pijnen et al. (2013)). Collecting technology information from the studies gave also insight of complexity of development because complexity of development increases the more technologies are involved. Medical domain in chart explain how widely in the medical field CeHRes Roadmap has been adopted and how widely in medical field eHealth technology has been used. Description of developed eHealth solution were included to get general view of eHealth technology project's content, which have used CeHRes Roadmap in development work.

Because CeHRes Roadmap is based on participatory development approach, persuasive design techniques and business modelling, also those attributes were added to data charting form to illustrate if those elements were found from studies. Attributes were not found from all studies and field was then left empty. Different CeHRes steps (Contextual inquiry, Value specification, Design, Operationalization, and Summative evaluation) were identified from studies and added to the chart to express utilization of used CeHRes steps and to give insight that how those were used in eHealth technology development. All studies were not describing used steps clearly and for those studies fields were left empty. Lack of all steps in research was explained by the fact that some researches concentrate only to one specific part of the roadmap and were not going through whole roadmap. Different methods can be used in CeHRes Roadmap steps and those are not restricted by the roadmap. Used methods on each study were presented in column methods. Gathered information was used for analysing how CeHRes Roadmap has been utilized in studies.

Three charts were created to help analysing the result. First chart presented in Appendix A contained general data of studies, author(s), title, publication year and publisher and that was merely used to identify studies. Some studies were combined in analysis phase because those were identified to contain information of same research but maybe from different phase or from different aspect. Separate IDs were defined for the studies for identification purposes. Second chart in Table 3 contained location, used technology, medical domain, and description of developed eHealth technology solution. This chart was used for analysing where CeHRes Roadmap has been used in geographically, which technologies have been identified and which medical domains have utilized CeHRes Roadmap in development work. Third chart in Table 4 contained CeHRes attributes, steps and used methods and that information was used for analysing how CeHRes Roadmap has been used in selected studies and to define the main key characters of CeHRes Roadmap.

Table 3 Study location, technology, and medical domain information

ID	Study location	Technology	Medical domain	Description
S1	Netherlands	W, M, S	Cancer	Application to self-monitor symptoms and web-based portal for physical exercise program
S2	Netherlands	W	Infection Control	Application to improve antibiotic prescribing by providing information of patients, medicine, work practices and protocols
	Netherlands		Infection Control	
	Netherlands		Infection Control	
S3	Netherlands	W, M, H	Infection Control	Application to support nursing homes during registration of clients during prevalence measurements of HAIs
S4	Australia	M, H	Palliative care	Self-reporting of symptoms
S5	Netherlands	W	Cancer	Self-care application providing information, education, troubleshooting, exercise programs and diary.
S6	Netherlands	W	Depression	Web based intervention application for preventing depression
S7	Denmark	W	Down syndrome screening	Provide information of Down syndrome screening to support decision making
S8	Sweden	W	Cancer	Self-care application for cancer patients to mitigate sexual problems and fertility-related distress
S9	Netherlands	W	Knee and hip osteoarthritis	Application to promote physically active lifestyle
S10	Spain	W, BI	Diabetes	Set of tools that improves diagnosis, assessment, and management of diabetes
	Spain		Diabetes	
S11	Netherlands	W, M	Chronic pain	Program to prevent relapse
S12	England	M, H	Cancer	Remote patient self-monitoring system
S13	Netherlands	M	Tick bites	Promotes checking for tick bites and instruct treatment, gives alerts based on location
S14	Netherlands	W, B2B	Infection prevention	
S15	Netherlands	W, BI	Dementia	Web tool to facilitate shared decision making
	Netherlands		Dementia	
S16	Netherlands	W	Depression	
S17	Netherlands	W	Depression	Web based instrument to assist blended care setups and decision
S18	Netherlands	W, BI	Infection control	Set of tools that provide education, document sharing, decision aids, and monitoring, depending on the needs of stakeholder
S19	Canada	W, H	STTBI	Program for evaluating STBBI risk, educate, and recommend, print laboratory requisition
S20	Netherlands	W, HR	Diabetes	Personal health data, self-monitoring, education, and coaching
S21	Netherlands	D	Dementia	
S22	Netherlands	WC	Dementia	

W = Web, M= Mobile, H= Health Information Exchange, S=Sensors, gateways, and wearable, HR=Health records, B2B=Business to business, BI=Business Intelligence, D=Domotics, V=Video communication

Table 4 Key characteristics of selected studies

ID	Attributes*	CeHRes Steps **	Methods
S1	a, b	not clearly defined	Semi-structured interviews including mock-ups, focus groups, scenario evaluation. Prototype design, usability evaluation using thinking-aloud tasks and interviews
S2	a, b, c	1,2,3,5	Focus groups, literature review, interviews, scenarios, observation, card sorting task, scenario-based information searching task, prototype evaluation, expert opinions, workshops, critical decision process, needs assessment
S3	a, b, c	1, 2, 3	Expert discussion, questionnaire, In-Depth interviews, scenario-based tests
S4	a, c	1, 2, 3	Meetings, workshops, Process descriptions
S5	a, b	not clearly defined	Focus group interview, prototyping, think-out-loud tasks during end user and expert user usability evaluation
S6	a, b, c	1, 2, 3	Literature review, discussion in project team, Interviews and rapid prototyping, prototype creation, scenario-based think aloud protocols with users, cognitive walkthrough with experts
S7	a, b, c	1, 2, 3, 4, 5	Literature review, interview, focus group interview, field observation, prototype creation, evaluation of prototype
S8	a, b	3, 4, 5	Meetings including group discussions and plenary discussions, mock-ups
S9	a, b, c	1, 2, 3,	Interviews, focus groups and discussions, content scenarios
S10	a, b, c	1, 2	Meetings, focus groups, business model canvas, Analytic Hierarchic Process, workshops, prototype, heuristic analysis, walkthrough, usability tests
S11	a, b	1, 2, 3	Focus group discussions, Rapid prototyping, semi-structured interviews, scenario based think-aloud protocol
S12		not clearly defined	
S13	a, b, c	1, 2, 3	Interviews, focus groups, personas, scenarios
S14	a, c	1, 2	Literature scan, expert recommendations, snowball sampling, interviews, survey, semi-structured interviews
S15	a, b, c	3	Focus group sessions with mockups, cognitive walkthroughs, usability tests
		2	Interviews, focus group interviews, expert consultation, workshops
S16	a, c	1, 2	Delphi method, explorative and confirmative surveys, Interviews
S17	a	not clearly defined	Literature review, focus groups, interviews,
S18	a, c	5	Log file analysis of usage (datamining, content analysis, card-sorting)
S19	a, b	not clearly defined	Literature review, expert consultation, user consultation, usability testing,
S20	a	1, 2, 5	Interviews
S21		5	Field trial, interviews, observations during project group meeting, diary, cost analysis
S22		5	Log files of system use, interviews, a focus group, observations during project groups meeting and a cost analysis.

