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Miriam Eileen Nes Begnum

Facilitating and Advancing Universal Design of ICT

Doctoral Thesis

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Thesis for the degree of Philosophiae Doctor

Gjøvik, November 2019

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To Team Begnum ♥

Abstract

Background: In modern societies, the consequences of digital exclusion are severe. Legislation on Universal Design (UD) reflects socio-economic, democratic and ethical reasons for ensuring all citizens are able to use solutions based on Information and Communications Technology (ICT). Still, industry and higher education lack guidance on what UD of ICT entails in practice.

Aim: This thesis investigates the possibilities and challenges when implementing the legislation in complex real-life settings, and articulates how educators and professionals should view UD expertise, and the necessary latitudes and appropriate priorities for ICT-projects. We answer:

(1) What are best practice methodologies for ensuring UD of ICT?
(2) What are applied aspects impacting UD of ICT?
(3) How can we create advice or tools to facilitate UD of ICT?
(4) How should we move towards advancing UD of ICT, and why?

Method: Using a mix-method and applied approach, research methods include literature reviews, survey, interview studies, and case studies. We apply content analysis, statistics, and grounded theory to interpret the data, and generative and design-based research to utilize the insights.

Contributions: We start by investigating best practice methodological stances and approaches. Due to the complexity of viewing UD of ICT as one field, we reframe our view and propose a uniform understanding of what UD entails for interaction design (IxD) and service design (SD). We find a mutual influence of Personal, Processual, Organizational and Social factors on UD success, and identify Critical Success Criteria (CSC) for ensuring UD in ICT-projects.

From this empirical basis, different methods, models, and tools are developed, piloted and prototyped; including defining UD of services, and predicting UD success based on compliance to the CSC. A theoretical framework is modeled, reflecting the identified factors influencing UD.

Conclusions: By increasing our abilities to predict and facilitate UD quality prior to or early in ICT-procurement and development processes, the thesis contributions inform future actions and advance a continued integration of UD in society.

The findings can have relevance for researchers in the field of UD, for policy makers, for IxD and SD educators and professionals, for providers of ICT solutions targeted to the public, and the designers and developers creating these solutions and services.

Preface

This thesis is submitted to the Norwegian University of Science and Technology (NTNU) for partial fulfillment of the requirements for the degree of philosophiae doctor. The doctoral work has been performed at the Department of Computer Science, NTNU, and at the Department of Design, NTNU, with Simon McCallum as main supervisor and with co-supervisors Ole Andreas Alsos and Mariusz Nowostawski. The work was financed through a stipend from the Norwegian Ministry of Education and Research as well as a stipend from Institute of Design, NTNU.

Acknowledgements

I want to start this acknowledgement section with expressing my deep gratitude to all the brilliant students I have had the honor of teaching and mentoring at NTNU Gjøvik, Institute of Design. At times, you have been my closest peers, with whom I have discussed my most resent findings. In particular, I would like to thank my former Master in interaction design students Susanne Harder, Rikke Julie Foss-Pedersen, Oda Lintho Bue, Therese Thorkildsen, Øyvind Nordeide, and Lars Furuheim – as well as the 2018-class of Bachelor in Interaction design. You are awesome!

Next in line, is the love of my life, Kyrre, whom often finds himself in second place, but never gives me a hard time about it. He introduced me to sushi, to homebrew, to computer science, to academia and to the art of messiness – basically, all the finer things in life. Together, we are raising two wonderful boys, but lately, he has done more of the togetherness than I have. My life would have been completely different had I not met you, Kyrre min, and as I quite like my life, I thank you from the bottom of my heart for your patience, understanding and encouragement.

I have dedicated this thesis to my family, whom I all love dearly - and especially to team Begnum.

Team Begnum is a wonderful band of brilliant one-of-a-kind misfits who work remarkably well together. Thank you to Susanne & Charlotte for all the lattes, the input, the help, shared tears and shared cheers! You have supported me whenever I have needed it. Thank you!

Thank you to my sons for cheering me on, and for helping out when I have needed you too. Lukas, your sense of humor is superb, and you have the kindest heart I know of (except perhaps your father's). William, you are wise, funny, and fierce, and I love hanging out with you! I am so incredibly proud of you both & and I love you more than to the moon and back!

I also have another team, my girls, you know who you are! Ida & Caro: thank you for having my back. And to Lucy Chamberlin, thank you for literally picking me up from the ground, taking me to the hospital, and not leaving until I was able to stand on my own again a day or so later. You are a superhero, and deserve a red cape. (Or at least a permanent position. Just saying.)

Last, but not least, thank you to my supervisors Simon McCallum, Ole Andreas Alsos and Mariusz Nowostawski for you advice and your faith in me. Simon & Rachael: thank you for dinners, shared worries, late nights & great wine, for your assistance and for your support.

Table of Contents

List of Figures

List of Tables

Introduction, Background and Research Design

1 Thesis Introduction

At some point during their life, most people will experience a mental or physical condition that limits their capacity to perform certain tasks. Persons with disabilities are argued to be the collectively largest group experiencing discrimination in society (Åmås, 2018). In addition, non-disabled users are in danger of exclusion, such as elderly over 80 years of age, first-generation non-western immigrants and persons with low digital competence (Slettemeås, 2014). Whether these user groups receive adequate attention in the digitalization of modern societies, is uncertain.

Over the last couple of decades, there has been a rapid increase in digitalized services across public and private sectors. Services based on ICT (Information and Communications Technology) are becoming prevalent in our daily lives. Both public and private service providers deliver these services through web-based and mobile applications and interfaces. These include information sharing, eCommerce, eGovernment and social media (European Commission, 2017).

In advanced eGovernment countries, such as Norway (UN, 2014), digital communication is the standard for both private and public sectors. As such, the consequences of digital exclusion are severe – in relation to education, employment, consumerism and citizenship.

In order to avoid creating digital barriers, those that create digital solutions must know how to achieve universal design (UD) of ICT. The idea of UD is to develop products, environments and services that make usage possible for all intended users, to the largest extent possible (Difi, 2017). Ron Mace, founder of the Center for Universal Design in Raleigh, NC, states[1]: *"Universal design seeks to encourage attractive, marketable products that are more usable by everyone. It is design for the built environment and consumer products for a very broad definition of user."* The Norwegian government aims for UD of ICT-solutions targeted towards the public.

Within the Norwegian context, all citizens have equal rights and opportunities to make use of digital solutions for information, communication and interaction from public and private actors alike. Several White Papers from the Norwegian government emphasize the necessity of ensuring an inclusive digitalized society, where all citizens can participate and contribute. They focus on ensuring UD in digital services (Brynn, 2009). However, though Norwegian policies reflect a clear principal intention, the enforced regulations only covers part of what is needed in order to ensure UD of ICT (BLD, 2017; KMD, 2013, 2017).

[1]Quote: Institute for Human Centered Design, http://www.adaptiveenvironments.org/adp/profiles/1_mace.php

For example, UD is not explicitly ensured across service chains. All ICT-based solutions made available for the public must be Universally Designed, as must physical environments. Non-digital and non-environmental touchpoints in cross-platform service chains, such as letters, are currently not covered by current legislations. A digital exclusion gap may thus not only persist, but also grow, if new self-service cross-platform service-chains are launched without UD awareness.

Further, the focus in current legislation is on minimum measurable criteria for the resulting end-solutions, such as adherence to the WCAG criteria (KMD, 2013). These do not cover the full aspect of UD, but are typically limited to only ensuring *technical* accessibility. There is a lack of criteria for ensuring *usable* accessibility, and no focus on process methodology criteria.

In addition, the term "ICT" is used broadly, spanning technologies and systems used for "expressing, creating, transforming, communicating, storing, multiply or publish information, or in other ways making the information usable" (KMD, 2013). The term "UD of ICT" is never made explicit. The law allows for leeway in terms of the cost of UD to an enterprise, and "as many as possible" is vague. Therefore, it is up to the service provider to interpret the policies, and decide whether regulated technical accessibility adherence is enough, too little – or even too much. They stand the risk of being penalized if deemed non-compliant, but risk loosing their competitive edge if unnecessary effort is spent.

The effect of this important legislation's clear principals but vague requirements, is that the industry faces a knowledge gap, where the best way to ensure UD remains elusive to most. Even though there are success cases to be found, the "how", as supposed to only the "what" is not articulated well enough to be transferable from one project to the next. There has been a lack of proper analysis of domain expertise and industry successes, leading to a lack of any set of well-defined principles, factors or processes, which could facilitate and predict a higher UD quality outcome.

Furthermore, even through higher education (HE) institutions have a particular responsibility to provide students with the expertise necessary to create inclusive solutions, in line with the government's UD ambitions, this sector face the same uncertainty as industry on what UD of ICT entails in practice. A further challenge is the current lack of oversight over how UD is included in various education programs, potentially undercutting the idea of a uniform understanding of how UD can be achieved.

In short, the law currently mandates UD of ICT, yet both industry and higher education struggle to identify how to get there. Bearing in mind, that success cases now can be found, and that experts on UD of ICT can be identified, it is now possible to collect, analyze and articulate a set of core factors for success, knowledge and skills, which will be of direct benefit for educators, industry, and ultimately all of us.

1.1 Research Aim

This thesis investigates what contributes to successfully achieve UD, in order to advance the continued integration of UD in digitalized societies. Using a mixed-method and applied research approach, the thesis articulates the necessary latitudes and appropriate priorities for ICT-projects, and advancing how professional, and educators, should view UD expertise. Thesis contributions increase our abilities to predict and facilitate UD quality (prior to or early on) in ICT-based procurement and development processes.

1.1.1 Research Questions

Given the challenges and aims outlined above, the following research questions are formulated:

(1) What are best practice methodologies for ensuring UD of ICT?
(2) What are applied aspects impacting UD of ICT?
(3) How can we create advice or tools to facilitate UD of ICT?
(4) How should we move towards advancing UD of ICT, and why?

1.2 Research Design

The thesis work is structured into four parts, corresponding to the four research questions. The first two parts focus on investigating current best practices for ensuring UD. The last two parts focus on facilitating and advancing UD.

Several studies and publications are made within each of the four parts. In all, 8 different studies have been conducted. Four of the 8 studies (Studies 4-7) are conducted in collaboration with other researchers. Table 1 shows the relation between the 8 studies and the 4 research questions.

Table 1: The relation between research studies and research questions

Research Questions	1	2	3	4	5	6	7	8
(1) What are best practice methodologies for ensuring UD of ICT?	•	•						
(2) What are applied aspects impacting UD of ICT?			•	•	•	•	•	
(3) How can we create advice or tools to facilitate UD of ICT?				•	•	•	•	
(4) How should we move towards advancing UD of ICT, and why?								•

Part 1: UD Methodology

The first research question "What are best practice methodologies for ensuring UD of ICT?", is based on the assumption that identifying best practice could a) improve our ability to understand how to support *usable accessibility*, b) provide us the means to control the UD quality outcome prior to development, and c) provide knowledge on what skillsets students and professionals should attain in other to create an inclusive digital society.

This research question is broken down into four sub-questions:

1.1. What are common methodological approaches used in UD of ICT?
1.2. What are the key traits, differences and similarities of these approaches?
1.3. Which methodological stances and views do domain experts hold, and is there a shared understanding of suitable practice for achieving UD of ICT?
1.4. How do domain experts understand and view key terms?

Questions 1.1 and 1.2 are researched using a literature review, investigating paradigm-related, methodological, and epistemological personal stances and viewpoints. Questions 1.3 and 1.4 are investigated through a survey questionnaire to experts on UD of ICT, with the intention of triangulating evidence-based practices identified from literature. Results are of particular interest to researchers in the field of UD and related inclusive and user centered design methodologies.

Part 2: Applied Aspects

The second research question "What are applied aspects impacting UD of ICT?" explores factors critical to the successful integration of UD in real world settings, asking the sub-questions:

2.1. How may agile settings impact user-centered UD work?
2.2. What characterizes ICT-projects that have achieved "best-practice UD quality"?
2.3. How is UD quality being ensured in procurement processes?
2.4. What is the current UD expertise within the SD discipline?
2.5. What is the current UD expertise within the IxD discipline?

We turn from focusing on methodological stances, to investigating other aspects critical to the successful integration in real world settings from the practice field, such as processual constraints, disciplinary expertise, and organizational and social influence. Different research approaches and research methods are applied, including case study, content analysis, survey research, literature reviews, interview studies, and exploratory studies.

Part 3: Designing Tools

The third research question builds on empirical insights made so far, and asks: "How can we create advice or tools to facilitate UD of ICT?" It contains the following sub-questions:

3.1. How can characterizing ICT-project success criteria be used to predict UD quality?
3.2. How can UD quality be better ensured in procurement processes?
3.3. What should be regarded as "best practice" UD expertise in the SD discipline?
3.4. What should be regarded as "best practice" UD expertise in the IxD discipline?

As our insights deepen, they provide a basis for facilitating UD through generative design and design-based research, in particular articulating what contributes to successfully achieving UD, and whether these aspects can be modeled, planned, measured and managed.

Results from parts 2 and 3 are of interest not only to researchers, but also to academics and practitioners involved in designing, developing or managing ICT-based solutions and services, and procurers and providers of ICT-solutions targeted to the public.

Part 4: Assuring UD of ICT

The final research question of the thesis is "How should we move towards assuring UD of ICT, and why?" Here, grounded theory research is used to model empirical insights, hypothesize factors that foster and advance UD, and discuss future interventions. We reflect on:

4.1. Why are procurement requirements important UD-triggers?
4.2. Why is legislation an important UD-trigger?
4.3. Why are passionate individuals important UD-triggers?

The results from Part 4 is of particular interest to lawmakers and politicians, as well as to anyone interested in helping promote UD.

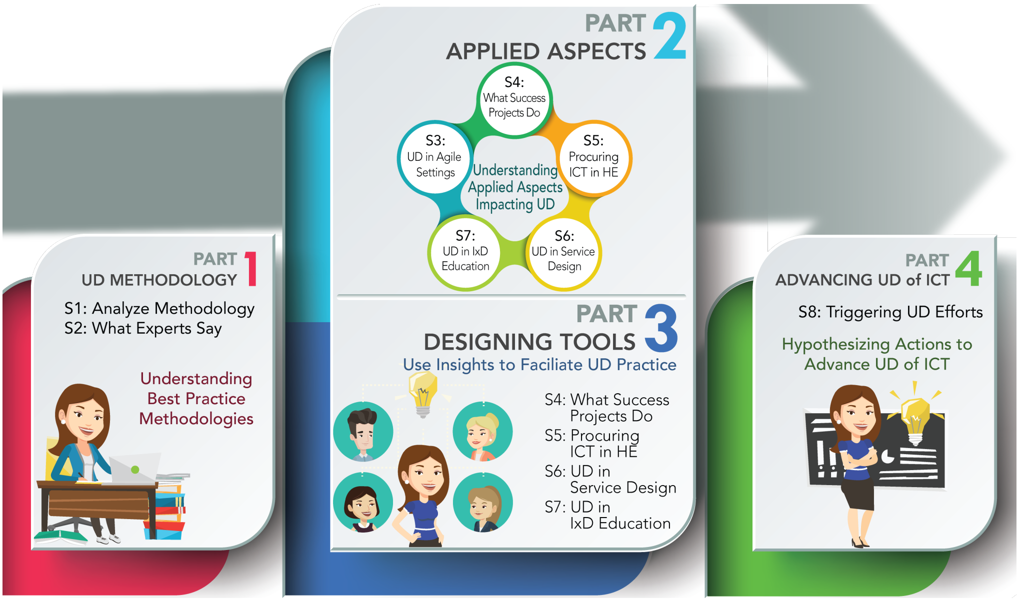


Figure 1: Overview of the thesis research process (S1-8 refers to Studies 1-8)

Figure 1 visualizes the overall structure of the thesis research process. The Thesis Research Design chapter overviews the research methodologies used, while details on particular studies are presented in the four thesis parts, as well as in the specific papers reporting on the work done.

1.3 Contributions

In all, 15 papers resulted from the 8 studies. 11 are peer-reviewed and published as conference proceedings, book chapters or journals. One is a presented NordiCHI workshop paper (Paper 15). One manuscript is awaiting publication (Paper 13). The final two articles are currently in review for journal publication (Papers 1 and 9). The 15 papers are:

Paper 1. Begnum, Miriam E. Nes. *Common Approaches to Universal Design of IT*, Manuscript submitted for review to Journal of Design Research, Inderscience.
Part 1, Study 1: "Analyze Methodology"

Paper 2. Begnum, Miriam E. Nes. (2016) *Methodology for Universal Design of ITs; Epistemologies Among Norwegian Experts*. In: Miesenberger K., Bühler C., Penaz P. (eds) Computers Helping People with Special Needs. ICCHP 2016. Lecture Notes in Computer Science, vol 9758. Springer, Cham.
Part 1, Study 2: "What Experts Say"

Paper 3. Begnum, Miriam E. Nes. (2017) *Universal Design Approaches among Norwegian Experts*. In: Antona M., Stephanidis C. (eds) Universal Access in Human–Computer Interaction. Design and Development Approaches and Methods. UAHCI 2017. Lecture Notes in Computer Science, vol 10277. Springer, Cham.