* a= User-centered design, b= Persuasive design techniques, c=Business modeling
** 1= Contextual inquiry, 2= Value specification, 3= Design, 4= Operationalization, 5= Summative evaluation

4.5 Collating, summarising, and reporting the results

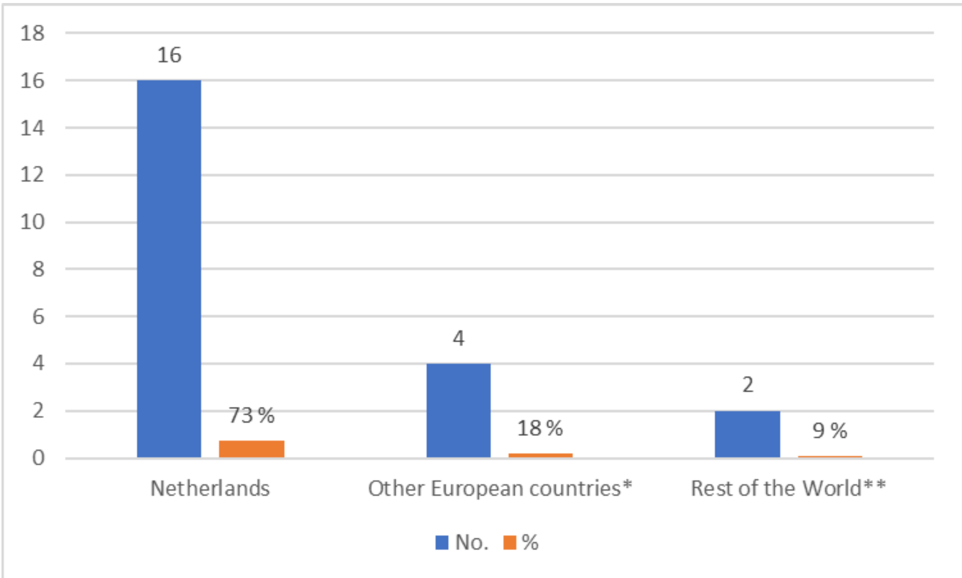
After data was charted, it was possible to analyse included studies. Narrative analysis was done using basic numerical analysis including charts and diagrams, and organizing selected studies thematically. Basic numerical analysis was done for location and medical domain information from studies included in the review. Charts for presenting geographical distribution and medical domains utilizing CeHRes Roadmap were generated using MS Excel program. Purpose was to present which areas have adopted CeHRes Roadmap into use both geographically and medically. Studies were organized thematically in two different ways. First studies were organized based on CeHRes Roadmap characteristics, participatory development, persuasive design techniques and business modelling to get insight that how widely all these three characteristics were visible in the studies. Secondly studies were organized based on project phases. CeHRes Roadmap has five steps, and these were divided to three categories: design and development, implementation, and evaluation. First three steps from CeHRes Roadmap were merged into “design and development” category because those were commonly used together in the studies and include the design and development tasks. Category “Implementation” includes operationalization step from CeHRes Roadmap which consist of actions required for taking solution into daily use. Evaluation between steps is important part in CeHRes Roadmap and therefore both formative and summative evaluations were considered in “Evaluation” category even formative evaluation is not own step in CeHRes Roadmap but rather intertwined element of each step.

5. Results

This chapter presents results from charted data. From the initial 1569 search results, 26 were identified to be relevant for this scoping study. After full reading, some studies were identified to concern same research topic but from different phase and those were considered in analysis as one study. Results are presented to answer research question "What is known in literature about CeHRes Roadmap utilization in development projects in eHealth technology area?". Question was answered narratively using tablets and charts, and thematically using categories.

5.1 Geographical distributions of studies utilizing CeHRes Roadmap

Figure 3 shows geographical distribution of studies using CeHRes Roadmap in eHealth technology development by country. The majority of the studies using CeHRes have been published in Netherlands (73 %) and this is probably explained by the fact that CeHRes Roadmap has been developed in Netherlands. Other European countries have used CeHRes Roadmap much less, only 18 percent of found studies. It was pleasing to notice that CeHRes Roadmap has been accepted also outside Europe and studies from Australia and Canada where found that were using CeHRes Roadmap though amount is still low.



* Denmark (1); England (1); Spain (1); Sweden (1)
** Australia (1); Canada (1)

Figure 3 Geographical distribution of studies utilizing CeHRes Roadmap (N=22)

Even CeHRes Roadmap has not been utilized yet widely outside Netherlands, article by van Gemert-Pijnen et. al. (2011) has been cited often. Google Scholar shows 316 citations, Scopus 135 citations, Web of Science 104 citations and PubMed 96 citations just to mention few databases. Citation count was taken on June 2017 from the databases. Analysis tools in Scopus show how citations are divided between countries. Figure 4 compares ten most cited countries and how citation counts are divided between them.

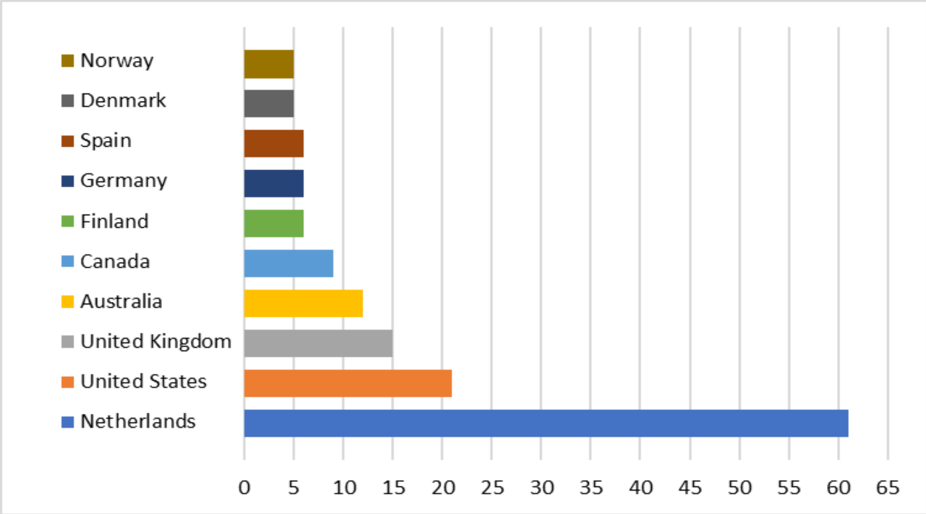
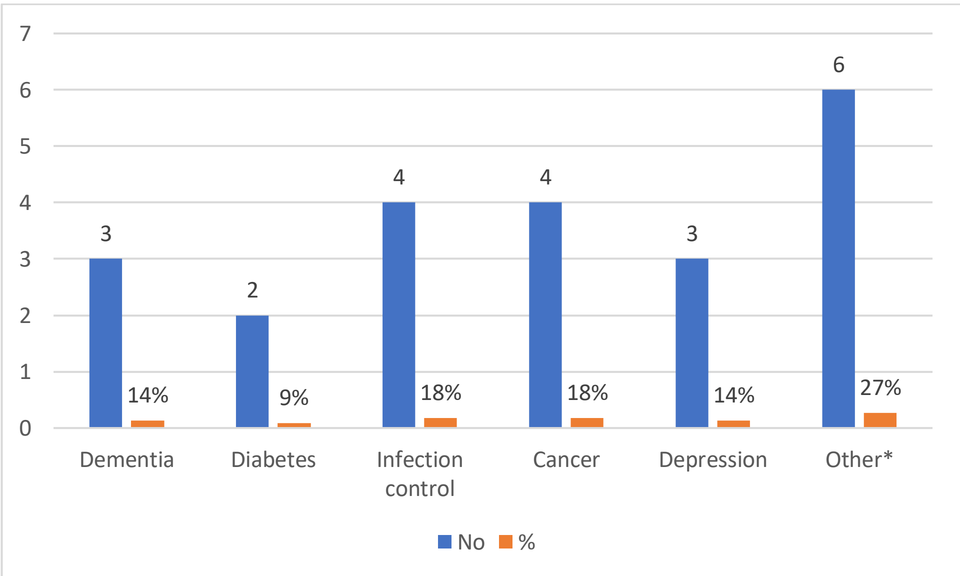


Figure 4 Citations by country (figures from Scopus)

Most of the citations have been done in Netherlands but CeHRes Roadmap has been noticed also in United States where over twenty citations have been done. Thus, the CeHRes Roadmap has not been used yet very widely it has been recognized outside Netherlands and Europe and it has been cited in 29 different countries altogether.

5.2 Medical domains using CeHRes Roadmap

Figure 5 shows number of studies for each medical domain group and illustrates CeHRes Roadmap usage in different domains. Eleven different medical domains were identified utilizing CeHRes Roadmap for development and evaluation. Medical domains having only one study included in selected studies are shown in category other.



* Palliative care (1); Down syndrome screening (1); Knee and hip osteoarthritis (1); Chronic pain (1); Tick bites (1); STTBI (1)

Figure 5 Medical domains using CeHRes Roadmap (n=22)

Most popular CeHRes usage has been in infection control and cancer interventions. In infection control area eHealth technology has been used for controlling antibiotic usage, reporting infectious diseases, and providing information and decision aid. Both web and mobile technologies has been used for Infection control solutions. Altogether six studies were found concerning infection control and three of those were regarding antibiotic information application (J. Wentzel, Van Limburg, Karreman, Hendrix, & Van Gemert-Pijnen, 2012; J. Wentzel et al., 2014; M. J. Wentzel, Jong, Nijdam, e-Pierik, & Gemert-Pijnen, 2014) and were considered as one in analysis phase. Other studies were concerning registration and monitoring of Health-care associated infections (Beerlage-de Jong, Eikelenboom-Boskamp, Voss, Sanderman, & van Gemert-Pijnen, 2014), zoonosis prevention and control (van Woezik, A F G, Braakman-Jansen, Kulyk, Siemons, & van Gemert-Pijnen, J E W C, 2016) and infectious disease management web platform (M. J. Wentzel, Karreman, & van Gemert-Pijnen, 2011). Infectious disease management web platform contains several tools e.g. antibiotic information tool but those were considered as separate studies because development was done independently for every tool and Infectious disease management web platform gathered tools together to ease usage.

eHealth technologies used in cancer treatment were providing information, self-care, and monitoring services for patients after diagnosis to support recovery. Two studies were identified for lung cancer (Maguire et al., 2015; Timmerman et al., 2016) for monitoring symptoms and providing self-exercises using mobile and web technologies. For laryngeal cancer (Cnossen et al., 2016) web technology was used for providing information, education, exercise programs, and troubleshooting. Web-based intervention (Winterling et al., 2016) for providing information about sexual problems and fertility after cancer diagnoses was developed to support young cancer patients generally and not targeting to any specific cancer disease.

For dementia altogether four studies were found but two of those were concerning same research topic, shared decision making web tool (Span et al., 2014a; Span et al., 2014b), from different phases and were therefore considered as one in analysis. In dementia, along with web solutions also sensor and touch screen devices were used. Sensor technology (Nijhof, van Gemert-Pijnen, Woolrych, & Sixsmith, 2013) allows monitoring elderly people in their homes and enables them to stay home longer. Touch screen devices (Nijhof, van Gemert-Pijnen, Burns, & Seydel, 2013) provides information for elderly and allows communication between family and caregivers.

For depression, web based solutions were utilized to prevent depression (Kelders, Pots, Oskam, Bohlmeijer, & Van Gemert-Pijnen, 2013), supporting face to face treatment (van der Vaart et al., 2014), and providing decision support tool (J. Wentzel, van der Vaart, Bohlmeijer, & van Gemert-Pijnen, 2016) for deciding possibility to use web solutions together with face to face sessions.

Only one study regarding palliative care, down syndrome screening, knee and hip osteoarthritis, chronic pain, tick bites and sexually transmitted and blood-borne infections (STTBI) was found. Studies had several purposes for eHealth solutions such as symptom reporting from home care (Tieman, Morgan, Swetenham, To, & Currow, 2014), support decision making (Skjøth et al., 2015), promoting lifestyle and behaviour change (Fledderus, Schreurs, Bohlmeijer, & Vollenbroek-Hutten, 2015; van der Vaart et al., 2014; van Velsen, Beaujean, Desirée J M A, Wentzel, Van Steenbergen, & van Gemert-Pijnen, Julia E W C, 2015), and evaluating risks and providing recommendations (Gilbert et al., 2016).

5.3 Medical domains of studies according to used technology

Used technologies on the studies are categorized using variants of eHealth technologies presented by Krijgsman and Klein (2012) (as cited in van Gemert-Pijnen et al., 2013). eHealth variants are web, mobile, health information exchange, sensors, gateways, and wearable, business to business, business intelligence, domotics, and video communication. Descriptions of variants are described in table 5.