Part 1, Study 2: "What Experts Say"

Paper 4. Begnum, Miriam E. Nes. (2016) *Views on Universal Design and Disabilities among Norwegian Experts on Universal Design of ICT*. Proceedings of NOKOBIT - Norsk konferanse for organisasjoners bruk av informasjonsteknologi, vol. 24 (1). Open Journal Systems.
Part 1, Study 2: "What Experts Say"

Paper 5. Begnum, Miriam E. Nes; Thorkildsen, Therese. (2015) *Comparing User-Centered Practices in Agile Versus Non-Agile Development*. Proceedings of NOKOBIT - Norsk konferanse for organisasjoners bruk av informasjonsteknologi, vol. 23 (1). Open Journal Systems.
Part 2, Study 3 "UD in Agile Settings"

Paper 6. Begnum, Miriam E. Nes; Furuheim, Lars. (2016) *Exploration of User-Centered Agile Development Practices*. DS 85-1: Methodology: Special Applications, Proceedings of NordDesign 2016. The Design Society.
Part 2, Study 3: "UD in Agile Settings"

Paper 7. Hjartnes, Øyvind Nordeide; Begnum, Miriam E. Nes. (2018) *Challenges in Agile Universal Design of ICT*. DS-91: DESIGN IN THE ERA OF DIGITALIZATION, Proceedings of NordDesign 2018. Design Society.
Part 2, Study 3 "UD in Agile Settings"

Paper 8. Harder, Susanne Klungland; Begnum, Miriam E. Nes. (2016) *Promoting and obstructing factors for successful universal design of ICT*. Proceedings of NOKOBIT - Norsk konferanse for organisasjoners bruk av informasjonsteknologi, vol. 24 (1). Open Journal Systems.
Part 2, Study 4 "What Success Projects Do"

Paper 9. Begnum, Miriam E. Nes; Harder, Susanne Klungland; Hjartnes, Øyvind Nordeide. (in review) *Ensuring Universal Design: Towards Predicting Project Success through UD3C Critical Criteria Compliance*. Manuscript submitted for review to Interacting with Computers.
Part 3, Study 4 "What Success Projects Do"

Paper 10. Foss-Pedersen, Rikke J.; Begnum, Miriam E. Nes. (2017) *Universell utforming og digital eksamen i UH-sektoren: 5 anbefalte tiltakspunkter*. Proceedings of NOKOBIT - Norsk konferanse for organisasjoners bruk av informasjonsteknologi, vol. 25 (1). Open Journal Systems.
Part 3, Study 5 "Procuring ICT in HE"

Paper 11. Begnum, Miriam E. Nes; Foss-Pedersen, Rikke J. (2017) *Digital assessment in higher education: Promoting universal usability through requirements specification and universal design quality (UD-Q) reviews*. Universal Access in the Information Society. Springer.
Part 3, Study 5 "Procuring ICT in HE"

Paper 12. Bue, Oda Lintho; Begnum, Miriam E. Nes. (2018) *Towards Inclusive Service Design in the Digital Society: Current Practices and Future Recommendations*. DS-91: DESIGN IN THE ERA OF DIGITALIZATION, Proceedings of NordDesign 2018. Design Society.
Part 3, Study 6 "UD in Service Design"

Paper 13. Begnum, Miriam E. Nes; Pettersen, Lene; Sørum, Hanne. (in process) *Identifying archetypes of Interaction Design competence and their Universal Design expertise*. Manuscript accepted for publication to Interacting with Computers. In process; DOI: 10.1093/iwc/iwz023
Part 3, Study 7 "UD in IxD Education"

Paper 14. Begnum, Miriam E. Nes. (2018) *Ensuring Universal Design of ICT: Triggering the Triggers!* Studies in Health Technology and Informatics Vol. 256, Transforming our World Through Design, Diversity and Education, Proceedings of UDHEIT 2018. IOS Press.
Part 4, Study 8 "Triggering UD"

Paper 15. Begnum, Miriam E. Nes. *Triggering Universal Design in HE Digitalization.* Workshop Paper, NordiCHI 2018 [available at: https://www.mn.uio.no/ifi/english/research/projects/udfeed/events/Workshops/contributions-documents/paper11_nordichiworkshop_triggering-universal-design-in-he-digitalization-processes.pdf].
Part 4, Study 8 "Triggering UD"

Table 2 shows the relationship between the 15 papers and the four research questions (• = paper reporting findings, • = paper partly reporting findings).

Table 2: The relation between the research questions and the 15 research papers

	Research Papers														
Research Questions	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
(1) What are best practice methodologies for ensuring UD of ICT?	•	•	•	•											
(2) What are applied aspects impacting UD of ICT?					•	•	•	•	•	•		•	•		
(3) How can we create advice or tools to facilitate UD of ICT?									•	•	•	•	•		
(4) How should we move towards advancing UD of ICT, and why?														•	•

Table 3 summarizes the research studies and their corresponding papers.

Table 3: The relation between the 8 research studies and the 15 research papers

	Research Papers														
Studies	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
Study 1. Analyze Methodology	•														
Study 2. What Expert Say		•	•	•											
Study 3. UD in Agile Settings					•	•	•								
Study 4. What Success Projects Do								•	•						
Study 5. Procuring ICT in HE										•	•				
Study 6. UD in Service Design												•			
Study 7. UD in IxD Education													•		
Study 8. Triggering UD														•	•

1.4 Thesis Overview

The rest of the thesis is organized as follows:

- Thesis Background outlines the background for the research field.
- Thesis Research Design overviews the research methods and overall approach.
- **Part 1** presents the work done in relation to the first research question.
- **Part 2** presents the work done in relation to the second research question.
- **Part 3** presents the work done in relation to the third research question.
- **Part 4** presents the work done in relation to the forth research question.
- **Thesis Conclusion** concludes the thesis, and suggests future work.
- The **Appendixes** holds all articles, both published and in review, as well as supporting documents related to the studies.

First, a background chapter briefly presents the history of UD of ICT, and the current state of the field. Next, we overview the thesis research approach, and describe the research methodologies used. The four main parts of the thesis work is then presented.

Each of the four parts contains an introductory presentation, and a summary of the contributions made by the studies in the part. Within each part, its relevant studies are described. Each study details additional background literature, research approach and results, ending with a discussion.

Finally, an overall conclusion is made based on a discussion of the entire thesis work, and outlining the way forward.

2 Thesis Background

This chapter starts with presenting the terminology used in the thesis on the topic of UD. This is followed by a summarized history of UD legislation, including a local context. Next, some challenges are outlined related to the status quo, focused on the topic of local legislation, digital divides and the road ahead. The chapter ends with a look at current research on UD of ICT.

2.1 Universal Design Terminology

The term **universal design** is widely used, and has been for the last 10 or so years. The term grew out of "barrier free design", which is not widely used anymore (Persson, Åhman, Yngling, & Gulliksen, 2014). The term originates from US, and was coined by Ronald L. Mace, founder of The Center for Universal Design at North Caroline State University.

Universal design (UD) is about designing products and environments for the broadest possible range of users (Bergman et al., 1996). The goal is for the design to be usable for all people, to the greatest extent possible, without the need for adaptation or specialized design (NCSU, 2007).

The starting point for UD is typically to recognize human diversity, and agree with the ideal aim; "to create solutions that stretch to the edges in the scatterplot of human needs" (Treviranus, 2018). Adaptations may complement the design, as specified in the United Nations (UN) Convention on the Rights of Persons with Disabilities: "Universal design" shall not exclude assistive devices for particular groups of persons with disabilities where this is needed (Article 2).

In Europe, the alternative term **design for all** (DfA) is also commonly used, used for example in "Design for All Europe". Further, **inclusive design** (ID) is used in the British Standard on Managing Inclusive Design as well as in Canada. In 2000, Newell and Gregor presented **user-sensitive inclusive design** (Alan F Newell & Gregor, 2000; A. F. Newell, Gregor, Morgan, Pullin, & Macaulay, 2011). In Asia, the term **universal access** is according to Persson et al. (2014) commonly used within design disciplines. Persson et al. described the term **design for dynamic diversity** as targeted towards elderly users in particular – and as such less "universal".

Though different terms are used, many are overlapping. Stephanidis (Stephanidis, 2001) argues the term **universal design** can be used interchangeable with the term **design for all**. On the term **inclusive design,** Prof. Jutta Treviranus (Treviranus, 2018) who is claimed to have coined the term, says she wanted a term to reflect on personalization aspects, but further states there aren't huge differences between the terms UD and ID today. It further appears inclusive design is often used when one is concerned with being "reasonable"; acknowledging a "one size fits all" may not be achievable (Persson et al., 2014). Compared to the Norwegian legal interpretation of UD, we however find a similar degree of pragmatism; UD is thus interpreted in Norway to typically mean "as inclusive as possible within reason".

2.2 Universal Design Legislation

In Article 4f, UN obligates countries that have ratified the Convention on the Rights of Persons with Disabilities (CRPD) to conduct or encourage research and development work within UD:

> "To undertake or promote research and development of universally designed goods, services, equipment and facilities, (…), which should require the minimum possible adaptation and the least cost to meet the specific needs of a person with disabilities, to promote their availability and use, and to promote universal design in the development of standards and guidelines;" (UN, 2006a, Article 4f)

Since the turn of the century, UD has received increased political focus. Accessibility issues and UD guidelines have been strengthened both in national and international legislation (ACCESS8878, 2010; BLD, 2017; Brynn, 2009; EU, 2016a, 2016b; Hosein, 2004; KMD, 2017; UN, 2006a, 2013; USAccessBoard, 2017, 2018) – reflecting a need to ensure that as many people as possible have similar opportunities to access and use digital information and services.

The overall political aim of UD legislation seems to be to include as many citizens as possible into the "self-service society", thereby overcoming democratic, economical and ethical issues raised by internal digital divides; *"Universal design is a long-term national strategy to help make society accessible for all and prevent discrimination"* – Norwegian Ministry of Local Government and Modernisation (25.05.2009).

2.2.1 The History of Norwegian Universal Design Legislation

Towards 2008: In 2005 Norwegian policies on higher education (HE) and work were updated to encompass ensuring Universally Designed environments along with legislation in the Plan- and Building Act (KD, 2005; KMD, 2008). Further, disabled citizens became entitled by law to representation in municipalities in matters of particular importance – such as accessibility (BLD, 2005). In 2006, universal design was defined as one of three criteria for choosing public information system solutions (a long side environmental issues and lifecycle costs) (Accessibility), 2005; Norwegian Ministry of Trade, 1999 (relevant update 30 June, 2006)).

Since the Discrimination and Accessibility Act was passed in 2008, Norwegian government policy states that all systems and services targeted to or made available for a large, unspecified user group ("the public") must be designed and developed such that as many users as possible are able to use the main features – either directly or through adaptation (BLD, 2008; updated 2013, 2017).

White Papers: White Papers to the Parliament have also accounted for government values on disability prior to the 2008 Discrimination and Accessibility Act. We can follow the UD of ICT development in White Papers such as: "Action plan for disabled 1998-2001" (No. 8, 1998-99)

(Parliament), “Breaking down disabling barriers” (No. 40, 2002-03) (Parliament, 2002-2003), “An information society for all” (No. 17, 2006-07) (KMD, 2006).

No. 8: White Paper No. 8 focuses on how the Norwegian welfare state is built on solidarity and conscious choices (Parliament). Disability is viewed as “a gap between the individual's abilities and demands from the environment and society”. Parliament states it will work actively for a “warm” society for all, ensuring equal opportunities for participation and independence through adaptation and compensatory solutions.

NOU 2001: While the 1998-99 White Paper No. 8 is mostly focused on information via Internet (Parliament), the committee report “From user to citizen - A strategy for dismantling of disabling barriers” (NOU 2001:22) by Manneråk; et al. (2001) published only two years later emphasizes how new technology is vital for both information, communication and interaction in the emerging eSociety. Here, technological barriers in the eSociety are discussed (Manneråk; et al., 2001). The report highlights exclusion risks in the shift from manual services to digital services, both in public sector, education and the private marked. Telecommunications services and the need for workplace inclusion of disabled in eNorway 2.0 also receive attention.

The committee report also finds that values such as full participation, equality, human dignity, a society for all, a cohesive society and better living conditions is viewed as established political objectives. The challenge is, the report states, in the inadequate realization of these objectives. Related to ICT-solutions, the committee’s conclusion is viewed as fitting. Action plans for implementing universal design and increased accessibility in Norway are vague when it comes to ICT solutions and services (BLD, 2009). The committee proceeds to discuss the difference between open and hidden values, saying in Section 3.1: “These deficiencies makes the ideals to some extent appear as words of honor one is not entirely willing to accept the consequences of.”

No. 40: In White Paper No. 40 equality, self-sufficiency, active participation and personal and social responsibility is emphasized. The government here underlines societal benefits related to all citizens being active contributors, and refers to the sector responsibility of working to include universal design in all sectors and the corresponding Program of Action for Universal Design from 2002 (KLD, 2002).

The 2002-03 White Paper no. 40 has no section on ICT, but rather a section on (digital) services. The emphasis is on public services and public service coordination, but the White Paper discusses a variety of measures intended to reduce disabling barriers in education, work and leisure; “New technology is increasingly impacting people's daily lives. Unless new technology in its design takes into account people with disabilities, new barriers arise.” – Ministry of Labour and Social Affairs (Parliament, 2002-2003).

No. 17: The 2006 White Paper “An information society for all” refers to political ambitions for making Norway a leading ”knowledge- and ICT-nation” and views digital inclusion in the Norwegian information society as a democratic necessity; stressing digital access, universal design and digital competence. White Paper No. 17 emphasize the importance of eInclusion, and convey their aim that all technological developments in ICT and media will be based on the principle of universal design (KMD, 2006). As such, there seems to be a persistent cross-political view that universal design of ICT and services will ensure an inclusive eNorway.

A first step in 2008: The 2008 Discrimination and Accessibility Act (BLD, 2008) represented an advancement in relation to UD of ICT; introducing legislation specifically related to ICT. The Discrimination and Accessibility Act demand all ICT-solutions targeted or made available for a large, unspecified user group ("the public"), public and private alike, must be Universally Designed; designed and developed such that as many users as possible are able to use the main features – either directly or through adaptation.

One-track legislation: Norwegian UD legislation spans all public and private solutions targeted to the public, including ICT-solutions as well as physical conditions. §5f emphasizes the right of all citizens to have access to all public places and services, such as transportation, hotels, restaurants, cafés, theatres and parks (BLD, 2017). The law covers every solution that is a part of the general purpose of an enterprise, and that are solutions either targeted to or made available for the public. The law states all of these solutions must be designed or adapted so that as many as possible can use them, regardless of any disabilities. Norwegian ICT legislation is somewhat unique in that it places the same demands on public and private sectors.

A second step in 2013: From a political point of view, government policies are now in place to ensure the inclusion of all citizens. In practice however, the goal of eInclusion in the Digital Age quickly faced several and severe challenges. There was a lack of methodological knowledge within the Computer Science disciplines (including User eXperience (UX) disciplines, such as interaction design and service design, as well as disciplines such as front-end development and software engineering); no clear recipes for how to ensure a Universally Designed ICT-solution, and no established way for the evaluation of UD. Thus, the definition of what the law would consider a Universally Designed ICT-solution was not determined.

In response, success criteria for UD of ICT were established in the Regulations on UD of ICT, which was laid down in law on June 2013 (KMD, 2013). The regulations came into force July 1st 2014 for new solutions, and January 1st 2021 for existing solutions (§ 11). The relatively broad definition of "ICT-solution" from the 2008 Discrimination and Accessibility Act was still used, however the regulations was limited to only encompass web-solutions and vending machines. The regulations legislated a range of standards for vending machines. For web-solutions the minimum standard set was reaching WAI WCAG 2.0 AA-level, with the exception of the WCAG success criteria 1.2.3, 1.2.4 and 1.2.5.

The Agency for Public Management and E-Government (Difi) oversees compliance with the law. The regulation applied to all solutions directed at the Norwegian public, defined as a large, unspecified user group (including distinct target groups) (DIFI, 2015). Further, the solution must be an integral part of how services are offered for the regulations to apply. For example, the report "Social municipalities and universal design" clarifies that social media is an integral part of public and business enterprises, thus covered by the law (ialloffentlighet, 2015). Recently, Difi specified they also consider web-based mobile applications fall within the law.

Sector legislation: In Norway, each public sector is assigned the responsibility for ensuring UD in their domain. Norwegian legislation is thus extensive and fragmented across sectors.

On the area of ICT, Norwegians need to know of the 2013 regulations and the update to these made in 2017 (KMD, 2013, 2017). These regulations outline the UD of ICT criteria.

A third step in 2017: Sometimes, the sector legislation is not updated as expected. This happened in the case of the educational sector, which did not embed UD aspects in a satisfying manner. As of January 1st 2018, the 2013 version of the anti discrimination law (BLD, 2013) was thus expanded to encompass the educational sector (BLD, 2017). The current regulation demands all new ICT-solutions are being Universally Designed. For existing solutions, January 1st 2021 is the deadline for these being Universally Designed (including in the HE sector).

A forth step expected: Other times, European legislation is updated or strengthened in a certain area, which typically triggers the same update to the Norwegian legislations. For example, the Web Accessibility Directive (WAD) is a directive on the UD of websites and mobile applications in EU's public sectors that went into force September 23rd 2018. WAD refers to the EN 301 549 standard, which was recently updated to include the new version 2.1 of the Web Content Accessibility Guidelines (WCAG) from the Web Accessibility Initiative (WAI). As such, EU legislation now adheres to a newer WCAG version.

Further steps expected from 2020: We await a Norwegian legislative update in accordance with WAD, expected in the summer of 2019 and to be enforced a year later. With this update, user feedback opportunities and accessibility inclusion specifications from service/solution providers is likely be legislated for the public sector. What is still debated is whether these requirements will be legislated for the private sector.

2.3 Reflections on Current Norwegian UD of ICT Legislation

Focus on Technical Accessibility: The focus in current legislation can be viewed as emphasizing minimum measurable criteria for the resulting end-solutions, such as adherence to the WCAG criteria. These do not cover the full aspect of UD, and are typically limited to only ensuring web-based technical accessibility. Procurement and specification processes for ICT-based solutions adhere to these legislated minimum measurable requirements. They typically do not ask for additional UD criteria, e.g. a maximum amount of time to complete a key task for disabled users relative to the time spent by non-disabled users.

Unfortunately, research indicates the regulated criteria are not sufficient to ensure usable accessibility for real users in real life. Though WCAG 2.0 guidelines promotes UD, merely adhering to the WCAG 2.0 standard does not necessarily ensure usability for all even in independent web services (Milne et al., 2005). In particular two issues are being raised related to the use of guidelines; 1) lacking understanding of guidelines and 2) lack of coverage of guidelines. Rømen and Svanæs calculates less than 50 % of website accessibility issues are in fact identified through WCAG guidelines in their validation (Rømen & Svanæs, 2012). To counter these shortcomings, the need for more user-sensitive methods is being argued for. It may be argued that the knowledge on how to evaluate whether a single ICT-solution is Universally Designed has limitations, and that with the current legislation at least the technical accessibility aspects can be ensured. However, UD is more than technical accessibility in independent solutions.

What about Usable Accessibility: In accordance with the law, there are no demands to ensure usable accessibility (KMD, 2013, 2017). Currently, we have no methodology recommendations or process demands in place attempting to ensure real-life technical and usable accessibility. In the

EU WAD directive public enterprises must enable end-user feedback – which could be seen as a post-test on real life accessibility. In the UK, they recommend the BS8878 standard as best-practice process approach (ACCESS8878, 2010). Through attention on what achieving "UD of ICT" entails in practice, perhaps some process demands ensuring the criteria implemented is tested in real life, e.g. real-life testing with assistive technologies, could be added. This could strengthen usable accessibility.

In addition, the ever-increasing amount of mobile applications and cross-channel eServices has few specific regulations. Despite suggestions that methodological process-criteria for design and development of ICT-solutions would be beneficial (e.g. in the commissioned impact analysis of accessibility regulations for ICT (Halvorsen & Andersen, 2007)), general guidelines related to methodology were not drawn up as part of the regulations. As such, there is no overall strategy in place for ensuring eInclusion into cross-platform digital services. The regulations may thus limit the practical definition of ICT in relation to universal design – focusing on the web, as well as the definition of universal design itself – focusing on accessibility standards, not on usability. The question thus arises if complying with the existing regulations will indeed support the original purpose of the law; an inclusive self-service eNorway.

2.3.1 Legislative Vagueness

Loose definition of "ICT": The term "ICT" is used broadly in Norwegian anti-discrimination legislation, spanning technologies and systems used for "expressing, creating, transforming, communicating, storing, multiply or publish information, or in other ways making the information usable" (KMD, 2013). According to §3e, the law covers all ICT-solutions that are integrated as a part of how an enterprise informs the public and offers their services. As such, web-based mobile applications, social media platforms and digital services are considered ICT-solutions.