Table 5 Descriptions of eHealth technologies

Technology	Description
Web	Applications used via web browser and can be used independent from time and place.
Mobile	Applications available on smart phones and/or tablet-PC.
Health Information Exchange	Integrated networks for exchanging medical information.
Sensors, gateways, and wearable	Devices used for measuring and recording automatically vital physical functions and transmit data to medical professionals.
Business to business	Integrated networks to exchange data between collaborating partners.
Business intelligence	Systems that analyse data to create information for decision support.
Health records	Medical-administrative systems for health-care professionals to record, document, consult, or share medical information. Can be divided to Electronic health records managed by professionals, and personal health records managed by patients.
Domotics	Automation of home processes usually with sensors, e.g. for emergency alarming or self-management support
Video communication	Video communication, vide conference etc. to enhance relationship between patient and care taker.

eHealth solutions can utilize several eHealth technology variants together described in table 5. Figure 6 presents proportion of studies using different amount of technology variants. Half of the studies were using only one technology variant, and only 9% were using three different technology variants. No studies were found using more than three different technology variants. Use of different technology variants in same eHealth solution refers to complexity of eHealth solution (van Gemert-Pijnen et al., 2013).

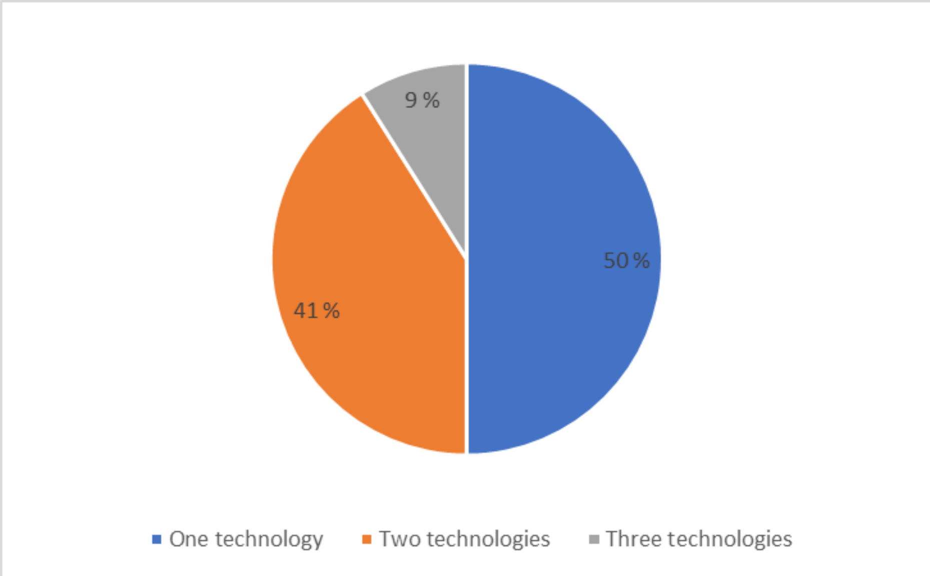


Figure 6 Proportion of studies using different amount of technologies

Table 6 shows the number of studies by medical domain for used technology variant. Same study can have several different technology variants. Medical domains having only one study included in selected studies are shown in category other.

Table 6 Medical domains of studies according to used technology

	Web	Mobile	Health Information Exchange	Sensors, gateways, and wearable	Business to business	Business Intelligence	Health records	Domotics	Video Communication	Number of different variants
Dementia	1 (S15)	-	-			1 (S15)		1 (S21)	1 (S22)	4
Diabetes	2 (S10, S20)	-	-			1 (S10)	1 (S20)			3
Infection Control	4 (S2, S3, S14, S18)	1 (S3)	1 (S3)		1 (S14)	1 (S18)				5
Cancer	3 (S1, S5, S8)	2 (S1, S12)	1 (S12)	1 (S1)		-				4
Depression	3 (S6, S16, S17)	-	-			-				1
Other**	4 (S7, S9, S11, S19)	3 (S4, S11, S13)	2 (S11, S19)			-				3
Total No	17	6	4	1	1	3	1	1	1	
Total %	77%	27%	18%	5%	5%	14%	5%	5%	5%	

* Palliative care[S4] (1); Down syndrome screening[S7] (1); Knee and hip osteoarthritis[S9] (1); Chronic pain[S11] (1); Tick bites[S13] (1); STTBI[S19] (1)

Majority of the studies (77%) were using web technology. Infection control were utilizing different technology variants diversely and using five different technology variants. All solutions were using web but also mobile, health information exchange, business to business, and business intelligence solutions were used. Dementia and cancer medical domains were the second more diverse medical domains using four different technology variants. In medical domain of cancer mostly used technology was web and one study combined web with mobile and body sensors (Timmerman et al., 2016) and one study did not use web but mobile and health information exchange (Maguire et al., 2015) to monitor patient health condition in home care. Dementia used web only in one of the studies (Span et al., 2014a; Span et al., 2014b) along with business intelligence for providing decision support. Other solutions contained domotics (Nijhof et al., 2013) and video communication (Nijhof et al., 2013) technologies for supporting dementia patients to stay home longer. In diabetes three different technology variants were used and all solutions contained web technology that was combined with other technologies. Depression was only medical domain using only web technology and it did not combine any other technologies.

The low cost of web based solutions probably explains popularity of web based eHealth solutions because it does not require any additional applications or devices and computers usually have web browser. Domotics and video communication technologies that were utilized in dementia care require more investments on devices and that generates more cost pressure on research projects. Nature of dementia as medical field is such that it requires solutions such as sensors and other long-distance monitoring technology due to patients' ability to use technology. Dementia is usually diagnosed with older people who are not used to use technology and due to their disease learning is difficult. Use of mobile technology was rather low despite increasing number of mobile users (Fehske, Fettweis, Malmodin, & Biczok, 2011) that is creating huge potential for exploiting mobile health solutions. Reason could be challenges in security and identification, interoperability of systems, data ownership, and multilayer infrastructure that can slow down development of mobile health solutions (Adibi, 2012).

5.4 Characteristics of CeHRes Roadmap on studies

CeHRes Roadmap is based on participatory development approach, persuasive design techniques and business modelling (van Gemert-Pijnen et al., 2011). Although roadmap is based on these elements, those were not utilized or visible in actual usage. Table 7 shows how CeHRes Roadmap characteristics were utilized on selected studies.

Table 7 Studies by identified CeHRes Roadmap characteristics

	All studies	
	N (22)	%
Participatory development	19 (S1-S11, S13-S20)	86 %
Persuasive design	13 (S1-S3, S5-S7, S13, S15, S19)	59 %
Business modelling	12 (S2-S4, S6, S7, S9, S10, S13-S16, S18)	55 %

Most of the studies (86 %) were based on participatory development approach and that was the common theme and quite well documented in the studies. Participatory development approach in CeHRes Roadmap was so strong that studies by Cnossen et al. (2016) and Timmerman et al. (2016) were referencing to CeHRes Roadmap when discussing about participatory development approach. Some studies reported only evaluation step from CeHRes Roadmap and those did not include participatory development approach.

Persuasive design techniques were not documented so clearly than participatory development approach. Even persuasive design techniques were not documented on studies, persuasiveness in eHealth solution were visible on studies and persuasive aims were reported. As an example of documenting persuasive design techniques to study is study by Beerlage-de Jong et al. (2014) that is incorporating elements of PSD model by Oinas-Kukkonen and Harjumaa (2009) to eHealth technology design process in user-centered manner not using all PSD elements but only relevant ones. Studies by Fledderus et al. (2015), Span et. al (2014a), and Wentzel et. al (2014) were evaluation design against persuasive design techniques. All studies did not have design step and that also explains why persuasive design techniques were not utilized in all studies.

Business modelling is considering stakeholder identification and their value recognition and creating business model through that information and therefore business modeling characteristics were regarded for all studies introducing value specification step. Although value specification step was introduced in the study, that did not necessarily mean that business modeling approach was explained clearly in study. None of the studies explained business model creation itself but few studies mentioned, that business model creation is planned (Beerlage-de Jong et al., 2014; Fico & Arredondo, 2015; J. Wentzel et al., 2012; M. J. Wentzel et al., 2011).

5.5 Categorizing CeHRes Roadmap usage in studies

CeHRes Roadmap has five steps: contextual inquiry, value specification, design, operationalization, summative evaluation (van Gemert-Pijnen et al., 2011). Steps were categorised by merging contextual inquiry, value specification and design to category "Design and development", fourth step operationalization was considered as category "Implementation", and last step summative evaluation was combined with formative evaluation to be category "Evaluation". Table 8 shows how categories are present on studies.

Table 8 Studies divided to categories

	All studies	
	N (22)	%
Design and development	18 (S1-S11, S13-S16, S18-S20)	82 %
Implementation	2 (S7, S19)	9 %
Evaluation	14 (S1, S2, S5-S10, S15, S18-S22)	64 %

First three steps from CeHRes Roadmap were merged into “Design and development” category because those were commonly used together in the studies and include the design and development tasks. Evaluation between steps is important part in CeHRes Roadmap and therefore both formative and summative evaluations were considered in “Evaluation” category even formative evaluation was not own step in CeHRes Roadmap but rather intertwined element of each step. 64% of the studies contained evaluation tasks. Studies, such as (Nijhof et al., 2013; Nijhof et al., 2013; M. J. Wentzel et al., 2011) were utilizing CeHRes Roadmaps evaluation steps for already implemented eHealth solutions to get insight of feasibility and usage of solution and possible improvements that can be used as starting point for contextual inquiry step in potential new project. Most of the studies (82 %) were utilizing CeHRes Roadmap to carry out design and development tasks which include first three steps of CeHRes Roadmap. Those form the basis for eHealth technology development project via user requirement determination and prototyping and therefore those were used in almost every study. Few studies used only evaluation step from CeHRes Roadmap and those did not include design and development steps. Three of the studies (Cnossen et al., 2016; Gilbert et al., 2016; Timmerman et al., 2016) did not explain exactly used CeHRes steps using same naming but it was clearly detectable that study contained design and development activities and therefore those were included to category. Two of the studies (Maguire et al., 2015; J. Wentzel et al., 2016) were referring for using CeHRes Roadmap in their study but still it stayed unclear that how it was utilized and phases were not described. Implementation was not described very clearly on studies and only two of the studies contained trace of implementation. Study of Down syndrome screening (Skjøth et al., 2015) implemented public web page for pregnant women to support decision of down syndrome screening. Study did not describe implementation phase very clearly, but it was mentioned to been carried out. Study of web portal for STTBI diseases education and treatment recommendations (Gilbert et al., 2016) described preparation activities that were required for implementation related to privacy and security, IT support, operational protocols, reporting, communications, and final validation.

5.6 Used methods on studies

CeHRes Roadmap enables using different methods in design, development and evaluation phases depending on what is suitable for each project. Table 9 shows which methods have been applied on selected studies. For design and development phase van Gemert-Pijnen et. al. (2011) were mentioning several different methods that could be used with CeHRes Roadmap but for implementation and evaluation methods were not described only what the phase should achieve.

Table 9 Used methods on studies

	Design and development	Implementation	Evaluation	Proportion of studies
Interviews	14 (S1- S3, S5-S7, S9, S11, S13-S17, S19)		5 (S2, S7, S20-S22)	86 %
Mock-ups	4 (S1, S8, S10, S15)			18 %
Workshops	4 (S2, S4, S10, S15)			18 %
Observations	2 (S2, S7)		2 (S21, S22)	18 %
Scenarios	7 (S1-S3, S6, S9, S11, S13)		1 (S1)	36 %
Prototyping	6 (S1, S5-S7, S10, S11)			27 %
Think-aloud tasks			3 (S1, S2, S5)	14 %
Literature review	6 (S2, S6, S7, S14, S17, S19)			27 %
Focus groups	10 (S1, S2, S5, S7, S9, S10, S11, S13, S15, S17)		1 (S22)	50 %
Expert consultation	5 (S2, S3, S14, S15, S19)		1 (S5)	27 %
Questionnaire/survey	3 (S3, S14, S16)			14 %
Meetings	3 (S4, S8, S10)			14 %
Cognitive walkthrough	2 (S6, S15)		1 (S10)	14 %
Log file analysis			2 (S18, S22)	9 %
Cost analysis			2 (S21, S22)	9 %
Usability tests			3 (S1, S5, S10, S15, S19)	14 %
Implementation plan		2 (S2, S8)		9 %
Other*	9 (S2, S13, S10, SS14, S16)		3 (S21, S8)	12

*Critical decision process[S2], card sorting[S2], process descriptions[S2], personas[S13], business model canvas[S10], analytical hierarchy process[S10], heuristic analysis[S10], snowball sampling[S14], Delphi method[S16], field trial[S21], diary[S21], randomized controlled trial[S8]

Most of the studies were describing which methods were used for design and development and evaluation. Implementation was not described very clearly and only couple of studies mentioned implementation plan creation, but actual implementation plan was not described. Interviews and focus groups were most usual methods used in design and development phase to gather user requirements. Altogether 86% of studies used interviews and 50% of studies used focus groups at some phase of the research. Also, scenario creation, prototyping, and literature review were popular methods for achieving design and development objectives. Interview was most common method also in evaluation phase to get feedback from the users about developed solution. Altogether 29 different methods were identified from studies which indicates that variety of suitable methods were wide. Almost all studies were using several different methods and only Personal health record study by Sieverink et al. (2014) were using only interviews for user requirement determination and evaluation.

6. Discussion

This scoping review was done to give overview of usage of CeHRes Roadmap in eHealth technology development. This chapter will discuss of CeHRes Roadmap usage based on the results presented on earlier chapter, research method used in this master's thesis, and limitations that this study has.