With the addition of the educational sector to the legislation (BLD, 2017), new ICT-solutions were specified in the updated regulation (KMD, 2017); web-based solutions that are integrated as a part of an enterprise teaching or dissemination of information (and that the enterprise can control), as well as digital teaching aids. Digital teaching aids are explained as "web-based tools that can be used un the pedagogical work, and which is developed with the purpose of supporting learning activities".

Unclear UD of ICT definition: There is no specific definition of what Universally Designed ICT solutions are (compared to ICT that is not Universally Designed). It should be noted that the Norwegian legislation indicates UD should be defined to refer to the core functionality of an ICT solution, and not necessarily to all extensions. This implicates a Universally Designed system or service may have both functionality designed "for all" and additional elements targeted to specific groups. UD is often divided into accessibility and usability, emphasizing that UD goes beyond giving technical and physical access to use. Though access is a premise for use, UD also encompasses the general fit of a system to a user (e.g. the usefulness, usability, user experience, desirability and so forth).

Second, the current legislation holds no clear definition of UD in relation to services that moves across touchpoints, where not all are digital. Currently, it is clear that the regulations cover all web-based and digital touchpoints, but nowhere is there a clear overarching responsibility for ensuring a person can move through the entire user journey if parts of the service touchpoints are not covered by explicit sector legislation. When we move from independent solutions to digitalized cross-sector services, the aim of UD is increasingly complicated. A cross-sector service would have to conform to the UD legislation on ICT for the any digital service aspects, platforms and touchpoints, while conform to other sector-legislation when appropriate for non-digital aspects and touchpoints (such as products, transportation, environments and architecture). As such, digital exclusion gap may not only persist, but also grow, as new digitalized cross-platform services are launched.

Third, for all ICT-solutions, Norwegian UD of ICT regulations only enforces web accessibility and vending machine standards (KMD, 2013). Though the Norwegian government White Paper policies portray universal design as the key to ensure digital inclusion, neither the legislation nor the regulations (KMD, 2013) clearly define the term "UD of ICT" or what it entails aside from following the above-mentioned specific standards.

UD pragmatism: Finally, "as many as possible" in the overall UD definition is vague in itself, and the law allows for some leeway in terms of the cost to an enterprise. For example, billboards used for commercial purposes are not discussed as discriminating, though they are usually visual only. Thus, one may speculate that legal actions must be taken in order to clarify aspects covered by the law. The Norwegian Agency for Public Management and E-Government (Difi, no: Direktoratet for forvaltning og IKT) supervises compliance with the UD of ICT requirements (KMD, 2013, 2017) and issue decisions and fines based on their reviews. Thus, on of their main roles is to inform on their interpretation the regulations, which is the guiding star. Their decisions can be appealed to the Ministry of Local Government and Modernization (KMD).

Is vagueness needed? The limited and vague legislative interpretation of UD in relation to ICT, and the loose and largely overlapping terms and definitions used in research and practice fields are challenging. However, when it comes to clarifying key aspects, there is a risk of legislation quickly becoming dated if too specific, and not being forceful if too vague. The legal documents take time to update, thus it may be argued that a loose definition of "ICT" is reasonable, especially when Difi can easily state their guiding legal interpretations or if UD evaluations and accessibility declaration is the norm.

A way to overcome vagueness? The EU WAD directive demands enterprises issue an accessibility declaration and enable user feedback. This is now likely to also be included in Norwegian legislation. In demanding an accessibility declaration, one delegates the task of operationalizing UD to the suppliers of ICT-solutions; declaring any content *not* Universally Designed and why, any alternative content and an opportunity for users to complain on this accessibility declaration. The declaration builds on an internal, external or other approved UD assessment of the enterprise. This seems a clever approach to overcoming the vagueness of "UD of ICT", and to force UD assessments on key enterprises. Difi is currently discussing whether Norway should apply this approach in addition to current legislation, and if so whether this should cover both public and private sectors, private enterprises of a certain size (e.g. 50+ employees), or public sector only.

2.4 Internal Digital Divides

A simple definition of the term **digital divide** is an uneven balance in access to, knowledge of and use of technology. The term "digital divide" was first used to refer to the "developed" versus the "not-developed" world; talking about access to ICT and knowledge of how to use ICT – in other words, referring to a global digital divide. This perception of digital divides may create a strong focus on providing access to computers and the Internet to certain countries or users.

However, as our societies became increasingly more digitalized, one also realized **internal** digital divides exists (Compaine, 2001). These digital divides exist within different subgroups of a population. Digital divides create information gaps, democratic and even ethical issues in societies where utilizing technology is necessary to fully participate. Some digital divides are clearly discriminating, such as where a disability makes someone physically prohibited from participation. However, if physical digital divides is the key issues, these may be fairly easy to overcome compared to other reasons for internal digital divides – such as education, income, gender, ethnicity, age, location, culture and language (Fitch, 2002; Hendrix, 2005; Payton, 2003). These socio-economic divides are often intertwined. Other factors may also lead to internal digital divides, such as stereotypes, computer anxiety and performance expectations (Keil, Meader, & Kvasny, 2002; Shneiderman, 1999).

Research indicates efforts to decrease physical exclusion through accessibility may be more successful than attempts to combat cultural and socio-economic divides (Kirk & Zander, 2004).

Norway – an advanced e-Government country: UN estimated 80% of citizens in the Nordic countries were e-Government users in 2014 (Nations, 2014). The UN E-Government 2014 Survey report, already classified Norway as an "advanced e-Government country" and among the most digitalized countries worldwide. The Norwegian E-Government Development Index (EGDI) was calculated at 0,84, placing us as e-Government country #13. Finland was right ahead of us in 2014, while Sweden and Denmark were just below us. All the 4 Scandinavian countries have an EGDI score at 0,8x. In 2012 Norway was even higher ranked, at #8 and thus among the top 10 countries (Nations, 2014).

On February 7th 2014, digital communication was legislated as the main rule of public administrations (KMD, 2014). This applied to the entire public sector entities, municipalities and counties. The Norwegian governments aimed for fully digitalized communication with Norwegian citizens through digitalized services. Further, the Agency for Public Management and E-Government (Difi) developed a common project model for implementation of digitization projects in public enterprises (DIFI, 2014b), as well as criteria-based expert evaluations of independent public web-services and websites (DIFI, 2014a) – both launched in 2014.

Huge investments into new digital services: Since 2014, the digitalization of public services has only increased. In 2016, a new government co-finance plan was established in order to enable profitable small and medium-sized digitalization projects to be implemented (Hagen, 2018). This has been a success. For 2019, the government proposes a NOK 127.2 million budget for this co-financing. In addition, the Norwegian budget proposal for 2019 presented on Oct. 8th 2018, points to a huge and historic investment of NOK 1,7 billion for public service digitalization (Hagen, 2018). NOK 575 million is proposed to finance the Health Platform in Central Norway;

improving coordination and communication between health services. NOK 423.5 million is proposed for modernizing ICT solutions and services offered by the Labor and Welfare Administration. NOK 50 million is proposed used to support more efficient customs control. The educational sector may receive NOK 49 million to implement Universally Designed examinations and assessment solutions. Finally, NOK 25.5 million is proposed for digitalization efforts in child welfare, with the aim of increasing efficiency, documentation and quality assuring decision making processes.

Are all citizens able to use the new services? In Norway, the 2014 commissioned report "ICT-use in the population and barriers to digital inclusion" indicated 93 % of the Norwegian population above 16 years of age are Internet users (Slettemeås, 2014). The report utilizes information from Statistics Norway's "Norwegian media barometer". According to the media barometer 2013 numbers, on an average day 85 % of the Norwegian population between 9 and 79 use Internet, of whom 9 % use digital public services, whereas 9 % purchase goods, 6 % book tickets for travel, 39 % banking services and 16 % use other online services (Vaage, 2014). The numbers corresponds well to the 2014 UN estimate. Though these numbers are high, a closer look revealed there are user groups in Norway ending up on the wrong side of the digital divide. The statistics on access, use and competence identified four user groups that are particularly vulnerable to exclusion; i) among disabled users, visually impaired, ii) elderly above 80 years, iii) first-generation immigrants from non-western countries and iv) people on social security/homemakers (not participating in the job marked) (Slettemeås, 2014).

Four internal divide hinders: The UN E-Government 2014 Survey report (Nations, 2014) recognizes four "hinders" for overcoming internal digital divides. These are **access** – physical and technological, **capabilities** and abilities – including knowledge (for example of assistive technologies), **inclusion** – related to how people view you as well as hinders for interaction and usage, and **desirability** – including incentives for use. While technical accessibility solves the first hinder, **access**, it does not solve the remaining three. If disciplines are focused on usable accessibility, practitioners may however contribute to solve issues related to lessening the need for capabilities, ensuring an inclusive interaction and universal usability, and even designing for desirability.

Capabilities: In relation to knowledge and capabilities, there should be a match between the expected abilities for users (including how to use assistive technologies) and actual programs for training. One of the aims of an HCI-person or interaction designer is to ensure the capabilities needed in order to understand, interact with and use a product, system or service are less than or equal to the expected user capabilities. Many heuristics used within interaction design are targeted to aid the designer in ensuring this, e.g. related to human cognition, perception and memory. However, an interaction designer is faced with challenges when his/her knowledge of assistive technology (AT) is too limited, or the end-user do not have the knowledge needed to fully utilize the AT. For example, the WCAG and ARIA guidelines are useful to a screen reader user only if the user knows how to utilize the tagged information.

In Norway, there has been very limited research into the technological knowledge of disabled users. However, one example is the project Universal User Competence (UUC) from 2009-10

(MediaLT, 2009-2010). Here, a knowledge gap was been detected between the AT and digital competence needed in order to make use of web-solutions adhering to the current UD of ICT regulations, and the actual AT and digital competence disabled end-users hold – in particularly in relation to visually impaired. As reported by the NOU report "ICT-use in the population and barriers to digital inclusion" (Slettemeås, 2014), persons with visually impairments belong to one of the main excluded disabled user groups. A 2016-17 SIFO survey financed by the Delta Centre, Children, Youth and Family Affairs (Bufdir) confirm the digital competence among persons with disabilities appears to be below the general Norwegian population. However, they report that based on their survey data, this result is equally likely explained by age then by disability. MediaLT and "Mission for the Blind IL" (Blindemisjonen IL) piloted improved coursework for teaching digital competencies, and stress the importance of financing not only ATs to persons with disabilities, but also the necessary training to utilize the ATs. However, we are not aware of any currently on-going efforts to specifically bridge the **capabilities** knowledge gap.

Inclusion: The third hinder, inclusion, seems tightly matched with the job description of an interaction designer – namely ensuring high usability and that of a UX designer – ensuring positive user experiences for all users. Focus should therefore not only be on accessibility for all, but also on adding UD perspectives to UX disciplines. User-centered design methodology as well as service design methodology holds user research strategies for investigating if service/solution interactions are enjoyable and comfortable, as well as possible, for all indented users as possible. In order to accomplish usable accessibility for as many users as possible, a designer must (as a starting point) know who the intended users are, and understand their different needs.

Desirability: Universally Designed products do not change underlying reasons for exclusion of certain groups of users, such as internal digital divides caused by culture differences or knowledge gaps. Technology does not in itself minimize divides. The belief that people will in fact use the technology merely because it exists, is a technological deterministic view - as well as highly optimistic. Universally Designed services and ICT are merely products and environments better designed with respect to fit more users in a diverse society. Thus, even if something is inclusive, one must also ensure usefulness, desirability and incentives for use strong enough to overcome cultural and emotional reasons for not choosing usage.

2.5 The Road Ahead

The UN survey warns against usage divides across different types of users within E-Government countries. Though e-Government is broader than services, eServices receive a fair share of attention in the report. The report views e-Government usage divides as a democratic problem, where citizens are being shut-off from government services. Taking a look at the implications of the 2014 Slettemeås report information in relation to current Norwegian UD of ICT legislation and the UNs survey findings on internal digital divides, at least three observations can be made:

Access is not always the key issue: First, only the first two of the four identified vulnerable groups - physically disabled and elderly - have received a lot of research attention. The data also point to marginalized user groups beyond disabled and elderly, who must also be considered in terms of inclusive E-Government policies. It seems unlikely that WCAG 2.0 AA-compliance will significantly contribute to ensuring inclusion of first-generation immigrants from non-western countries and people not participating in the job marked.

Access is not enough on its own: Second, the need to ensure a low threshold of use for visually impaired seems vital (e.g. focusing on usability aspects such as learnability and error-tolerance). Disabled are in general at a high risk for exclusion in our society. In relation to Internet usage 3-4 % of respondents state disability issues as reason for non-use, however especially visually impaired seem truly marginalized in eNorway (Slettemeås, 2014). Their needs goes beyond accessibility issues, and touches upon most of the UN described hinders, especially capabilities and inclusion hinders (Slettemeås, 2014).

Access is more than a digital issue: Third, 80 % of non-Internet users in Norway was above 66 years in 2014 (Slettemeås, 2014). In relation to service design, offline service channels and touch-points should thus be considered for elderly non-users. These offline channels may gradually become obsolete as time progresses, as there are indications that younger generations will sustain their existing digital competences into old age.

Listen to the marginalized: The UN conclusion is that internal digital divides must be overcome in order for e-Government success. UNESCO suggests mandatory participation of disabled users in political and industrial plans (Hosein, 2004), to include disabled user perspectives and uncover marginalized user group needs.

2.6 Technological Determinism versus Socio-technical Co-Constructionism

Technological determinism is an ideology that considers technology the primary reason for technological changes on society. Some take a pessimistic technological determinism stance; worrying technological interventions negatively affect a society. More common however is optimistic deterministic stances; attributing the growth and progress of a society to technology. Optimist technological deterministic stances can be identified in modern political rhetoric – for example, when assuming environmental or healthcare issues will be partly solved by technology, through removing CO_2 from the atmosphere or decreasing the need for elderly care.

Optimistic technological determinism stances seem somewhat frequent in relation to digitalization; where **digitalization** (redesigning interactions, communications and services into (more) digital ones) may be confused with **digital transformation** (profound transformation of activities, processes, competencies and models to fully leverage the opportunities of digital technologies and their impact across society in a strategic manner). Though digitalization aims to increase revenue, efficiency or quality aspects, it will not automatically get you to a digital transformation.

Socio-technical co-constructionism: Perhaps as a reaction to the technological determinism of the classic mechanical view, a more reflective socio-technological co-constructive view emerged. Social constructionism believes technology develops because of social, cultural, or economic factors, rather than being the reason for social growth. Socio-technical co-constructivist stances view humans as playing a major role in actively shaping history, culture, and politics through the co-creation of technology **and** society; where both influence each other. Technological impacts cannot be predicted, and depend on how technology is utilized. This stance criticizes the deterministic view of technology as an autonomous process that occurs independently of society, as beyond human control and neutral in nature where its characteristics determine societal impact.

2.7 A Brief Look at Research Focus in the Field

A limited literature search was performed to get an overview of the current research focus in the field of UD of ICT. The search was conducted in September 2014, and only included 2014 publications and limited to publications within computer science and/or engineering. The search was made across several relevant databases see Table 4.

Three databases presented a fair amount of relevant research; Springer, IEEE Xplore and ScienceDirect. ScienceDirect was chosen for further analysis. From screening 134 ScienceDirect journal papers, we found a large spread in UD of research focuses in the field, with a high degree of case-specificity. The inclusion criteria were 1) attempts to achieve universal design for more than one user group and 2a) at least one user group is marginalized or 2b) theoretical aspects related to UD is discussed.

Table 4: Search Results

Search String	Database	Limitations	Hits
Design for all OR Universal design OR Universal access OR Inclusive design OR User sensitive inclusive design	Springer Link	Published: 2014	8403
		Published: 2014, Discipline: Computer Science, Type: Articles, Language: English	135
	ACM	Published: 2014	11
	IEEE Xplore	Published: 2014, Type: Conference & Journal Articles	137
	Sage Journals	Published: 2014	157
		Published: 2014, Discipline: Engineering & Computing	0
	ScienceDirect	Published: 2014	737
		Published: 2014, Discipline: Computer Science	140
		Published: 2014, Discipline: Computer Science, Type: Journal Articles	134

45 of the 134 publications fulfilled these criteria and were analyzed with regards to research focus. The focuses of the 45 articles were mapped; using non-mutually exclusive categories (see Table 5). While screening articles, the inclusion criteria were interpreted quite generously. Mentioning low-vision users in addition to blind users or elderly with aphasia versus elderly without aphasia in e.g. the introduction or conclusion was considered sufficient to be assessed as focusing on multiple user groups. It may be argued that research on UD should be taking into consideration more that one particular type of case and user. If this inclusion criterion applies, 17 of the 45 articles should be excluded, as they focused more on *specialized* design (design to one specific marginalized user group).

A typical piece of research was on one particular user group (e.g. blind) and the utilization of a specific technology (e.g. smartphones) in a certain context of use (e.g. wayfinding). Table 6 shows not all marginalized or disabled user groups received equal attention in the sample. Elderly and persons with visually impairments were the most frequently in focus. The overall impression is that most of the research is linked to developing solutions to specific cases. There is a strong case-based focus on solving a specific problem for specific users in a specific context. These cases vary greatly, from researching ambient assistive living (AAL) to developing new haptic interaction techniques.

Table 5: Research Focus in the Science Direct sample

Research focus	Number of articles
Navigation in environments	5
Ambient Assisted Living (AAL)	5
Training, therapy and rehabilitation	2
Education	4
Interaction techniques (modalities)	6
Speech technology	3
UD methodology	10
Web accessibility	11
Mobile accessibility	4
Web accessibility	1

Table 6: User group focus in the Science Direct sample

User group in focus	Number of articles
Elderly	7
Visually impaired	7
Dysarthria	1
Hearing impaired	1
Cerebral Palsy	1
Autism	1

A surprising insight was how the high degree of case-specificity may present a challenge for accumulating generalizable knowledge across cases. There was a systematic accumulation of knowledge within some areas –for example navigation for visually impaired and automatic speech recognition optimizations. Other areas appeared less synergetic – such as smartphone accessibility, where recommendations were typically made for one user group at a time, without clear alignment with previous work.

3 Thesis Research Design

In the previous chapters the motivation and background for this thesis was presented. The aim of this chapter is to present the general research design and the research methods we have used:

Part 1: The research approach in Part 1 was a combination of literature review for gathering research recommendations (Study 1) and survey research gathering domain expert knowledge (Study 2). Deductive and inductive statistics was used on the quantified Study 2 survey data.

Part 2: In Part 2, a wider range of research topics linked to the overall aim of the thesis is presented. These explore different multi-faceted perspectives. All the studies in Part 2 are collaborative. Study 3 utilizes (again) literature reviews, complemented by an interview study. Study 4 also uses an interview study, extended by design-based research. Study 5 is an explorative case study (using survey and interviews for data collection); Study 6 is an exploratory study (iterating literature review and interviews), and Study 7 a multiple case study (applying document analysis). Different types of content analyses are applied to the data from Studies 4, 5, 6 and 7.