Usage of CeHRes Roadmap is not spread widely outside Netherlands and University of Twente where it was developed by van Gemert-Pijnen et. al. and it is not adopted for eHealth development usage in generally yet. But it was promising that CeHRes Roadmap has been used in couple of studies outside Europe and it has potential to spread into use in wider geographical area. Even CeHRes Roadmap has not been used yet very widely it has been referenced also outside Netherlands. Thus, the framework existence has been recognized even it has not been utilized yet in research and development. Great importance of participatory development approach in CeHRes Roadmap was noticeable also in cited articles and it was commonly referenced as participatory development approach. In research results it was visible that participatory development was the most common characteristics among selected studies.

Eleven different medical domains are identified from the studies using CeHRes Roadmap and that proofs how widely in health care field it can be utilized, and it is not concentrated to any specific health care field. Cancer and infection control are the most common health care fields using CeHRes Roadmap. In health care field of cancer both self-care solutions for patient's own use and solutions for interaction between health care professionals and patients are created. Infection control is concentrating on creating solutions for health care professionals use and their interaction. Health care field of dementia is providing solutions where patients, caregivers and health care professionals can communicate with each other and monitor patient's condition and enable for dementia patients to stay at home longer. Dementia as a sickness is such that it affects to patient's ability to take care of themselves and therefore it is understandable that solutions are not purely self-care solutions and require involvement from health care professionals and caregivers. In general, CeHRes Roadmap is used for creating eHealth technology solutions for patient's independent use, for interaction between patient and health care professionals, and for interaction from health care professional to another.

Web based solutions are the most represented solutions using CeHRes Roadmap. Using applications that work on web browser reduce the need to create clients that run on specific computer or operating system and this save resources on development. On health care field where several organizations might use solutions and have different kind of operating systems, use of web browser based solutions reduce compatibility issues. Use of mobile solutions in health care is second most popular technology among studies using CeHRes Roadmap but number of studies is quite low compared to the number of mobile subscriptions and sold mobile phones in whole world. There is a lot of variety in technologies that can be used in Health care and all the time new technologies are invented. Health care systems are getting smarter (Rahmani et al., 2015) and using Internet of Things, gateways, wearable sensors, and so on. Complex eHealth technology solutions can combine more than one technologies and from selected studies half were using at least two different technologies.

CeHRes Roadmap enables using different methods in development process depending on the project characters and what suites for it best. Most common element is participatory development approach and used methods in studies consider user and stakeholder view in development process. Iterative development process enables reshaping technology via user feedback and evaluation and recognizing problems before technology is fully operationalized and taken into daily use. Persuasiveness is visible in the studies even that is not documented very well. Many of the studies reported to have goal e.g. to improve health but it was not described that how that is considered in development work. Use of PSD model (Oinas-Kukkonen & Harjumaa, 2009) in the studies could have explained better persuasive aspect on design. As persuasive design techniques were one of the six principles on CeHRes Roadmap that could have been better considered on the studies. Business modelling is mainly considering stakeholder identification and value specification and using this data business models are created. Business modelling is important for eHealth technology development and adoption due to economic aspects. Development work requires money and via business modelling requirement can be justified.

There are several different eHealth frameworks in addition to CeHRes Roadmap that can be used in eHealth development project and selection of used framework is subjective. But is the development of eHealth solutions so different compared to other ICT development projects? Sure, it has own specialities such as security of personal data, laws, and processes but in the end, it is developing working technology solutions for users. Thus, should eHealth field exploit more frameworks and models from Information Processing science? DSRM for Information processing science developed by Peffers et. al. (2007) has similarities to CeHRes Roadmap's overall process. DSRM process is described in Figure 7.

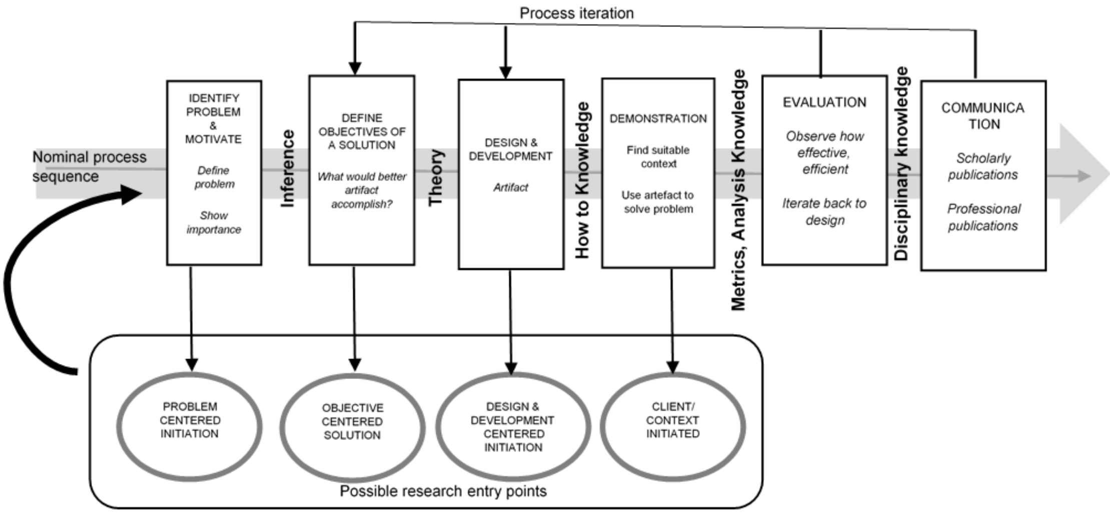


Figure 7 Design Science Research Methodology (DSRM) Process Model (Peffers et. al., 2007 Originally published in Journal of Management Information Systems)

In DSMR first two steps are defining the problem, justifying value of a solution, and determining objectives of a solution. In CeHRes Roadmap first two steps are identifying the problem, how technology could match for that, and defining values that should be reached by new solution. Third step in DSMR and CeHRes Roadmap is creating the solution or artefact. Fourth step is different and DSMR is demonstrating that solution works when CeHRes Roadmap is implementing solution to daily use and that could also be kind of demonstration. Fifth step is evaluation in both models. DSMR has also communication step in the end and purpose is to communicate results officially. DSMR is not suggesting any methods how carry out different steps like CeHRes Roadmap does, thus in that sense content is different even the main process has many similarities. CeHRes Roadmap is encouraging using participatory development and persuasive design techniques, and incorporating business modelling already from the beginning of the development process. DSMR is problem, objective, or design and development centred depending on the starting situation for the project (Peffers, Tuunanen, Rothenberger, & Chatterjee, 2007) but generally it is concentrating more on the problem that requires solution and not considering user involvement in problem and solution definition.