Part 3: This part seeks utilizes insights from Part 2 to provide artifacts or guidelines to the field. From this work, a design-based research approach is applied to Study 4 findings, in order to design, prototype, and test a tool that facilitates UD management and predict UD success for ICT-projects. A generative research approach is applied in Studies 5-7; creating artifacts such as methods, models, definitions and archetypes, based on theoretical insights, in order to promote and facilitate UD of ICT practices.

Part 4: Finally, in Study 8 we do grounded theory research, by applying theories to the empirical data through new content analyses, building new hypotheses and creating and adjusting models.

The Norwegian Social Science Data Services (NSD) approved all studies; Project number 44702 covers Studies 2, 4 and 8 (original application received 15.09.2015, approved 23.20.2015; update received 31.01.2018, approved 13.02.2018), Project number 45440 covers Study 5 (application received 01.11.2015, approved 26.11.2015) and Project number 53271 covers Study 6 (application received 24.02.2017, approved 03.04.2017). Studies 1, 3 and 7 did not require NSD approval.

3.1 Research Approach

Due to the interdisciplinary nature of the UX field, research methodologies are utilized from a variety of traditions, including the fields of design, social science and computer science. Table 7 overviews the research approaches used in the different thesis studies. Table 8 overviews the approaches used in the different papers. The rest of this chapter presents each research approach and accompanying methodology used in the thesis in a general manner.

Though writing a chapter of this kind may be considered untraditional in a PhD thesis, the text is designed to provide a thorough introduction to the reader unfamiliar with any of the in Table 7 overviewed methodologies, and was also instructive for my own part as a way to collect and sort the vast scope of methods that my work has covered.

The "Research Approach" sections within each study further details the research approaches applied, including how data is analyzed and which papers provide additional details. Thus, readers experienced in all overviewed methods in Table 7, can jump right ahead to page 66, and start reading the four main parts of the thesis.

Table 7: Research methodology used in the 8 research studies

	Studies							
Research Methodology	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Literature Review	●		●					
Survey Research		●						
Case Study					●		●	
Interview Study			●	●				
Exploratory Study						●		
Design-based research				●				
Generative research					●	●	●	
Grounded theory research								●

Table 8: Research methods used (or drawn on insights from) in the 15 research papers

	Research Papers														
Research Methodology	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
Literature Review	●				●		●					●			
Survey Research		●	●	●						●	●				
Case Study										●	●		●		●
Interview Study						●		●	●	●	●	●		●	●
Exploratory Study												●			
Design-based research									●						
Generative research											●	●	●		
Grounded theory research														●	●

3.2 Literature Review

Reading previously published literature is a great way to get an overview of a field or learn in-depth about a specific topic. However, literature reviews require mastering a quite complex, elegant and iterative research approach.

Searching: To succeed with a literature review, you need to find the right literature – of high quality and relevant for what you want to know. This is in many ways the most challenging step. First, you need to determine where to search for literature. Second, you need to determine your search strings or terms. Third, you need to determine if any other constraints should be added – such as citations, publication channel, year of publication and so forth. Forth, you need to determine your inclusion criteria.

Screening: Only when all these decisions are made can you begin to determine what literature is excluded and included by screening your results. For each result, you check whether they are of the right quality, have the right relevance and fit your other inclusion criteria. Silverman (2005) advises to show respect for earlier research, while being focused and critical.

Reading: The next step is more immersive; you delve into your included literature and read. Marshall and Rossman (2011) describe this process of reading and understanding as "a conversation" between the researcher and the literature. You now need to combine knowledge with critical through (Silverman, 2005) and identify your contribution and findings. As you look more closely into the included literature, you again determine if you have a fitting sample for your research questions. If not, some of the decisions made earlier must be adjusted in order to extend, alter or limit your sample.

Writing: Based on what you learn as you read, you start writing. Critical assessment of the literature is a crucial component of the literature review – e.g. strengths and weaknesses in key studies, if you consider certain studies a breakthrough, synthesizes into trends or stances, and your opinions on the literature. A literature survey may provide distinct contributions through creating new perspectives (Machi & McEvoy, 2009). Silverman (2005) strongly warns against mere description, and advice to critique instead of report on central studies. Merriam (2009) describes the review as a narrative essay, that "integrates, synthesizes and critiques" research on a particular topic, which we found a good description.

Organization: Depending on the type of literature that is being presented, there are many different ways of organizing a literature review. A theme-related organization is common (as is most of the study-background sections). Sometimes, a chronological narrative fits (such as on the legislative history on UD, in section 2.2), and sometimes chronologic and thematic structures are combined (which is the case of the thesis-background chapter) (Merriam, 2009, p. 76). Silverman (2005, p. 299) discusses the separate review ("background") chapter, versus drawing upon literature as needed in a research narrative. We try to balance both approaches, by adding study-background sections relevant for specific studies as "just in time" knowledge within a narrative.

Ending: Unless a systematic review is undertaken, a review process must be ended. Merriam (2009) discusses when to end your review, and describes two ways of determining this; 1) Saturation point: when you two or three times experience you are familiar with all the references at the end of an article, and 2) Literature command: you realize you know the literature and can cite studies, people, dates, trends, theories and so forth. The background chapters and sections of this thesis have usually ended based on a feeling of literature command.

3.2.1 Types of Literature Reviews

There are several types of literature reviews. This thesis have used the following:

Traditional "State-of-the art review" This type of literature reviews presents the "state of the art" in a certain area, to situate your study into the knowledge base of a field (Merriam, 2009), e.g. to present previous work you build upon and which you discuss your results in relation to. These types of reviews are typically less extensive, as they only need to provide a relevant and updated overview. Silverman (2005) recommends that you not finish (and publish) such literature reviews until you know (based on your findings) that all relevant literature is included. The same way as a background section is updated based on the discussion of paper results, he suggests researchers should finish and write up a literature review chapter at the end of a thesis. The background chapter in this thesis is an example of such a literature review.

"Framework review" Literature reviews can also be used to identify your theoretical base. Here, the newness of the research is less important. Instead you draw on theories to develop the overall theoretical framework of your study (Merriam, 2009). Study-background sections within Part 1 are examples of framework reviews.

Scoping review Sometimes, a literature review is used to identify knowledge gaps in a field – as a starting point for future research. This would typically be a scoping review (Jesson, Matheson, & Lacey, 2011). Literature reviews traditionally focus on updated research, however a scoping review also allows for a limited set of key articles to form a theoretical base guiding the review process. A scoping review is typically undertaken to explore and refine a research question, and allows the researcher to form and synthesize current knowledge on a specific topic. Study 3 (Paper 6) applied the scoping approach, in order to identify challenges in Agile UD.

Systematic review In a systematic review, *all* empiric evidence adhering to the pre-determined selection criteria for the study is identified, assessed and systemized. Study 1 (investigating UD methodologies), Study 3 (on comparing methods used in traditional and agile UCD) and Study 6 (UD in SD) partly touched upon the systematic approach. However, the reviews were not as stringent as classical systematic reviews, thus do not claim to be systematic.

"Loose" criteria present a risk in reviews, as the size of the review can easily blow up. In our studies, selection criteria were thus designed to make sure the reviews ended in a timely manner. For example, we based Paper 5 on a previous systematic review, attempting an update to the previous research, and could thus limit the search to new publications since this review had ended (repeating the search as identically as possible).

The danger with "tightening" inclusion criteria, as we did, is that the results may no longer be representative or valid across the research field. For Paper 12, we detected improvements in hindsight. Here, we had focused on "impact" (citation counts) over "newness" (publication date) and "relevance" (match to search terms). This approach worked well in Study 1, where we wanted to look at key papers on established methodologies. However, new and relevant studies will not necessary have a high citation count in an emerging field, such as UD of services is.

3.3 Survey Research

In survey research, self-administered answers are common (you hand out a set of questions to a sample of people, and wait for responses). If the survey design is robust, the questionnaire items well tested, the sample representative for a population and the response rate high, you will have information with a high-degree of validity that is generalizable to the population.

Easy: As it is easy to reach a large number of responses quickly from a geographically dispersed sample (Jonathan Lazar, Feng, & Hochheiser, 2010), surveys are extremely useful to explain behaviors in a populations and "explore uncharted waters" (Babbie, 1990 in Jonathan Lazar et al., 2010, p. 100).

Accurate: Depending on the type of data, you can apply different types of statistical analysis to investigate, describe, and make statistically accurate estimates. Inferential statistics, where you look for e.g. correlations between different factors (as we did in Study 2), is very exciting. Leedy and Ormrod (2014) describe survey research as "a study designed to determine the incidence, frequency, and distribution of certain characteristics in a population."

Risks: If you fail at any one of the steps related to sampling and survey design, you may end up with data of questionable validity (Jonathan Lazar et al., 2010). Three errors are common: coverage error (when not all members of a population has an equal chance of being asked to participate), non-response errors (when there are major differences between the sample and the respondents) and measurement errors (when questions are biased or poorly phrased) (Jonathan Lazar et al., 2010).

Shallow: The risk of errors is one weakness of the survey method. Another is the type of data you get. Surveys do not help you experience a topic yourself, and are typically not so suited for exploring the complexity of a case or uncovering in-depth insights from people and contexts.

3.3.1 Survey Design

In order to avoid measurement errors, a survey must be carefully designed.

Guidance: First, the front-page or start of a survey should offer an easy-to-read explanation of how to answer – e.g. dummy examples of the type of questions and how to answer them. Each question in a survey should also offer guidance text on how they should be answered. For example, if using Likert-scale items, you might say; "*On a scale from 1 (strongly agree) to 5 (strongly disagree), please indicate how much you agree with the following statements*".

Neutrality: You cannot ask biased questions. Thus, you need to be carefully with how you phrase the question (so that is neutral in tone – e.g. not only asking for the positive or the negative, but including both as in the example above), and the words you are using (e.g. no loaded, culturally inappropriate, emotive language or "politically correct/incorrect" words).

Clarity: Respondents must interpret questions in the same manner. Thus, avoid complicated language, vague terms, or imprecise words, and only ask for one thing in each question (no compounded or double-barreled questions). Jonathan Lazar et al. (2010) warn against negatives in questions, as they can cause confusion. In addition, you should not be ignorant about not using double negatives (= don't use double negatives), or other confusing sentence phrasings.

Open or Closed? There are two types of questions: open-ended and closed. Using open-ended questions, you let the respondents answer a question within an allocated open or lined space. However, open-ended questions should be quite specific, or else you may end up with too vague answers – or no answers at all. When analyzing open questions, you typically use emergent coding to create categories, or code the replies into an a-priori categorization scheme.

Closed questions are a bit more complicated to design, but are easier to analyze, as they are already categorized. There are two types of closed questions: ordered response categories and unordered response categories (Jonathan Lazar et al., 2010). Likert-scales are a good example of ordered categories, but all logically ordered categories are included – such as the number of years of experience a person has within UD of ICT. Any categories not logically ordered, are unordered.

Categories: Categories can help respondents interpret the answer asked for. If "*How long have you worked with Universal Design of ICT?*" is asked as an open question, we need to add an explanation such as "*Please round up to whole years.*" However, if we offer categories such as "*0-2 years*", "*3-5 years*", "*6-8 years*" etc., the explanation is no longer needed. However, make sure that the categories you provide 1) Cover all possible answers, and 2) Do not overlap. In order to ensure all possible answers are covered, you must consider adding alternatives such as "none of the above", "other", "all of the above" or "I don't know".

When unordered categories are used, you may want the respondents to choose more than one choice. For digital surveys, this is also supported through the affordance presented by single selection buttons and multiple selection check-boxes. In Study 2, we also added explanations and phrasings to clarify, e.g. such as "*In your opinion, are any of the following terms synonymous with "universal design"? Please select all that apply.*" and "*Please select the statement you agree with the most.*"

Sections: Questions related to a similar topic can be grouped into sections with fitting headings. This will lower the cognitive load of the respondents (Jonathan Lazar et al., 2010), and may increase readability and the feeling of progress. The overall survey design should start with questions that are not too hard to answer, however most now seem to recommend ending with the background information section. Interesting question that may motivate the respondents to answer should be placed early, and sensitive questions should be placed near the end (Jonathan Lazar et al., 2010). We also used the survey design to guide the respondents. When we moved into a section with a lot of questions asking about methodological styles, we started the section with "*The next questions try to measure your methodical "style". Please select the choices that suit you the best.*"

3.3.2 Survey Sampling

Census: In a census, you attempt to get a survey response for *all* members of a population. This is an accurate way of sampling. Examples are organizational surveys to all employees.

Probabilistic: Census sampling is not always viable, and probabilistic sampling is recommended as the next best thing (Jonathan Lazar et al., 2010). Sometimes you have a list of the number of cases (persons, organizations etc.) in a study population, you can randomly select a number of cases to make up your sample. Other times you have an estimation of your population to draw from.

Response size: When probabilistic sampling is used, you can calculate the approximate response size needed for the data to be generalizable within different levels of confidence. With more responses, you lower the margin of error.

Stratification: If you know your population has sub-population, you can also use stratification – ensuring you have an appropriate number of responses from each sub-population (Babbie, 1990 in Jonathan Lazar et al., 2010, p. 105). You are then doing stratified random sampling.

Non-probabilistic: If you do **not** have clearly defined population to draw from (as is often the case in HCI studies), you need to do non-probabilistic sampling: define the population based on a set of established data, and search for cases for your sample fulfilling these criteria. If you have data on your population, a strength of non-probabilistic sampling is you can ensure the sample reflects the diversity of the population, and as such is representative (Jonathan Lazar et al., 2010).

Self-Select: Another type of non-probabilistic sampling is the self-selected surveys. An example is online-site surveys prompted to all visitors of the site (Jonathan Lazar et al., 2010). When investigating a new population, Jonathan Lazar et al. (2010) propose self-selected non-probabilistic sampling, using demographic data on the respondents to establish validity.

Piloting: By piloting a questionnaire survey, you may discover survey design errors and correct them before launching the survey. We conducted limited pilot testing of Study 2 and 5 survey questionnaires, in both cases asking five persons to read, answer and provide feedback. In Study 2, we did not have access to experts in the population aside from the sample. We thus asked persons with overlapping knowledge. In Study 5, we did have access to representative participants outside the sample, and could realistically pilot as recommended (Krosnick et al., 2002).

3.4 Case Study

Case studies are typically in-depth and contextual investigations. You usually draw on multiple data sources (triangulation) and emphasize qualitative data (Jonathan Lazar et al., 2010). Different methods are utilized, such as interviews, document analysis, surveys, and observations (Yin, 2012). The difference between a case study and other qualitative studies is the investigation is "bounded"; you can express (theoretically) as a finite set of cases – e.g. number of people to be interviewed or observed (Merriam, 2009). This is why case study as methodology was only claimed for studies 5 and 7, where for a defined set of HE institutions, Study 5 surveyed their digital assessment solution experience and Study 7 screened any offered IxD study programs.

Yin (2012, p. 13) defines a case study as an "empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident." He (in Merriam, 2009, p. 45) suggests case study research is advantageous for answering "how" and "why" questions. Gerring (2004, p. 342) defines a case study as "an intensive study of a single unit for understanding a larger class of (similar) units."

There may be no unified definition on what a case study is (S. S. Andersen, 1997), but we find Jonathan Lazar et al. (2010, p. 147) sum it up quite nicely by stating "a case study is a detailed examination of one or more specific situations."

Strength & Weaknesses: Usually, you will not be able to generalize from a case study as you would through survey research, as you will not have the sample size acquired to do so. However, general knowledge is not necessarily more valuable than context-dependent. Merriam (2009) and Silverman (2005) argue the force of a single example is underestimated. Further, that the difficulty in summarizing case studies into general theories lies in the properties of the reality studied, not in the research method.

3.4.1 Types of Case Studies

You create a case study (research) design based on your aim and questions (goals), hypotheses (expectations), units of analysis (focus) and the plan for analysis (data). Case studies differ a lot in design, focus, and methods used. Several researchers have classified them into "types", which can help provide an overview of the possible choices. Here are some examples:

- In an **instrumental** case study, a case is examined to revise a generalization or shed light on an issue – leading to broader insights (Jonathan Lazar et al., 2010; Silverman, 2005).
- A **single** case study only investigates one single case (Jonathan Lazar et al., 2010).
- An **embedded** case study investigates several aspects within one case (Jonathan Lazar et al., 2010).
- A **holistic** case study investigates one aspect across several cases (Jonathan Lazar et al., 2010).
- A **multiple** case study enables the researcher to explore differences both within and between cases, and to draw comparisons (Yin, 2003 in Baxter & Jack, 2008).
- In a **collective** case study, a number of cases are studied to investigate some general phenomenon (Silverman, 2005).
- An **exploratory** case study focuses on novel insights (Jonathan Lazar et al., 2010).
- An **explaining** case study focuses on modeling or making visible (Jonathan Lazar et al., 2010).
- A **descriptive** case study focuses on in-depth documentation (Jonathan Lazar et al., 2010).
- A **demonstrating** case study is shorter, reporting on utilization (Jonathan Lazar et al., 2010).
- A **historical** case study looks at the development of a case over time (Merriam, 2009).
- An **observational** case study mainly uses observation for data collection (Merriam, 2009).

The different case study types can "overlap." For example, we chose a **multiple** case study approach in Study 7, where our goal was to investigate the current UD expertise within the IxD discipline. Multiple cases give some external validity, if findings are consistent across cases. In multiple and collective case studies, each case narrative is described before case comparison, which matches what we did. The result is a "thick" overall narrative, thus limiting the number of cases.

We kept our sample small (which is acceptable for qualitative studies), which made it possible to first study each case in depth, and then to study them comparatively. Further, our focus was initially descriptive, and we used an embedded case study approach to investigate each of the cases – looking at several traits within each case. We then focused on just the aspect of UD competence, now across the cases, using a holistic, and more exploratory, approach. For Study 5, we utilized an **exploratory** approach from the start.

Some use the terms "collective" and "multiple" case studies interchangeably. Other terms that highly overlap are "multisite", "comparative" and "cross-case".

3.4.2 Case Study Sampling

Just as when sampling for a survey, selecting the right cases for case studies is key. A "case" can be a phenomenon, technology, person, group, institution, policy or a curriculum (Merriam, 2009). Which cases you aim for, depend on the type and purpose of the case study. Merriam (2009, p. 40) views the selection of the case as "the single most defining characteristic of a case study." For example, you may want **representative** cases in order to paint a status quo picture – such as the experiences of a specific marginalized user group. You may want **edge** cases in order to demonstrate something – seeking out unusual or distinctive cases - for example worst-case scenarios. Some studies use **critical** cases that are particularly interesting or distinctive in relation to the topic at hand – for example a large accident or incident (Jonathan Lazar et al., 2010). You may also want to compare the experiences of different users, thus selecting **comparable** cases. Cases are as such not randomly chosen, but purposive sampled. Still, convenience is a factor – for example chosen simply because they allow access or selecting geographically close cases.

In Study 5, a non-probabilistic targeted sampling was used to identify cases **representative** for the current practices of digital assessment solution procurement. However, as explained on p. 145, we were also close to claiming a census sampling approach was used for the initial survey.

For Study 7, focus was on selecting **comparable** cases. On the overall sampling approach, arguments can be made for a local census approach. Details of the sampling process are described on pages 163-164.

3.4.3 Case Study Data Collection & Analysis

Different case studies utilize different research methods, depending on what kind of data is desirable. This also means they are analyzed differently, through a common way to analyze qualitative data is through some form of content analysis. Leedy and Ormrod (2014, Table 4.2) describe content analysis as "a detailed and systematic examination of the contents" of a body of material, with the purpose of "identifying patterns, themes, or biases within that material".

Jonathan Lazar et al. (2010) states techniques from grounded theory are generally used to code and categorize the data. Often, a bottom-up and inductive approach is used in case studies –

"letting the data speak to you". This is often done through emergent coding (as opposed to a-priori). Even if emergent coding is used, this does not mean you do not have a plan to sort the data collected into different topics – usually tied to your initial assumptions and research questions. Observations can for example be matched to predictions from the theory ("pattern making") (Jonathan Lazar et al., 2010).

3.5 Exploratory Study

Qualitative research "embraces a reach diversity of overall design" (Marshall & Rossman, 2011). Exploratory approaches are typically used to investigate little-understood phenomena, discover important categories of meaning and generate hypotheses for further research (Marshall & Rossman, 2011, p. 69). In Study 6, we used qualitative research methods in an exploratory manner; studying UD in SD through iterating exploratory interviews and literature reviews. Some might have framed Study 6 as an exploratory case study; however, our investigation was not explicitly expressed as a finite set of cases. Since we were open to exploring a wide set of UD perspectives in non-specified SD practice settings, our view was we were not doing case study research, but rather an "exploratory study" within the qualitative genre.

3.6 Interview Study

Interviewing is a common technique within qualitative research. Marshall and Rossman (2011) recommend in-depth interviews to elicit individually lived experiences. Jonathan Lazar et al. (2010) describe interviews in HCI used for initial explorations, gathering requirements and evaluations. Marshall and Rossman (2011) regard the strength of interviews as: fostering face-to-case interaction with participants, allowing for immediate follow up-clarification, describing complex interaction, discovering cultural nuances, help formulate hypotheses, facilitating analysis, validity checks and triangulation, collecting data in a natural setting, and providing information in context. They summarize interviews depend on participants' honesty and openness, the interpersonal skills of the interviewer and the power of the research question, are difficult to replicate, and risk misinterpreting participants and influencing data.

In Study 4 and for Paper 6 in Study 3, we used interviews as the sole research method. Here, we did not focus on defining the boundaries for our studies, but rather to explore (Study 3) and gather data from all relevant cases (Study 4). We did not triangulate several methods. As interviewing is the overall research approach, we frame these as "interview studies".

We also used interview as one of two data collection method in the Study 5 exploratory case study as well as the Study 6 exploratory qualitative study (respectively combined with questionnaire and literature surveys).

3.6.1 Interview Types

As for most qualitative methods, there are several types of interviews. Which one you should choose depends on trade-offs linked to time, expediency, depth and difficulty (Jonathan Lazar et al., 2010).

Structure: Interviews can be structured, semi structured or open. Fully structured interviews use a rigid script, where you cannot (theoretically) ask follow-up questions if interesting phenomena start appearing (Jonathan Lazar et al., 2010, p. 189). However, you have the opportunity to make sure the participant understood your question the way it was intended. As such, even a structured interview study, where the survey guide is a replica of a questionnaire form, would be different than a survey. The strength of adding structure, is it makes the data easier to analyze. Thus, semi-structured interviews are common (Jonathan Lazar et al., 2010); allowing the conversation to be adjusted if something of interest is mentioned, and allowing the use of probing questions.

Focus groups: Interviews can be conducted as focus groups, interviewing several participants at once, or as traditional interviews. Marshall and Rossman (2011) state the traditional one-on-one interview is better at uncovering participant's perspectives than focus groups, while focus groups are more valuable for documenting major events or conflicts, encourage collaboration, and obtain larger amounts of data than traditional interviews.

Context: Some interviews are made in non-context settings, such as a neutral meeting place. Others take place "in-situ" – in the situation of interest – for example in a workplace setting. Some interviews are done as an extension of observations, where you strengthen the observations and impressions of what is being done. If the observation is followed by "in-situ" probes to uncover implicit knowledge or to better understand details about the situation, this is called "contextual inquiries" (Jonathan Lazar et al., 2010, p. 209). Contextual "in-situ" interviews, even if not initiated by observations, can help deepening the interpretation and understanding of what is being said – for example, you can ask the participants to demonstrate a task.

Medium: Interviews can be electronically mediated, for example as Skype interviews, email interviews and phone interviews (all techniques that were used in Study 4). The reason for conducting such mediated interviews is usually practical issues; e.g. the inability or cost of travel.

Formality: Interviews can be formal or informal. In-situ conversations may be labeled "informal interviews", for example in a case study. In an observational context, you may label them as "contextual inquiries". Informal interviews typically open, and the researcher should be extra careful about ethical and informed consent issues. Formal interviews are often semi-structured or structured, and supported by an interview guide.

3.6.2 Interview Guide & Questions

Just as for questionnaire surveys, the interviewer must word questions in a neutral and clear manner. The quality aspects described for survey design should also be applied to the design of interview questions and interview guides. In addition to compounding and leading questions, Marshall and Rossman (2011, pp. 96-100) also recommend avoiding yes-or-no questions. They further suggest asking questions on a person's behavior, activities, opinions, feelings, knowledge, senses, background, speculations, and to validate your interpretations. In order to ensure your questions are good, pilot interviews are crucial (Marshall & Rossman, 2011, p. 95).

3.6.3 Participant Selection

Just as for case study sampling, participants must be selected carefully. Many of the case sampling quality aspects can be applied to participant selection. You can also use other methods to help find good participants, such as in Study 5, where an initial survey filtered the sample for willing and fitting participants. Sometimes you identify certain individuals that are particularly open or knowledgeable, and which insights can be validated by other sources. These may play the role of "key participants", which can be repeatedly called upon for information (Jonathan Lazar et al., 2010).

3.6.4 Interview Recording

Marshall and Rossman (2011) state there are three basic ways to record interview data; tape recording, taking notes during the interview and writing down notes after the interview. They do not recommend the latter approach. In this thesis, the former two recording types are used. When tape recording, you are collecting (indirectly identifiable) personal data, and the study must as such both ask for participants' consents and apply to NSD for approval. In the cases were we did not view tape recording as necessary or desirable, for example in interview with many closed questions and a stricter structure, we avoided tape recording, and relied on notes. When only having notes, it is important that the interviews are transcribed immediately, or as soon as possible. When full tape records are used, the transcriptions can be verbatim.

3.7 Generative and Design-Based Research

Generative research: Hanington and Martin (2012) present methods of design, and categorize their contributions as either exploring, evaluating or generating. They use the term "generative research" to denote the phase of generating concepts and early prototypes; placed between exploratory research and evaluating research. Generative research is typically informed by empirical methods, and can be participatory, e.g. through workshops.

Design-based research: The term "design-based research" indicates proposed solutions are not only generated, but applied to the problem, evaluated, and adapted; in an iterative manner. The aim is to gather new data and further improve the proposals. Leedy and Ormrod (2014, Table 4.2) explain design-based research as "a multistep, iterative study in which certain instructional strategies or technologies are implemented, evaluated, and modified to determine possible factors influencing learning or performance". There is no prescribed way of going about the process. Later iterations may adjust how solutions are (re-)applied and (re-)tested.

We find generative research fitting for describing the type of research work we did in Part 3 of the thesis; creating artifacts to facilitate UD-promoting practice based on our Part 1 insights, with one exception. The work done in Study 4 is better described as "design-based research". In Study 4, we also used the term "prototyping" to emphasize going beyond proposing based on insights, into testing how well they work.

3.8 Grounded Theory Research

Glazer and Strauss first described grounded theory, in 1967. Grounded theory research is as "a type of qualitative research aimed at deriving theory through the use of multiple stages of data collection and interpretation" (Leedy & Ormrod, 2014, Table 4.2). It is an inductive, systematical approach; starting with a set of empirical data and developing a well-grounded theory from that data set (Jonathan Lazar et al., 2010, p. 283). Silverman (2005) and Jonathan Lazar et al. (2010) explain the research process in four steps. We draw on literature and summarize the grounded theory process as:

1) Open (emergent) coding of data.
2) Develop concepts and tentative emergent categories, based on the codes.
3) Iteratively define properties relating to categories and re-categorize as needed; saturating categories with appropriate cases to establish their relevance,
4) Forming a theory (general analytic frameworks), with relevance outside the setting.

Codes: The grounded theory approach moves from open codes to categories, and then to properties describing the dimensions of those categories (Merriam, 2009). Merriam (2009) recommends three types of coding in grounded theory; first, open (emergent) coding; second, axial coding (refining the category scheme, by relating properties and categories); third, selective coding (where hypotheses are developed).

Categories & Properties: Constant comparisons lead to tentative categories, which are further compared to each other and other instances, developing conceptual links between and among categories and properties in the data set (Jonathan Lazar et al., 2010, p. 283). By immersing yourself into the data, and applying a constant comparative analysis, patterns emerge.

Theories: As you build hypotheses of suggested links between categories and properties, tentative hypotheses emerge "simultaneously with the collection and analysis of the data" (Merriam, 2009). These are continuously refined or abandoned. An emergent theory formulation takes place. As the theories relate to specific practice aspects, they are called "substantive theories" (Merriam, 2009).

This approach fit our work in thesis Part 4. Multiple rounds of data collection and (re-)analysis may be conducted in the theory formulation. The work in Part 4 reflects this; proposals in (workshop) Paper 15 (on the HE-sector) are less mature than the theory presented in (conference) Paper 14 (on IT-industry factor relationships), based on a thorough NVivo analysis.

Part 1

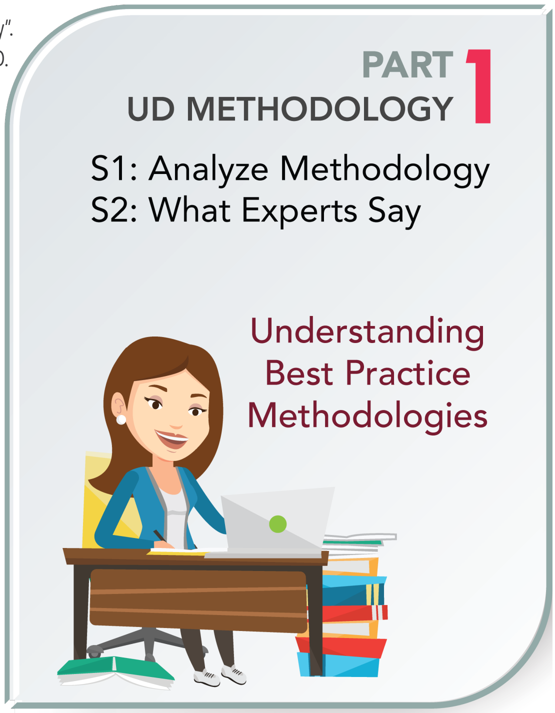
UD Methodology

Executive Summary of
Part I Universal Design Methodology

This section introduces and summarizes Part 1. Separate chapters follow, detailing Part 1 studies.

Part 1: Understanding Best Practice Methodology for UD of ICT

- Define key terms, such as "UD of ICT" and "UD Methodology".
- Map existing methodological stances and approaches to UD.
- Investigate relationships between stances & approaches.
- Explore "best thinking" and "best practice" profiling
- Explore whether Methodological Profile is predictive indicator of UD Quality.



Studies & Deliverables

S1: Analyze Methodology
Begnum, M. E. N: ***Common Approaches to Universal Design of IT***, in review .

S2: What Experts Say
Begnum, M. E. N: ***Views on Universal Design and Disabilities among Norwegian Experts on Universal Design of ICT***, NOKOBIT 2016

Begnum, M. E. N: ***Methodology for Universal Design of ITs; Epistemologies Among Norwegian Experts***, ICCHP, LNCS 2016

Begnum, ***Universal Design Approaches among Norwegian Experts***, UAHCI LNCS 2017

SPSS files with survey data from 26 Norwegian experts on their approaches and views on UD of ICT.

Part 1 Outcome

- UD terms and disability views are not fully established.
- Diverse stances and views are identified in Expert sample.
- Personal stances are not a clear driving factors for methodological choice,
- UD methodologies are mapped and a model created based on literature "best practice"
- Methodological profiling is not easily done, as Experts combine methods in a flexible, pragmatic and interdisciplinary manner, highly overlapping with "mainstream" UCD. There are different ways of viewing the necessary degree of user contact, though most agree with the need for some direct user contact and a need for user empathy.

Figure 2: Overviewing the research design of Part 1 – studies, papers, aims and outcomes.

Based on the assumption that methodology influences the quality of the resulting solution, one strategy to ensure UD would be through identifying high quality methodological best practices.

How we think ➜ What we do ➜ UD of ICT Quality

Figure 3: Part 1 research assumption

The hope was that by looking at methodological practices, a framework for comparing methodological UD quality could be created – extending current technical accessibility regulations by adding methodological process recommendations. The first research question asked was therefore: "What are best practice methodologies for ensuring UD of ICT?"

In order to answer this, Study 1 used a literature survey to identify methodological approaches commonly used in UD of ICT, asking:

1.1. What are common methodological approaches used in UD of ICT?

Next, an in-depth analysis of the identified common methodologies was conducted, to answer:

1.2. What are the key traits, differences and similarities of these approaches?

From these insights, a model of the UD methodologies and hypothesized connections between paradigm stances, epistemological preferences, and doxastic styles was created. However, in order to know which of the methodological practices identified from literature should be recommended, we needed a deeper understanding of the reasons and key constraints for methodological choices. Triangulating systematic reviews with input from experts or practitioners has proven a good way of identifying best practices. In Study 2, a questionnaire based on the theoretical model from Study 1 was therefore used to answer:

1.3. Which methodological stances and views do domain experts hold, and is there a shared understanding of suitable practice for achieving UD of ICT?
1.4. How do domain experts understand and view key terms?

In summary: Study 1 created a model through a top-down, literature and theory-based research approach. Study 2 complemented the research design of Part 1 by seeking empirical data through survey research to validate the model and discuss methodological practice.

The answers to our research questions were as follows:

1.1 What are common methodological approaches used in UD of ICT?

UD methodologies identified through Study 1 were largely human-centric (Slettemeås, 2014), inclusive and iterative. The indication from Study 1 that user-centeredness is generally recognized as important for ensuring UD, was strengthened through the expert sample data in Part 2. Overall, we found indications that UD strategies operationalized through different user-centeredness design approaches reflect current best practice thinking and doing.

Our findings supported Dong (2007) in her position that a paradigm shift has happened within the field, moving from specialized ICT solutions to an UD approach recognizing user and context diversity.

Note that though UD may be viewed as an extension of user-centered approaches, there are variations in recommended approaches as well as degrees of user sensitivity, user contact and user involvement (Abascal, Barbosa, Nicolle, & Zaphiris, 2015; Mustaquim, 2015; Panchanathan & McDaniel, 2015). Our data further support Dong (2007) in her position that multidisciplinary is the norm in UD of ICT work. Overall, our results indicated Norwegian professionals use cross-method user-centered UD methodologies, with direct user contact.

Study 1 identified four specific common methodologies approaches for UD of ICT. These are: user-centered design (UCD), participatory design (PD), inclusive design (ID) and user-sensitive inclusive design (USID). This answers question 1.1.

1.2 What are the key traits, differences and similarities of these approaches?

The degree of user involvement and user-designer relationships is the main divergent point between the four identified commonly utilized approaches. Based on the identification of common methodological approaches through a limited literature study, a larger literature review was completed for each of the methodologies. This answered research question 1.2 and resulted in Paper 1: Begnum (2018) *Common Approaches to Universal Design of IT*.

1.3 Domain experts on suitable practice for UD of ICT

Paper 2: Begnum (2016) *Methodology for Universal Design of ITs; Epistemologies Among Norwegian Experts* explains key findings on exploring strategies and epistemological traditions in order to identify methodological practices. The paper also discusses the successfulness of the survey items in measuring best-thinking practices and relationships between thinking and doing.

Further, Paper 3: Begnum (2017) *Universal Design Approaches among Norwegian Experts* studied specific methods usage in more depth, focused on the main factors influencing the methodological choices and methods used. It includes correlations between specific methods, design approaches and methodological stances, as well as correlations between specific methods and reported personal factors, external constraints and external influences.

Together, the findings presented in the two papers answers research question 1.3: Two different UD approaches were identified in our sample. The first applied a very low degree of user involvement, and appeared aligned with an Expert style and a Positivist epistemology – labeled "no-contact". The other was more complex, and is a non-positivistic doxastic style with a higher degree of user contact – thus the overall label for this style is "user involved".

1.4 How do domain experts understand and view key terms?

Our findings indicate key aspects, such as UD, UD of ICT and disability, are not well defined. It seems these aspects are largely "fuzzy" terms. More details on question 1.4 are presented in Paper 4: Begnum (2016) *Views on Universal Design and Disabilities among Norwegian Experts on Universal Design of ICT*.

Contributions from Part 1:

The goal of Part 1 was not to limit accepted approaches UD of ICT, but to encourage awareness of the reasoning and interdisciplinary flexibilities related to methodological decision making. This endeavor was quite successful, even if specific best-thinking and best-doing practices could not be detailed. We found indications that:

- UD terms usage and UD of ICT and disability definitions are not fully established;
- Experts use cross-method UCD, with some direct user contact, to achieve UD of ICT;
- Methods, stances and approaches highly overlap with "mainstream" UCD methodology;
- There are different ways of viewing the necessary degree of user contact, though most agree with the need for some direct user contact and with the need for user empathy;
- There are both Critical, Constructivist and Positivist epistemological and methodological stances within UD of ICT, and not a clear «best way of thinking»;
- Instead of seeing methods belonging to different methodological styles, it seems experts combine methods in a flexible, pragmatic and interdisciplinary manner.

We have made visible existing methodological strategies and values, and provided a basis for discussion of methodological choices and flexibilities within the field. The experts in the sample were hard to profile, and we have discussed whether this is a weakness (such as an acquiescence effect due to tacit knowledge or social norms) or indicative of a strength (such as a methodological flexibility and interdisciplinary capability of strategy utilizing based on needs, constraints and nuanced reflections).

We could not yet make a specific methodological recommendation apart from taking a user-centered design approach. In terms of our assumption of how methodology influences the end-result, we now understood that we also need to take into consideration the degree to which other factors – apart from personal views and stances – influence the choice of methodological approach in real life, including the degree of user involvement.