This can be also turned the other way around and considered whether eHealth frameworks could suite for other ICT development fields. When considering CeHRes Roadmap, that is not restricting roadmap usage for eHealth area only, even it was designed for eHealth technology. It is not concentrating to any particular technology area and it could suite well for all ICT development and steps are not restricting usage only to health care field. Six principles of CeHRes Roadmap that were explained in Chapter 2 are useful in all sort of ICT projects. Participatory development process is considering user requirements for the technology and enabling designing solutions that fit for the purpose. Participatory development might not suite for all development work if the actual users are not really known but only target user group is defined. But in situations where actual technology users are really known and can represent themselves in development work participatory approach is valuable. Iterative development with continuous evaluation ensure that user requirements are understood correctly. Iterative development is familiar also in Agile methods (Avison & Fitzgerald, 2006) that have been popular in recent years in ICT development. For avoiding surprises in implementation phase that should be considered already in development phase and implementation action plans help to execute successful implementation. Technology development can cause organizational or other changes also in other sectors than Health care and preparations for change acceptance are required. Persuasive design techniques ensure technology solutions that motivate users for desired actions and this is required also in other sectors than health care. Evaluation and impact assessment is as important in all ICT sectors as in health care sector.

This master's thesis is using Scoping review as research methodology and as far as I know it is first master's thesis in Oulu University Information processing science discipline using the method. Scoping review is aiming to map rapidly key concepts and sources of research area. According to Arksey and O'Malley (2005) there is four reasons to use Scoping review method: to examine the range of available material of research topic, to define the value of starting a full systematic review, to summarise and disseminate research findings, and to identify research gaps in the existing literature. Reason for using Scoping review research method in this master's thesis is to summarise and disseminate research findings. Holistic framework and CeHRes Roadmap presented by van Gemert-Pijnen et. al. (2011) usage is not studied earlier and scoping review method enabled broader aspect to research topic. Even the aim of scoping review is to map rapidly key issues it cannot be regarded as fast lane in master's thesis creation compared to systematic literature review. Search and study selection is like systematic literature review and that is the most time-consuming task. Study selection criteria can shape during study selection process when familiarity of literature increases. Charting the data gives overview of selected studies and it was conducted in parallel with study selection and it kept study selection more organized. Iterative approach for Scoping review framework steps is allowed and it is possible to go back and forth within the steps and this was exploit especially between study selection and data charting stages, and data charting and reporting the results stages. Used characteristics of selected studies evolved in data chart when knowledge of selected studies increased. Charting approach reflects to the reporting the results and it should be considered already in the charting phase that how reporting is intended to be carried out. Comprehensively charted data decreases demand for stepping back and forth between data charting and reporting the results stages and simplify research process. Even some researches claim that scoping review shouldn’t be used as research method for independent research, I consider this method to suite well also for master’s thesis when the subject is novel and broad enough.

6.1 Limitations

This scoping review is conducted following guidelines by Arksey and O’Malley (2005) trying to cover all possible studies considering CeHRes Roadmap. Still the main limitation in this research concern the conducted search. Search is limited to certain databases and therefore all relevant studies might not be found. Due to the multidisciplinary nature of research topic defining suitable search queries were difficult and most of the studies were found using reference and citation search. Other limitation of this scoping review is that no quality assessment has been done for selected studies. Scoping review does not require quality assessment and it is not restricted to any specific type of studies (Arksey & O'Malley, 2005) compared to systematic literature review where quality assessment is important part of study selection. According to Grant and Booth (2009) lack of quality assessment can limit the uptake scoping review findings.

7. Conclusion

Development of eHealth technology is complex because it is multidisciplinary in nature and development needs to combine health care field, computer science, and information science. Use of eHealth technology brings financial and social benefits and increases transparency in patient treatment when patients are more involved in their own care. Challenges in eHealth development are large investment costs, inadequate design, legal clarity, and insufficient knowledge and confidence on eHealth solutions among patients and healthcare professionals that is causing adoption problems. To overcome these problems researchers in University of Twente has created holistic framework and CeHRes Roadmap that guide eHealth development. Holistic framework consists from six principles that are promoting eHealth development and CeHRes Roadmap presents development and research activities.

The purpose of this master's thesis is to give overview where and how CeHRes Roadmap has been utilized and how widely it is adopted in usage in eHealth technology field. Using scoping review research method 26 studies were identified using CeHRes Roadmap in eHealth technology development. Results from this research indicated that CeHRes Roadmap is not adopted into research use very widely outside Netherlands but still it is recognized and referenced in hundreds of studies. According to van Gemert-Pijnen et al. (2011) CeHRes Roadmap is not restricting usage to specific technology or medical field and it is usable in all kind of eHealth technology development projects. Altogether eleven different medical domains and ten different technologies were identified from the studies. Same study could utilize several technologies and half of the selected studies included at least two different technologies. Variety of different technologies and medical domain in the studies demonstrated that it is suitable for wide range of technologies and medical domains. CeHRes Roadmap is combining participatory development approach, persuasive design techniques, and business modelling. Participatory development approach is the most essential part of the CeHRes Roadmap and it was present almost in all selected studies. Among the selected studies and referenced articles CeHRes Roadmap was commonly nominated as participatory development approach.

Selected research method in this study was Scoping review by Arksey and O'Malley (2005) and usage of this research method gave insights how suitable method is for master's thesis as it has not been used in Oulu University Information Processing discipline. Because the research question was broad in nature and topic was recent Scoping review was suitable research method and it allowed to get general view of the subject. Scoping review's aim is to recognize key concepts of research subject in relatively short time, but it cannot be regarded as easy research method. Iterative approach allows coming back to previous step when knowledge of subject increases and new ideas appear. There is risk that research is not proceeding if researcher keeps going back and forth of the steps. It requires decisions when to proceed and when to go back to previous step and not let the increased knowledge to change research focus. But overall scoping review as research method can be suggested for broad topics.

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Appendix A. General data of selected studies

Nro	ID	Author(s)	Title	Year	Publisher
1	S1	Timmerman, J. G., Tönis, T. M., Dekker-van Weering, Marit G H, Stuiver, M. M., Wouters, Michel W J M, van Harten, W. H., Hermens, H.J., Vollenbroek-Hutten, M.M.R.	Co-creation of an ICT-supported cancer rehabilitation application for resected lung cancer survivors: design and evaluation	2016	BMC Health Services Research
2	S2	Wentzel, J., van Velsen, L., van Limburg, M., de Jong, N, Karreman, J., Hendrix, R., van Gemert-Pijnen, J.E.W.C.	Participatory eHealth development to support nurses in antimicrobial stewardship	2014	BMC Medical Informatics and Decision Making
3		Wentzel, J., van Limburg, M., Karreman, J., Hendrix, R., van Gemert-Pijnen, J.E.W.C.	Co-creation with Stakeholders: A Web 2.0 Antibiotic Stewardship Program	2012	Proceedings of the Fourth International Conference on EHealth, Telemedicine, and Social Medicine
4		Wentzel, J., de Jong, N., van Gemert-Pijnen, J.E.W.C., Nijdam, L., van Drie-Pierik, R.	Understanding eHealth use from a Persuasive System Design Perspective: An Antibiotic Information Application for Nurse	2014	International Journal on Advances in Life Sciences
5	S3	Beerlage-de Jong, N., Eikelenboom-Boskamp, A., Voss, A., Sanderman, R., van Gemert-Pijnen, J.E.W.C.	Combining user-centered design with the persuasive systems design model: The development process of a web-based registration and monitoring system for healthcare-associated infections in nursing homes	2014	International Journal on Advances in Life Sciences
6	S4	Tieman, J. J., Morgan, D. D., Swetenham, K., To, T. H. M., & Currow, D. C.	Designing Clinically Valuable Telehealth Resources: Processes to Develop a Community-Based Palliative Care Prototype	2014	Journal of Medical Internet Research
7	S5	Cnossen I.C., van Uden-Kraan C.F., Eerenstein S.E.J., Rinkel R.N.P.M.,	A Participatory Design Approach to Develop a Web-	2016	Folia Phoniatrica et Logopaedica