3 papers were published from Part 1:

Paper 2. Begnum, Miriam E. Nes. (2016) *Methodology for Universal Design of ITs; Epistemologies Among Norwegian Experts*. In: Miesenberger K., Bühler C., Penaz P. (eds) Computers Helping People with Special Needs. ICCHP 2016. Lecture Notes in Computer Science, vol 9758. Springer, Cham.

Paper 3. Begnum, Miriam E. Nes. (2017) *Universal Design Approaches among Norwegian Experts*. In: Antona M., Stephanidis C. (eds) Universal Access in Human–Computer Interaction. Design and Development Approaches and Methods. UAHCI 2017. Lecture Notes in Computer Science, vol 10277. Springer, Cham.

Paper 4. Begnum, Miriam E. Nes. (2016) *Views on Universal Design and Disabilities among Norwegian Experts on Universal Design of ICT*. Proceedings of NOKOBIT - Norsk konferanse for organisasjoners bruk av informasjonsteknologi, vol. 24 (1). Open Journal Systems.

1 paper is still in review:

Paper 1. Begnum, Miriam E. Nes. *Common Approaches to Universal Design of IT*, Manuscript submitted for review to Journal of Design Research, Inderscience.

Overall, Part 1 studied whether different epistemological stances lead to different methodological approaches to ensure UD. We investigated recommended methodological approaches and strategies utilized by published researchers and recognized Norwegian expert professionals in the field. Our conclusion is personal stances does influence methodology, where the degree of user involvement splits the field. However, they are not the only influencers.

From the research conducted in Part 1, it is clear that the interaction between personal stances and pragmatic reality strongly influence outcomes. Rather than exploring personal stances and their influence on doxastic styles, it was necessary to explore the key factors that influence practitioners' choice of approach, and the effect on UD quality.

Study 1: “Analyze Methodology”

Study 1 sheds light on the multitude of approaches and methodological stances taken by researchers on UD of ICT. We started our research with reviewing approaches in use for achieving UD of ICT, looking to literature to inform us on relevant background knowledge. This is found in the Study 1 Background section. We continued by conducting literature reviews; identifying common methodological approaches and studying these in depth.

Study 1: Background

When attempting to derive general recommendations, we considered that the field is likely to hold different perspectives. We thus started our research with reviewing approaches in use for achieving UD of ICT. We looked to literature to inform us on relevant background knowledge.

Two Different UD Approaches?

At least two overarching approaches can be identified: 1) “idealistic”: to design products and environments that aims at being accessible and fitting for all users as-is, and 2) “flexible”: to design products that may be customized to fit a wider range of user. The first is more focus on the “ideal” of UD, while the second is more focused on providing flexibility.

Idealistic: In relation to ICT solutions, UD can be understood as a distinct professional perspective, namely one of respecting and valuing the diversity in human capabilities, technological environments and contexts of use (Jonathan Lazar et al., 2010). It is often claimed that many ICT solutions and services are designed for a stereotypical or representative average user, for example through generalized persona representations of primary user groups. In contrast, UD principles focus on diverse user groups. Participation of marginalized users in socio-technological decisions is often stressed as an important factor in order to reach social and digital inclusion. Some thus describe UD as a “culture shift” – a changed attitude and sensitivity (Stephanidis & Akoumianakis, 2001) when designing and developing technological products.

Flexible: Designing solutions to fit the needs of all user groups are not trivial. Some argues universal solutions are not always possible, nor necessarily desirable. The “**flexible**” strategy is not so focused on a “one size fits all” solution, but rather on supporting the edge-case users (also called extreme users) facing specific challenges. As such, the **flexible** approach can be viewed as a “specialized design” approach. These views can be found both among designers and developers, and are as such not tied to a specific profession. However, within UD of ICT many of the approaches to ensure flexibility are tied to **technical** strategies such as dialogue independence, multi modality, interface adaptability (modification by user), interface adaptivity (modification by system) and Assistive Technology (AT) developments.

Paradigm shift in designers' attitude: The position paper *Shifting Paradigms in Universal Design* (Dong, 2007) described another way to view these two strategies; by placing the first as an "idealistic" bottom-up approach and the second as an "assistive technology" (AT) top-down approach. Prof. Dong views the "ideal" strategy as the new approach, representing a **paradigm shift** by replacing the heavy focus on ATs. She states: *"There has been a shift from designing special aids and equipment for disabled people (an Assistive Technology Approach) to designing mainstream products for as many people as possible (a Universal Design Approach)."*

Disciplinary or Multidisciplinary Strategies?

In her position paper, Dong indicates a second paradigm shift in UD of ICT is moving from disciplinary to multidisciplinary efforts (Dong, 2007). She views **systematic** approaches (including design methodologies, processes and evaluation frameworks) as typical for researchers with an engineering background, while **inspirational** approaches (case studies challenging conventions) as typical for researchers with design backgrounds (Dong, 2007). We agree with her discussion on how UD benefits from multidisciplinary approaches, combined and integrated strategies, and the importance on critical and ethical reflections.

Common Technical Strategies for UD

Dialogue independence to provide flexibility: Through dialogue independence, the presentation layer of a system is separated from semantic and syntactic layers (i.e. the logic of and interaction to/from the system). Thus, the presentation, the user interface may be designed in different versions. McDonagh and Weightman argue for developing multiple alternative user interfaces, and let the user choose the best fit (Weightman & McDonagh, 2003). McDonagh and Weightman believe users should be able to adapt, modify, specify or design interfaces and/or interaction styles for themselves to match their own needs. One could also make customization settings possible, for example in browsers (Hartson & Hix, 1989). Dialogue independence is achieved in web-solutions through the separation of CSS (cascading style sheets) from underlying code (such as HTML, XML, JavaScript etc.).

Multi-modality to provide flexibility: Multi-modality is allowing different possible interactions forms for input to and output from a system. These are typically made available to the user through allowing different input and output devices, as well as ATs such as screen readers and switch systems. For example, being able to choose between using speech recognition, computer mouse or keyboard for input, and between receiving audio, textual or visual output.

Dissecting web-based solutions: Some like to approach UD for web-based solutions by dividing them into three "layers"; 1) First, technical accessibility as the base, 2) Second, a pedagogical level with interaction design of the website (including navigation structure, labeling etc.) – but also taking into account ergonomics and ensuring universal usability, and finally, 3) Third, the content of the website which must also be accessible and usable for all users.

This model merges all UX activities into the second level, and is not separating sub-disciplines such as visual design, pervasive design, information architecture, interaction design and digital ergonomics. However, it can help understand the inter-disciplinary nature of ICT-solutions.

Further, this layered model underscores how current regulations are mainly targeted towards technical and physical accessibility. There is some focus on content (e.g. public document formats) and visual design (color and contrast use), but aspects related to usable accessibility remain largely unregulated.

Technical standards and guidelines: The use of guidelines has been recommended as a good, cheap basis for integrating the needs of people with varying abilities into design at an early phase. An important set of guidelines for UD is the legislated **Web Content Accessibility Guidelines** (WCAG). The World Wide Web Consortium (W3C) is committed to UD. The main intent is expressed in the statement "The power of the Web is in its universality. Access by everyone regardless of disability is an essential aspect." The WCAG guidelines developed by W3C's Web Accessibility Initiative (WAI) is tailored to checkpoints for the accessible design of websites. WCAG guidelines are being heavily utilized in legislation. Currently, Norwegian legislation refers to the WCAG 2.0 version of the guidelines, however the EU legislation has been updated in 2018 to reflect the updated WCAG 2.1 version, with some added criteria. It is highly likely that Norwegian regulations soon will refer to WCAG 2.1 also, probably (still) demanding web-based ICT-solutions to adhere to an AA-level.

Promoting Technical Guidelines, including Technical Standards & Dialogue Independence, is viewed as a **technical strategy**, within flexible or assistive technology approach, which is frequently demanded from the industry through **top-down** legislative manner.

Common Design Strategies for UD

Improving designers' sensitivity: User involvement (or user participation) is an established technique for uncovering different user perspectives. Such methodologies could be adjusted to embed **empathic** and **sensitive** design approaches more, such as suggested by Milne et al. (2005). Empathic design strategies (such as empathic modeling) and increased **user contact** and closeness to users are methods that can provide a deeper understanding of user needs.

User-centered and participatory approaches have historical roots in Scandinavia, and have received political focus since the 1970s. User-centredness received renewed attention in the 2007 government renewal strategy, the government White Paper "An administration for democracy and community[2]" (No. 19 2008-09) (FAD, 2008) and the 2009 government communications policy. In 2010 the Agency for Public Management and E-Government (Difi) ascertained the extent of user-involvement (polls, surveys, user councils, user-involvement and user-centered strategies). Their investigation reveals most Ministries require user focus of their enterprises. A majority of the enterprises also feel user centeredness pays off. Almost all public enterprises report that user focus and/or user participation is a metric in the enterprise managment documents or other key documents. The main challenge seems to be to utilize user feedback for improvement (DIFI, 2010).

A wide range of user-centered approaches exists. At one end of the extreme, you find approaches taking knowledge about humans and users into account when designing, but with no

2 "Forvaltningsmeldingen"

direct user contact. Surveys are an example of a typical low-contact method for knowledge gathering and requirements specification. Knowledge about e.g. customer patterns, ergonomics or human cognition may form the basis for development, but only low-contact methods are used within the design process. These approaches may still be classified as **user centered**.

Next, you find processes adding low-contact methods, or combining low-contact methods with medium-contact methods. Classic user-centered approaches used within software engineering usually include at least some user contact, through iterative usability testing. Sometimes, more high-contact methods are also used for gathering requirements. If so, the approach may adhere to the ISO 9241-210 standard for **human-centric design** (ISO, 2010). This approach adhere to the following principles: 1) design is based upon an explicit understanding of users, tasks and environments, 2) users are involved throughout design and development, 3) design is driven and refined by user-centered evaluation, 4) the process is iterative, 5) the design addresses the whole user experience, and 6) the design team includes multidisciplinary skills and perspectives.

Human-centric, human-centered and user-centered are overlapping terms, and they have no clearly established degree of user contact. Further, each method does not have a clear degree of contact. For example, interviews and observations may be regarded as either medium or high-contact, depending on the distance maintained to the users in their application.

User involvement is used for user-centered processes where users are invited to contribute more actively. More high-contact methods are used, for example design workshops. When user are involved in design work, or alternatively in specification and prototyping, the design approach can further be labeled **co-creative**.

Participatory design is used where there is extensive user involvement throughout the process with the underlying notion that the "user knows best", or at least that "the users knowledge is as important as the designers", and where the voices of the users are viewed as equal to the designer's.

Empathic design aims to foster empathy with the user, typically through making the designer "experience" the challenges and pains of the user (e.g. simulating disabilities).

User-sensitive design aims for in-depth understanding, typically through high-contact methods and empathic design approaches – even encouraging the development of personal relationships between designer and users.

Inclusive design aims to include non-typical end-user groups, thus highly overlapping with UD in terms of wanting to create solutions that are usable for a wider audience.

Edge-case design points to specialized design to a specific and non-typical user or context of use.

Promoting Inclusive Values & Sensitivity: The different user-centered approaches are commonly mixed, for example adding user sensitive design to inclusive design, or mixing empathic design and edge-case design. Embedding inclusive design and empathic design strategies into existing user-centered design and development methodologies could be considered an **ideal** UD **strategy** from **within** the UX and **design** professions.

Towards Integrated Strategies for UD

Moving from the disciplinary idealistic or technical approaches to an integrated, multidisciplinary UD strategy is recommended, where cooperative efforts are made to reach universal accessibility, usable accessibility, flexibility in contexts of use and user abilities, technical accessibility and test assistive technology compliance.

The two overarching approaches "flexible" and "idealistic" are not necessarily mutually exclusive, and many of the strategies used to ensure flexibility are utilized within idealistic approaches. The boundaries between the approaches are blurred, and they have evolved in parallel.

Similarly, the use of technical and design approaches could, and should, complement each other. For example, guidelines seem the most powerful if the practitioner understands the reason behind a guideline, as well as the implication of following or not following the guidelines.

Also note, that there are other useful guidelines than technical standards such as WCAG. An important set of guidelines when we talk about UD is the **7 principles for UD**, developed by The Center for Universal design (Connell et al., 1997):

1) Equitable Use
2) Flexibility in Use
3) Simple and intuitive
4) Perceptible information,
5) Tolerance to Error
6) Low Physical Effort
7) Size and Space for Approach and Use

For any readers familiar in the field of HCI, the 7 principles are similar to interaction design heuristics, but may be interpreted as focusing more on usable accessibility (i.e. "universal usability") than on technical accessibility (i.e. "universal accessibility"). They are not specifically tailored to suit ICT solutions, however, but are instead rather quite focused on physical and ergonomic aspects of use.

Combining User Empathy & Checklists? Combining guidelines and other "checklist approaches" with increased user contact and empathy makes sense as an integrated approach. Empathic design can be applied to combat the criticism guidelines meet; namely, that guidelines will never be able to cover all possible issues of use in a case. Awareness of user diversity and more sensitivity to and knowledge of user needs can make a designer capable of take into account actual real usage problems, beyond guidelines (and determine if guideline is counterproductive). Milne et al. (2005) presents several ideas for combining top-down "guidelines" and flexible strategies with bottom-up user sensitive "understanding" strategies, encouraging a more holistic approach to accessibility.

Different UD approaches can as such be considered complementary towards the creation of a more accessible society through an **integrated** approach; acknowledging diversity among i) contexts of use, ii) users and iii) aims/tasks, and responding to this by iv) critically reflecting on the possible flexible design space and solutions to v) make informed design and technical decisions and trade-offs. Even if the ultimate goal is to design products to fit all users, some users may need to be prioritized to the disadvantage of others.

Paradigms, Epistemologies and Worldviews

When looking at the possible paradigm shift in the field towards integrated approaches, and the increased cooperation between disciplines, the different types of positions that experts typically hold today is likely to influence which UD strategy they apply, or are willing to apply (idealistic or flexible, bottom-up or top-down, sensitive or checklist etc.). We thus continued by looking into the paradigms, epistemologies and worldviews existing in relation to UD of ICT, and how they came to be, in order to identify the current mindset of professionals. This section presents one way of categorizing these stances.

Paradigms can be described as overarching mindsets including academic culture, ideology, epistemology and worldview.

Epistemologies refer to what we think, know, and know we know - in other words our frameworks for knowledge and how we justify our beliefs, truths and views.

A **worldview** is our conception of the world, which changes as we acquire, revise and eliminate our beliefs.

We identified three relevant paradigms: Positivistic, Constructivist and Critical – each with different epistemological views. We also identified the Mechanical, Romantic and Dialectic worldviews. Figure 4 overviews our findings from the background research.

Study 1: Research Approach

We concluded our background research by looking into existing paradigms, epistemologies and worldviews. Next, we wanted to answer our research question 1.1 "What are common methodological approaches used in UD of ICT?"

Literature Review 1: Methodological Approaches used in UD of ICT

A limited literature review was used to identify methodology used to accomplish UD of ICT. 134 ScienceDirect journal publications within the discipline of Computer Science were screened, as described in the Thesis Background section 2.7 A Brief Look at Research Focus in the Field.

Based on background literature, it seemed the terms "universal design", "design for all" (DfA), "universal access" and "inclusive design" were used somewhat interchangeably. "User sensitive universal design" was considered closely linked. These five terms were thus used as search terms.

The inclusion criteria were 1) attempts to achieve UD for more than one user group and 2a) at least one user group is marginalized or 2b) theoretical aspects related to UD is discussed, 3) the publication discussed methodology. 45 of the 134 publications fulfilled criteria 1 and 2a/b. These 45 papers were reviewed to extract methodologies and approaches (see Study 1: Results, p. 81).

Literature Review 2: In-Depth Analysis of Methodological Approaches

Then, methodological approaches identified as common are investigating through a second literature study, in order to answer research question 1.2: "What are the key traits, differences and similarities of these approaches?" The second literature review analyzed the focuses and meta-level discussions of the identified methodologies, including paradigm and epistemological stances.

The second literature review was much more in-depth, and spanned the highest cited academic publications on the methodologies identified as commonly used. Stances reflected were mapped out for each of the methodologies, and then compared. In this work, we iteratively explored whether methodological stances could be tied back to underlying beliefs.

Inclusion of research to be reviewed were stopped for each of the search strings when either a) more than 50 publications were included and a clean citation stop point were reached (all publications with an equal citation count is included), or b) all cited publications for the search term is included. The screening removed false hits and papers only using search terms in their references, while articles having the search terms within the article text or as a keyword provided by the authors were included.

For each of the resulting set of articles, the following analysis is made: First, an inquiry into methodological focus, utilizing Table 9: Methodological focus in the Science Direct sample classification as a-priori categories to look into distribution of focus and differences in the amount and type of focus between the approaches. The categories are treated as mutually exclusive. Some articles focus on both methodology and end-results, and in these cases, the category picked is the one receiving the most emphasis when specifying the contribution of the research in the conclusion and abstract.

Second, a look at the definitions, interpretations and operationalization of each approach in the research, what attributes and aspects of the approaches are given focus and how consistent. The following three stances were developed from the background research, and used when evaluating the focuses and emphasis of the different articles within the methodological approaches,

Stance 1 – The Positivist

The Positivistic paradigm: Technical sciences, including the computer sciences, are historically rooted in the positivistic paradigm – along with natural sciences (Milne et al., 2005). This paradigm manifests itself in desires to logically analyze, define and specify what (and how) to create (and evaluate) prior to development (as in "hard system thinking"*)*.

Positivist epistemology: The positivist epistemology believes there are facts about the world to be discovered, investigated and described, typically using quantitative and empirical proofs (rationalism or empirism).

Mechanical worldview: Computer scientist belonging to the positivist paradigm is believed to typically hold a mechanical worldview (Design, 2012). The mechanical worldview perceives the world as a machine guided by logics (Dahlbom & Mathiassen, 1993). This view was born in the 17th century, by among other Descartes. An important value was the belief in objectivism; *"It were far better never to think of investigating truth at all, than to do so without a method … by a method I mean* *certain and simple rules, such that, if a man observe them accurately, he shall never assume what is false as true, and will never spend his mental efforts to no purpose."* – Descartes in (Dahlbom & Mathiassen, 1993).

Stance 2 – The Constructivist

Constructivist paradigm: Though computer science has it's historical roots in positivistic and mechanical views, aspects from other epistemologies have emerged over time as the field has matured (Dahlbom & Mathiassen, 1993). In the constructive (or interpretive) paradigm, the desire is to understand different subjective perspectives, and from here interpret and negotiate to arrive at or construct a common subjective-objective agreement on what (and how) to create (and evaluate), and continue to collaboratively update, change and negotiate this throughout the development.

Constructivist epistemology: The constructivist epistemology recognizes that there is not only "one truth" – but rather we all have our own perspectives on the world. Qualitative research techniques are embraced. Instead of focusing on an objective truth, reflections upon coding and the researchers interpretation of the data are vital to ensure reliability and validity. Further, the world as well as our individual perspectives constantly changes over time. Viewpoints shared by many are more reliable "truths" than those only shared by a few. One typically also tries to make transparent the reasons for ones own views (staying objective despite knowing one cannot fully be so). In other words, one tries to carefully interpret. A (supposed) quote from Nietzsche: "Against that positivism which stops before phenomena saying 'there are only *facts*,' I should say: no, it is precisely facts that do not exist, only *interpretations."* (wikiquote).

Romantic worldview: If the designer's focus is on facilitating dialog and keeping stakeholders in agreement, in line with soft system thinking (Dahlbom & Mathiassen, 1993) and post-design attitudes (M. E. S. Nes, Ribu, & Tollefsen, 2007), a romantic approach is taken. Whereas a mechanical view places importance on objectiveness and measurability, a romantic view places importance on in-depth understanding and collaboration. True "objectiveness" is questioned, aligned with constructivist epistemology (M. E. S. Nes et al., 2007). The gold standard in the romantic worldview is managing to arrive at mutual understanding, where what is "the right" solution to build is agreed upon by stakeholders and various user groups in collaboration. Technology is viewed as being developed for specific users and contexts, and excluding others. The idea of one correct and neutral technological solution from the hard systems thinking is renounced (Sanders, 2002).

Stance 3 – The Critical

Critical paradigm: This paradigm also questions "objective" truths. Emphasis is more on uncovering all relevant information and ensuring nuances are identified. The critical paradigm desires to analyze, question and debate what (and how) to create (and evaluate) something.

Critical epistemology: The critical epistemology views truths as subjective, and as such, "truths" should be questioned. Why is something stated, and what is omitted or hidden? This type of critical questioning is found in *design thinking* approaches. If everyone creates their own subjective truths, these presented "truths" must be evaluated in a highly critical and reflective manner. As such, critical epistemology also contrasts the focus on quantitative objectiveness and correctness found in positivist epistemology.

Dialectic worldview: The dialectic (or interventionist) stand is that technology is non-neutral. The focus is not so much on creating a correct solution in relation to specifications, as arriving at a good solution from ethical and socio-technical viewpoints. This worldview takes on the perspectives of i) the responsibility and possibilities of humans in shaping the future through socio-technical co-constructivism, and ii) the view of there being several possible technological solutions, where none are neutral. As such, some solutions are better for specific user groups, while others benefit other aspects or users.

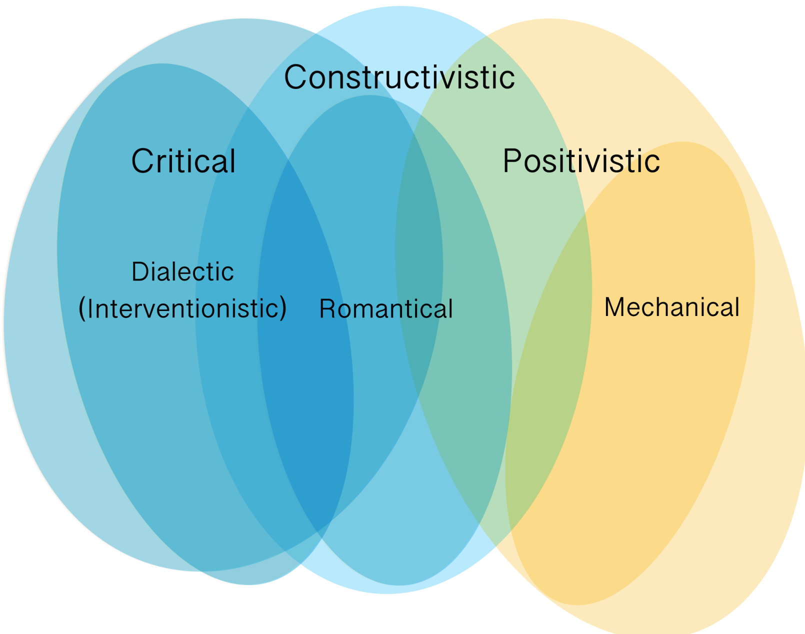


Figure 4: Identified paradigms stances and worldviews in the field of UD of ICT

Study 1: Results

The literature survey indicates generalizable methods for achieving UD in ICT are lacking, and instead the field has a high degree of case-specificity. The frequent case-based focus on finding a solution to a specific problem for specific users in a specific context of use presents a challenge for accumulating generalizable knowledge across cases. In addition, the varied nature of the research makes it challenging to create an overarching framework for how to design, specify, evaluate, compare and rate universal design attributes in ICT solutions.

Methodological Approaches used in UD of ICT

The aim was to identify common methodological approaches used in UD of ICT. However, only 10 of the 45 articles discussed methodology. Of these, three articles were concerned with specialized design only, thus excluded from further analysis. The remaining 7 articles were carefully read to analyze their reflections on methodology for UD of ICT, including paradigms, traditions, theoretical aspects, framework, general approaches or specific methods/techniques.

Investigating the Methodological Research Focus

Table 9: Methodological focus in the Science Direct sample

Methodological focus	Papers
Meta-level; paradigm; research tradition	1. Ethical debates in the Digital Age; the role of UNESCO (Dahlbom & Mathiassen, 1993) 2. Evolution and challenge of UD and ID in US (M. E. S. Nes et al., 2007)
Process-level; framework; process model; general approach	1. Applying a Participatory Design (PD) approach to idea generation for new mobility aid products (Pohle, 2014) 2. The role of IAUD[3] in advancing UD in Japan (Fletcher et al., 2014)
Method-level; technique; specific approach	1. Investigating use of personas & scenarios (low-contact UCD) in combination with ICF[4] for AAL (Wilkinson & De Angeli, 2014) 2. Propose a new tool (TEIF) for designing accessible mobile learning systems (Kawahara & Narikawa, 2014) 3. Compares known ID methods (user trials versus exclusion calculations) to identify usability issues and coverage (Queiros et al., 2014)

Table 9 displays the different topics and focuses of the papers, categorized into Meta-level, Process-level or Method-level perspectives. An emergent approach was used for the classification. The Meta-level category refers to discussions linked to epistemologies, traditions and paradigms. We classified two papers as on discussing meta-level methodology. The papers in this category reflect upon ethical values and challenges in the digital age. The Process-level category is used for articles presenting general approaches, models and frameworks for conducting universal design. We classified two papers as Process-level. In the Method-level category, we classified three papers as concerned with concrete approaches, methods or techniques that should or could be applied.

The 7 articles reflected different paradigms and views on UD, and different methodological focuses ranging from developing specific tools to societal structures. The articles seem to mainly be from positivistic and critical research paradigms, spanning from a more mechanical worldviews in articles narrowly focusing on technology and indicating a strong technological optimism, to softer, more pragmatic and value-based views.

Identifying Common Methodological Approaches

Though only so much can be induced from this limited set of data, we were able to identify four prevalent design approaches used across the 45 UD of ICT research publications. These

[3] International Association for Universal Design
[4] International Classification of Functioning, Disability and Health

methodological approaches were: 1) User-Centered Design (UCD), 2) Participatory Design (PD), 3) Inclusive Design (ID) and 4) Universal Sensitive Inclusive Design (USID), see Figure 5.

All the four named methodological approaches held values and views advocating for user-centeredness and design for diversity. As such, we found indications that the field did hold common ideal values and principles with regards to UD methodology, which was encouraging.

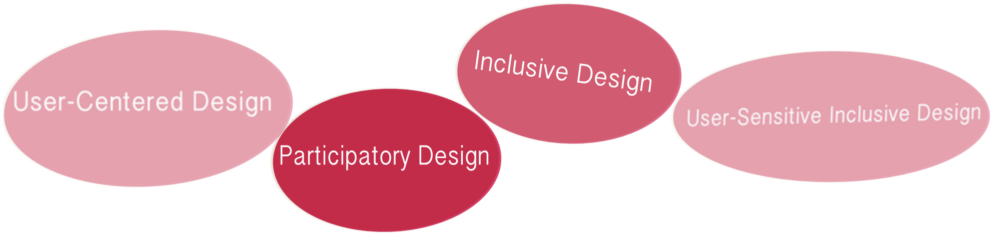


Figure 5: Methodological approaches used in UD of ICT

In-Depth Analysis of Identified Methodologies

The four design approaches were investigated in-depth, through a new literature review spanning 244 articles pre-screening and 139 articles post-screening. Post-screened articles were divided as follows among the four methodologies: 39 articles analyzed on the inclusive design approach, 24 on user sensitive inclusive design, 54 on participatory design and 35 on user centered design.

Each of the four approaches 1) User-Centered Design (UCD), 2) Participatory Design (PD), 3) Inclusive Design (ID) and 4) Universal Sensitive Inclusive Design (USID differ in what values and methodological stances are highlighted, see Table 10. The findings indicate that the approaches vary on aspects such as epistemological stances related to empathy and sensitivity, knowledge acquisition and interpretations of "truths", e.g. on degree of user involvement, the relationship between designer and end-user and attitudes towards active user participation. Detailed findings on each of the four methodological approaches and the discussion of their similarities and differences can be found in Paper 1: Begnum (2018) *Universal Design of IT: Common and Approaches*. Some may be viewed as sub-approaches to others, as illustrated in Figure 6.

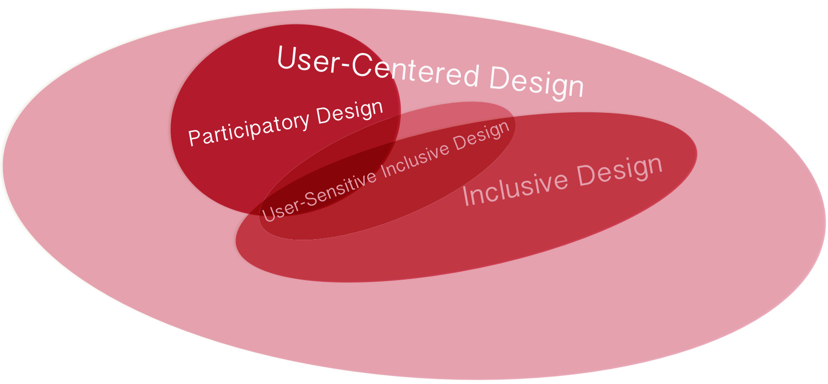


Figure 6: Relationship between methodological approaches in UD of ICT

Table 10: Attributes emphasized in publications' descriptions of methodological approaches

Attributes Highlighted in Paper Methodology Descriptions/Definitions	UCD	ID	USID	PD
User-centeredness (understanding needs)	11	6	13	-
Design for all/inclusiveness (user diversity)		16	10	
Design for distinct, specific user groups		5	8	
Users participating - active involvement	4	-	1	19
Contextual and conditional use	3	3	-	
Knowledge acquisition (sensitivity, empathic design, attitude of awareness)	-	-	7	-
Knowledge acquisition (perspectives/insights	-	-	-	13
Ethics; democratic design; politics	-	-	-	9
Task focused	6	-	-	-
Expert evaluation; guidelines/heuristics	7	-	-	-
Formative (informal) user centered evaluation	6			
Summative (formal) user centered evaluation	3			
Prototyping	8			
Iterative improvement	5			
Multi-disciplinary	3			
Product quality				1
No relevant definition provided	*7*	*19*	*7*	*31*

We further explored whether methodological stances can be tied back to epistemological beliefs. Based on the investigation of methodologies, the epistemologies and paradigms given emphasis are explored for each approach, using a bottom-up and phenomenological approach. Though the field contains worldviews from both classic positivistic thinking and critical thinking, the most prominent meta-level views seem linked to romantic, constructivist and interventionist stances.

To elicit awareness of the relationships between methodologies, we proposed the model in Figure 7. The model visualizes the overlapping and interconnected nature of the paradigms. This provides a basis for understanding and reflecting on the effect of epistemologies and provides a basis for understanding and reflecting on the effect of epistemologies and methodologies in the field, which are foundational to our analysis of UD.

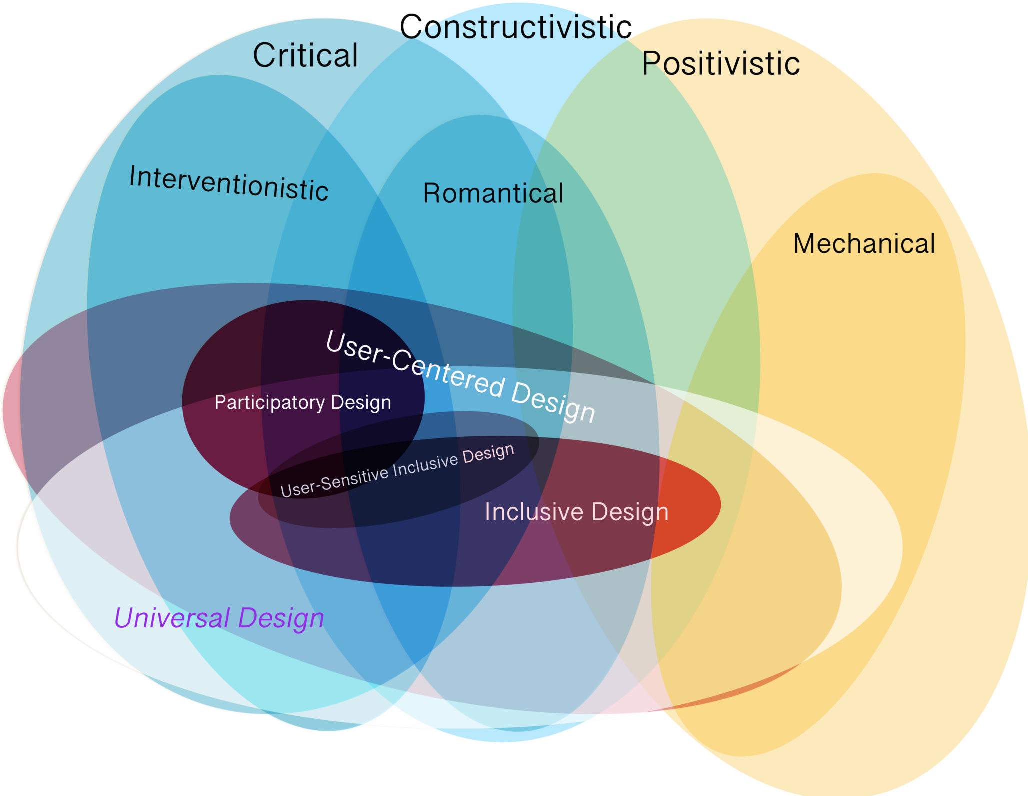


Figure 7: Relationship between methodological approaches and epistemological stances

Study 1: Discussion

Our viewpoint from conducting Study 1 was that researchers hold, recommend and argue for different epistemological stances related to UD of ICT. Further, paradigm stances and epistemological views seemed tied to methodological approaches. Three paradigms were detected in the field, however Critical and Positivistic stances seemed the strongest. Four specific methodological approaches were identified: UCD, ID, USID and PD. Our hypothesis on methodological and epistemological relationships was expressed in the model in Figure 7.

Identified design approaches are overall in alignment with the ISO standard for human-centric design processes for interactive systems ISO 9241-210 (Angkananon, Wald, & Gilbert, 2014). The British Standard 8878 Web Accessibility Code of Practice also propose a user-centered approach to producing solutions that are accessible to a wide range of users. This indicates user-centeredness is generally recognized important for achieving UD.

Even if all common design approaches were user-centered, at least two different epistemological stances appear present in the field. These offer different philosophical justifications for what one believes is valid knowledge.

The first stance seems influenced by (post) positivism (Goodman-Deane, Ward, Hosking, & Clarkson, 2014). We connected this Positivist stance to Mechanical worldviews, and hypothesized such views are tied to a user-centered methodology with low user contact. Figure 7 presents this stance in yellow. Researchers within this "positivist" stance seemed to emphasize technology, checklists, standards, automatic tests and inspections (ISO, 2010). Our impression is those with a "positivist" stance sometimes view UD as an added constraint to be checked of a to-do list, preferring a "just tell me what to do" approach to UD. This compliance focus may lead to a negative view on UD, seeing it as merely placing additional demands on and limiting the freedom of the developer or designer.

Contrasting the Positivist stance, we identified a Critical stance. This Critical culture seemed prominent in PD, ID and USID approaches, and was more focused on user contact and involvement. The stance was reflected participatory, inclusive and user-sensitive approaches (Dahlblom & Mathiassen, 1993) and appeared more supportive of UD values. The stance is colored blue in Figure 7. We felt an Interventionist attitude was tied to the stance; viewing technology as non-neutral and not so much focused on creating correct solutions as creating beneficial solutions for all. However, Romantic views were also identified; focused on dialogue. Constructivist and romantic views both seemed relativistic ("information represents individual truths"). These views were felt to oppose non-relativistic Positivist stances ("facts are facts").

Limitations of Study 1

Although it is considered unlikely to be bias between the databases ScienceDirect, IEEE and SpringerLink, using the selection of ScienceDirect in the first literature selection is a potential limitation in the review. We further assumed that the four identified methodological approaches can be regarded as commonly used within UD of ICT, despite the limited number of reviewed articles. We note however, that there is a chance there are other approaches common to the field. Further, in our analysis of methodological approaches, the authors of the 139 included publications were not interviewed. This introduced a risk of a potential misinterpretation in the analysis of the epistemologies and the described approaches.

Towards Study 2

Next, we wanted to know how Norwegian expert practitioners place themselves in relation to our methodological model in Figure 7. We wanted to validate the model against expert practice, and assumed correlations would be identified between stances and approaches as identified in the model. Further, we wanted to use the model to classify the expert practitioners, in order to understand the approaches and stances that should be considered best practice for UD of ICT.

Study 2: “What Experts Say”

Study 1 contributed to eliciting understanding and awareness of the different epistemologies, paradigms and related methodological approaches in the field of UD of ICT. This work was continued in Study 2. In Study 2, we asked the Norwegian community of UD of ICT experts on their epistemological stances, worldviews and methodological practices. Triangulating literature reviews with input from experts or practitioners has proven a good way of identifying evidence-based practices best practices, as the danger of ignoring factors critical to the successful integration in real world settings is then greatly reduced (Spencer et al., 2013).

We now investigated research question 1.3: “Which methodological stances and views do domain experts hold, and is there a shared understanding of suitable practice for achieving UD of ICT?” We also asked the sample on specific methods and techniques in use, including reasons behind methodological choices, in order to further deepen the understanding of the current practices. We hoped to identify attributes and constraints that could have predictive quality aspects.

We also explored UD definitions and terminology in use by the expert sample, and their disabilities views. We wanted to see if we could model such perspectives and answer question 1.4: “How do domain experts understand and view key terms?”