		Aalders IJ.J., van den Berg K., de Goede C.J.T., van Stijgeren A.J., Cruijff-Bijl Y., de Bree R., Leemans C.R., Verdonck-de Leeuw I.M.	Based Self-Care Program Supporting Early Rehabilitation among Patients after Total Laryngectomy		
8	S6	Kelders, S.M., Pots, W.T., Oskam, M.J., Bohlmeijer, E.T., Van Gemert-Pijnen, J.E.	Development of a web-based intervention for the indicated prevention of depression	2013	BMC Medical Informatics and Decision Making
9	S7	Skjøth, M. M., Hansen, H. P., Draborg, E., Pedersen, C. D., Lamont, R. F., & Jørgensen, J. S.	Informed Choice for Participation in Down Syndrome Screening: Development and Content of a Web-Based Decision Aid	2015	JMIR research protocols
10	S8	Winterling, J., Wiklander, M., Micaux Obol, C., Lampic, C., Eriksson, L.E., Pelters, B., Wettergren, L.	Development of a Self-Help Web-Based Intervention Targeting Young Cancer Patients With Sexual Problems and Fertility Distress in Collaboration With Patient Research Partners	2016	JMIR research protocols
11	S9	Kelders, S.M., Kok, R.N., Ossebaard, H.C., van Gemert-Pijnen, J.E.W.C.	A Blended Intervention for Patients With Knee and Hip Osteoarthritis in the Physical Therapy Practice: Development and a Pilot Study	2016	JMIR research protocols
12	S10	Fico G, Arredondo MT. .	Use of an holistic approach for effective adoption of User-Centred-Design techniques in diabetes disease management: Experiences in user need elicitation.	2015	Annual International Conference of the IEEE Engineering in Medicine and Biology - Proceedings
13		Fico, G., Hernandez, L., Cancela, J., Arredondo MT.	User Centered Design to incorporate predictive models for Type 2 Diabetes screening and management into professional decision support tools: preliminary results	2015	IFMBE Proceedings

14	S11	Fledderus, M., Schreurs, K.M.G., Bohlmeijer, E.T., Vollenbroek-Hutten, M.M.R.	Development and Pilot Evaluation of an Online Relapse-Prevention Program Based on Acceptance and Commitment Therapy for Chronic Pain Patients	2015	Journal of Medical Internet Research
15	S12	Maguire, R., Ream, E., Richardson, A., Connaghan, J., Johnston, B., Kotronoulas, G., Pedersen, V., McPhelim, J., Pattison, N., Smith, A., Webster, L., Taylor, A., Kearney, N.	Development of a Novel Remote Patient Monitoring System	2015	Cancer Nursing
16	S13	van Velse, L., Beaujean, D.J.M.A., Wentzel, J., Van Steenbergen, J.E., van Gemert-Pijnen, J.E.W.C.	Developing requirements for a mobile app to support citizens in dealing with ticks and tick bites via end-user profiling	2015	Health Informatics Journal
17	S14	van Woezik, A.F.G., Braakman-Jansen, L.M.A., Kulyk, O., Siemons, L., van Gemert-Pijnen, J.E.W.C.	Tackling wicked problems in infection prevention and control: a guideline for co-creation with stakeholders	2016	Antimicrobial Resistance and Infection Control
18	S15	Span, M., Smits C., Groen-van de Ven, L., Jukema, J., Vernooij-Dassen, M., Hettinga, M., Janssen, R., Eefsting, J.	An Interactive Web Tool to Facilitate Shared Decision Making in Dementia: Design Issues Perceived by Caregivers and Patient	2014	International Journal on Advances in Life Sciences
19		Span, M., Smits C., Groen-van de Ven, L., Jukema, J., Cremers, A., Vernooij-Dassen, M., Eefsting, J., Hettinga, M.	Towards an interactive web tool that supports shared decision-making in dementia: identifying user requirement	2014	International Journal on Advances in Life Sciences
20	S16	van der Vaart, R., Witting, M., Riper, H., Kooistra, L., Bohlmeijer, E.T., van Gemert-Pijnen, J.E.W.C.	Blending online therapy into regular face-to-face therapy for depression: content, ratio, and preconditions according to patients and therapists using a Delphi study	2014	BMC Psychiatry

21	S17	Wentzel, J., van der Vaart, R., Bohlmeijer, E.T., van Gemert-Pijnen, J.E.W.C.	Mixing Online and Face-to-Face Therapy: How to Benefit from Blended Care in Mental Health Care	2016	JMIR Mental health
22	S18	Wentzel, M.J., Karreman, J., van Gemert-Pijnen, J.E.W.C.	Towards an internet-based infectious Disease management platform to increase patient safety	2011	The third International Conference on eHealth, Telemedicine, and Social Medicine
23	S19	Gilbert, M., Haag, D., Salway Hottes, T., Bondyra, M., Elliot, E., Chabot, C., Farrell, J., Bonnell, A., Kopp, S., Andruschak, J., Shoveller, J., Ogilvie, G.	Get Checked… Where? The Development of a Comprehensive, Integrated Internet-Based Testing Program for Sexually Transmitted and Blood-Borne Infections in British Columbia, Canada	2016	JMIR research protocols
24	S20	Sieverink, F., Braakman-Jansen, L.M.A., Roelofsen, Y., Hendriks, S.H., Sanderman, R., Bilo, H.J.G., van Gemert-Pijnen, J.E.W.C.	The diffusion of a personal health record for patients with type 2 diabetes mellitus in primary care	2014	International Journal on Advances in Life Sciences
25	S21	Nijhof, N., van Gemert-Pijnen, L.J., Woolrych, R., Sixsmith, A.	An evaluation of preventive sensor technology for dementia care	2013	Journal of Telemedicine and Telecare
26	S22	Nijhof, N., van Gemert-Pijnen, J.E.W.C., Burns, C.M., Seydel, E.R.	A personal assistant for dementia to stay at home safe at reduced cost	2013	Gerontechnology