Study 2: Background

Different strategies may be applied when faced with real-life challenges such as tight deadlines and limiting resources. One’s **doxastic style** is used to denote the methodological approach one takes based on one's worldview and epistemologies. At this point in our research process, three caricatured doxastic styles appeared based on the identified paradigm stances:

Style 1 – The Expert

Within the positivist stance, it makes sense to view the professional as an expert. The experts can help articulate objective, static, generalizable insights, and specify precise criteria to make sure the correct solution is built, in the correct way. The Expert may ask questions such as: What do we know? What is the aim? How can we get there? How can the aim be measured?

We envisioned the Expert professional as someone rationally defining the best way forward within constraints; either top-down stepwise or more empirical, experimental and inductive. We hypothesized this stance was be influenced by classic (post) positivism and focused on technological solutions, UD checklists, automatic testing and expert inspections (Horton, 2014; Wobbrock, Morris, & Wilson, 2009).

Such strategies connects to **mechanical** worldview (Dewsbury, Rouncefield, Clark, & Sommerville, 2004; Massimi, Baecker, & Wu, 2007) viewing software engineering as a complex problem to be solved through analytical approach. Thus, preferring quantitative methods such as summative user testing and usability metrics benchmarking, eye tracking, surveys, marked research, statistical analysis, expert analysis, task analysis and so forth could indicate a positivist epistemology.

The Expert professional typically aims at gathering (objective, static, generalizable) information & advice on the (one correct) solution to create.

Style 2 – The Negotiator

Interpretive and constructivist paradigm is believed tied to romantic worldviews; opposing the positivist emphasis of facts being facts and instead viewing subjective "truths" as individual explanations of empirical experiences (relativism). It makes sense to view the practitioner as an interpreter within both critical and constructivist paradigms.

When the practitioner focuses on facilitating dialogue and coming to mutual agreements, we view the professional as a Negotiator. Solutions are developed because of discussions between influential social groups, with the Negotiator taking an active role to facilitate dialogue and reach a compromise between varying stakeholder opinions. The Negotiator may question: Who are the stakeholders (and users)? What are their priorities? How can we secure a fruitful collaboration?

The Negotiator's goal is to identify solutions that fit all stakeholders' needs, to the largest extent possible, within the defined constraints (which may change over time). The style should fit well with the agile process of continuous updating the goal and the prioritizations based on new insights and circumstances. He/she holds quite romantic views; assumed to fit with soft system thinking which encourages considerations of different perspectives and negotiations.

The Negotiator professional typically aims at (interpret and) understand (subjective-objective) stakeholder needs & help co-create one good solution (among several possible).

Style 3 – The Advocate

A final style is focused on advocating for positive change; working to actively influence decisions, including altering specifications and constraints. The Advocate may ask questions such as: Why did someone say that? What was left out, and why? Are there other viewpoints? Critical thinking is assumed to fit the Advocate style well; "Why this aim?"

Viewing technology as non-neutral and co-constructive, the Advocate is believed to apply an interventionist and dialectic strategy. Several possible solutions and viewpoints are considered (Horton, 2014; Wobbrock, Kane, Gajos, Harada, & Froehlich, 2011). As for the Expert, the Advocate practitioner is taking on the role of a problem solver, but this time in a more political manner. Based on the practitioner's critical understanding, an Advocate may advice on the best solution to build. Alternatively, perhaps, the Advocate will question if one should create technological solutions at all, or create something else. The style should fit well with design thinking approaches; supporting divergent ideas. Information is assumed viewed as subjective, evolving and nuanced.

Like the Negotiator, the Advocate practitioner interprets the "truth". Utilizing qualitative in-depth user research methods with the aim of gaining experience and knowledge of what (and how) to build (such as interview- and observation techniques, collaborative workshops and informal user testing) could be indicative of non-positivist doxastic styles. The Advocate would typically aim at questioning pre-perceived understandings (critically) & influence stakeholders in order to arrive at the (ethically) best (among many possible) solution.

Definitions of Disability

When answering research question 1.4 on key term usage, we also wanted to look into the disability models in use and how the expert sample understood disability. Though perhaps not often reflected upon, different models for defining "disability" co-exist. Paper 4 presents the different disability model views used in Study 2. A short summary is presented in Table 11.

Table 11: Short description of disability model views

Disability Model
Medical: A disability is a person's negative deviation from normal human bodily function, and should be treated (abnormality). Distinguishes between impairment and disability.
Expert: An expert identifies a disability, and creates a plan for treatment and/or assistance. A disabled benefit from intervention to correct/minimize deficiency.
Social: Disabilities are mainly socially created; thus a societal responsibility to remove attitudes, physical and social barriers that exclude from participation.
Right-based: Disabilities should not affect a person's opportunities for participating in the society, nor the access to products, goods and services.
Empowering: The disabled person should be the one in charge of any treatment or assistance plan (professional expert is an advisor and service provider).
Social adapted: Individual disability may somewhat limit, but mostly disabilities are socially created.
Bio-psychosocial: Disability defined by interaction between bodily functions and specific social contexts.
Legitimacy: Disabilities can be defined in many ways, thus rights should be based on personal needs for assistance and adaptations.
Spectrum: A disability is defined along a range of seriousness based on functional ability threshold levels (i.e. mild, moderate, severe, complete).
Marked: Disability is a part of personal identity. Disabled and their families is a large and influentional customer base with consumer power & stakeholders.
Economical: A disability is defined by a person's (in)ability to work and the degree to which economical and productive conditions are affected.
Charity: A disability is a personal, undeserved tragedy; disabled people deserve aid and sympathy.

Study 2: Research Approach

In Study 2, we developed a questionnaire survey based on the Study 1 findings and the tentative model. We sampled practitioners identified as experts in UD of ICT in the Norwegian community, and asked them on their views, practices, experience and stances. The aim was to check our theoretical assumptions, validate or correct the model and map the survey respondents into the model in order to visualize the current methodological styles of Norwegian expert professionals. The hope was we could map the experts and disability views into Figure 8.

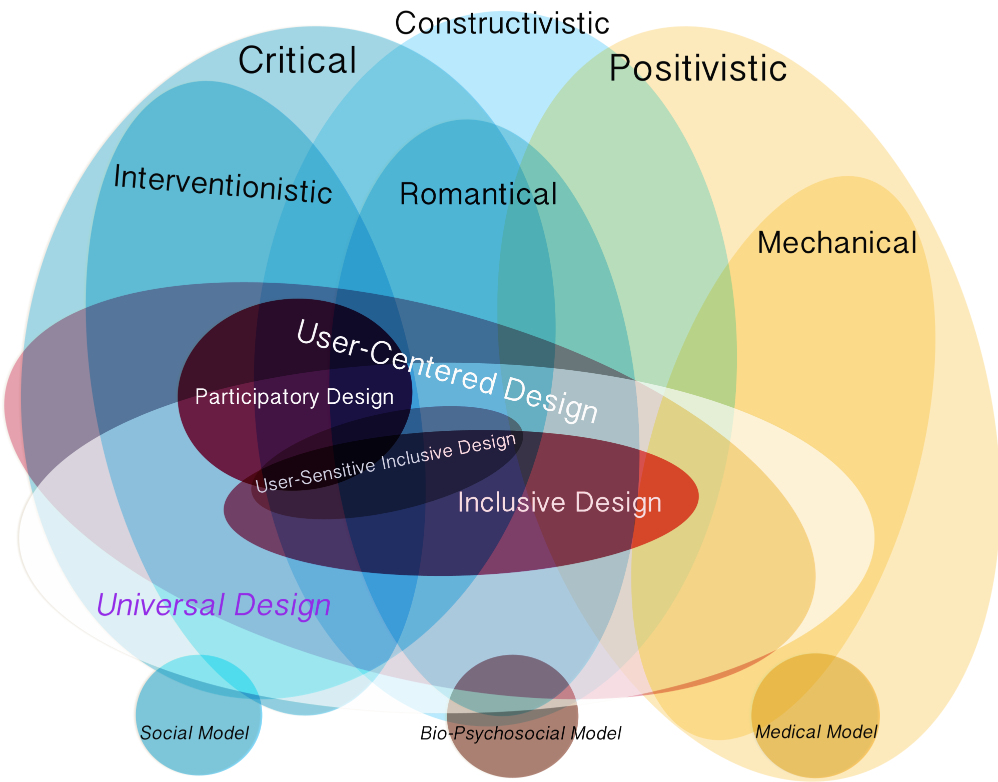


Figure 8: Model of expert professional stances as assumed from literature

Survey Design

We chose an online approach to data collection, to easily reach our participants. The survey questionnaire had 21 items, including background data. We struggled with shortening the quite long survey, as we did not know which questions were most important. In hindsight, a couple of initial interviews prior to finalizing the questionnaire could have helped in this regard.

Study 2 survey mixed open and closed questions, all designed to be non-biased, easily understood and without negative wording. We utilized short and long open answers, single selects, unordered multiple choices, ordered Likert-scales, and ordered single select matrixes (one choice per line, typically from “strongly agree” to “strongly disagree”). Matrixes helped make the survey shorter and easier to answer. We frequently used the open category "other, please explain:" with a short open answer at the end, to make sure we covered all relevant answers to closed questions.

Epistemological and Methodological Stances

Figure 7 from Study 1 formed the basis for creating survey items on Constructivist and Positivist statement agreement, Mechanical, Romantic and Interventionist view alignment, Relativist or Non-relativist agreement, Quantitative or Qualitative agreement and Design approach agreement; from no-user contact to participatory design. In other to verify and increase our understanding of the hypothesized links between attitudes and methodological choices, inferential statistics was used. Through correlations (Spearman's rho) and cross-tabulations, hypothesized connections between paradigm stances, epistemological preferences, worldviews and doxastic styles were investigated. Paper 2: Begnum (2016) *Methodology for Universal Design of ITs; Epistemologies Among Norwegian Experts* explains the survey design and analysis of these items.

Sometimes, we felt we had to make questions more specific, in order to make sure all respondents felt confident in answering. For example, when investigating methodological approaches, Study 2 asked for degrees of agreement with different strategies. We phrased these strategies in relation to the respondents work ("*In my work, I…*"), linking the answers to what the experts do – and not necessarily their opinions. While this may have introduced a bias, it also made the question less provoking and easier to answer. On agreements, we used 4-point Likert-scales to force the respondents into taking a non-neutral stand.

Methods and Doxastic Styles

The survey also included questions on methods, techniques and approaches in use by the experts, an open item on the reasons behind their methodological choices and methods and approaches considered ideal. If best practice methodological attributes in relation to UD could be identified, we believed this would be an important contribution towards predictable and early quality assurance on a processual level. We also attempted to categorize method usage based on our pre-conceived notions of doxastic styles – as well as through a more emergent approach using method correlations. Paper 3: Begnum (2017) *Universal Design Approaches among Norwegian Experts* outlines the design of these survey items and their analysis.

User Focus and Disability Views

The survey asked for the degree of focus on a list of marginalized user groups, based on the report from (Dahlbom & Mathiassen, 1993) and marginalized or digitally excluded user groups mentioned in the background literature (public research reports and white papers). Further, we asked the expert professionals to rate their agreement with disability views, and to clarify their term definition interpretations and term usage. All disability definitions that appeared relevant for the Norwegian culture were included. We excluded the moral model, as well as the rehabilitation and interface models (considered fitting for the health sector, but not for the ICT domain).

UD Terminology and Definitions

As a basis for the item asking on UD terms, we used the same set of terms as for the Study 1 literature search. However, we added "accessibility". "Accessibility" is frequently used, but is argued to mainly only cover "technical accessibility". Note that instead of translating "design" directly, the Norwegian term for UD is "universal *utforming*"[5]. We translated English terms using "design" into both Norwegian versions ("utforming" and "design"). The items on user focus, disability views and terms usage is described in Paper 4: Begnum (2016) *Views on Universal Design and Disabilities among Norwegian Experts on Universal Design of ICT*.

Sampling

The respondents in Study 2 were identified using a non-probabilistic draw (Dahlblom & Mathiassen, 1993). We wanted to investigate the population of "expert professionals on UD of ICT". Our focus was on Norwegian domain experts.

We specified the UD of ICT domain as developing Universally Designed IT-solutions (including but not limited to services). We defined our population; as professionals 1) working with developing (including advising on and assessing) IT-solutions (including, but not limited to services), and 2) known to have a long professional interest and expertise in UD, or have a clear media/online visibility within UD of ICT, or working in organizations known to strongly promote UD focus. As such, experts would be identified based on their visibility in the field, and not a specific academic background.

We conducted a stepwise sample selection of persons fulfilling these criteria. We comprised the sample using the following three-step process; 1) identify experts among the members of the previous Norwegian network on UD & ICT, 2) identify experts among companies sponsoring IxDA Oslo and 3) identify other experts, e.g. referred by already identified experts.

Norwegian Network of Excellence for Universal Design and ICT

First, we examined the discontinued "Norwegian Network of Excellence for Universal Design and ICT". The Network was initiated in 2007, and run based on governmental funding until 2010. We considered organizations in the Network to have a long-standing academic interest in the field of UD, and to have a high degree of competence in the field. Several individuals in these organizations had participated in research, development, or evaluation of ICT-solutions together with representatives from NGOs for people with disabilities or illnesses. We assumed their colleagues also had at least a moderate competence in the field. The Network had representatives from 20 enterprises: 9 businesses, 6 research institutions (including universities ad university colleges), 3 public institutions and 2 organizations. We screened the former members in order to identify personnel working within the area of UD and/or accessibility of ICT – both individuals who represented their enterprise in the Network as well as any colleagues.

[5] "Utforming" is typically translated back to "design", but can also be translated into e.g. "formation" and "creation" according to the dictionary DinOrdbok: https://www.dinordbok.no/norsk-engelsk/?q=utforming

Experts were identified in five of the Network member institutions; 3 private businesses (16 experts), 1 research institution (5 experts) and 1 public institution (11 experts). In total, we identified 32 experts, of which 10 were known as active members of the former Network.

Interaction Design Association (IxDA) Oslo

Second, we examined the IxDA Oslo sponsors. IxDA Oslo is volunteer-based and non-profit. 9 enterprises were sponsoring the network at the time of sampling. All these sponsors were medium to large consultancies, of which several international. All had offices in the Oslo-region. The companies were Googled, and we screened the Google-hits in order to identify relevant experts. The potential company-employed were typically also Googled, and we scanned you-tube videos, online articles, and other digital media information. Official company websites as well as the websites of possible relevant company-employed, the official company blogs as well as the blogs of possible relevant company-employed, the official company twitter account as well as the twitter accounts of possible relevant company-employed were also scanned in order to identify relevant experts. The information pointed us to individuals within these companies linked to UD or accessibility work.

28 experts were identified from 7 of the sponsors. 1 person who had recently worked in one of the sponsor enterprises was also identified and included. None of these 28 had been a part of the Network of Excellence for Universal Design and ICT. We now had 61 experts sampled.

Other Expert Professionals?

Third, we aimed to include other expert professionals, not working in an enterprise attached to the two networks. Potential experts were screened for through academic networks and digital media channels examined in the sampling process. A new UD of ICT focused company that had not participated in Network of Excellence for Universal Design and ICT was identified, from which 9 relevant domain experts were included. Sampled experts made referrals upon request. All but one of the referrals was already included, indicating the sample search was sufficiently broad. In all, we added 10 experts though this third step.

Filtering the Final Sample

Our initial goal was to sample 30-50 domain experts for the survey. The resulting list of recipients included 71 experts. Our worry was that the sample was potentially too broad, and the "expert competence" too weak. Thus, we added a filtering-question as the first item in the questionnaire, asking for the number of years of experience within UD of ICT. One participant withdrew from the sample based on this item, reporting lacking experience within IT.

This left 70 experts in our sample. We considered the final sample a representative selection of individuals within the field of UD of ICT in Norway, including key actors in the field. We viewed the level of confidence in the sample as sufficient for seeking insights over generalizable results.

Internationalization: At the end of Study 2, an improved survey was translated to English. A self-selected non-probabilistic sampling was attempted to increase our N. The survey was posted online and in social media groups where the international population of UD of ICT experts were assumed to congregate, as recommended by Schmidt 1997, in (Jonathan Lazar et al., 2010). However, the number of respondents was very low and the data was not analyzed.

Distribution & Data Collection

As the Research Design chapter explains, the survey was piloted. We distributed survey links via e-mails, including an introductory letter to inform and establish credibility. We used a multi-step contact approach to increase response rate, by reminding and encouraging non-respondents.

Taking Care of Privacy

In Study 2, we were careful not to save any personally identifiable information (such as browser type and version, IP address, operating system or e-mail) along with the answer, due to the possible sensitive nature of some questions (even though anonymous participation limited further Study 1 investigations, e.g. clarification of individual responses and follow-up interviews). In Study 5 we did the opposite – at the end of the survey, we asked the respondents if they would allow us to contact them for a follow-up personal interview (as part of a larger case study).

Consent: We consistently made sure the front-page of any paper survey, and the text in any invitation e-mail, held enough information to trigger interests, but also to inform possible respondents on our contact info, the purpose of the study, their rights, what would happen to the information they provided etc. Using this approach, we considered responding to the survey implicit consent of participation. We note that now, under GDPR, participants should instead give explicit consent (as well as specific consent to each type of information usage).

Data Analysis

The analyses of the different survey items diverge from each other. We will not go into specific detail on each survey item, as the papers presents this level of detail. Some are open items, which we generally categorized using emergent coding. Others are closed items, which we generally quantified and cleaned. We inputted the data into SPSS in order to run frequencies and descriptive statistics. For more investigative analysis, we used inferential statistics. As our N was low, we used non-parametric statistics. As the data was on different levels, we choose different statistical tests to explore connections. Some items needed re-coding.

For correlations, we generally used the Spearman rank-order correlation coefficient (Spearman's rho). This test evaluates the degree to which to continuous variables are associated (Jonathan Lazar et al., 2010, p. 118), and we used it to for example calculate if there were correlations between frequency categories. Spearman's rho is one of the most widely used non-parametric test in health care research Slettemeås (2014). It accepts data on ordinal level (e.g. obtained by using Likert scales) and does not assume a normal distribution.

Study 2: Results

We had a quite low N, with 26 responses (a 37 % response rate). We only allowed complete survey responses. We did not identify biases (non-response errors) in the respondents compared to the sample. Years of experience within UD of ICT varied from 2 to 25 years (arithmetic mean 7,73; median 7). Experience was high compared to the age distribution; as the majority was below 40 years. Our impression was that many highly experienced experts responded to the survey.

Highly Interdisciplinary Experts

The expert sample proved to be highly interdisciplinary, with diverse backgrounds. The experts worked across disciplines and had backgrounds from several fields, with different individual combinations. Further, 73 % worked within three or more areas. The most common areas were visual design (65 %), programming (65 %), IxD (85 %), and content production (50 %).

Terms Usage

Experts were not able to define "UD of ICT" in a clear and unified manner, and largely referred to the legislated overall UD definition or answered in a recursive manner (e.g. "UD of ICT is ICT that is UD"). Further, no UD-related term was agreed upon by all Norwegian experts as synonymous, or by all as non-synonymous.

Disability Views

The findings indicated several disability model views were present simultaneously and overlapping. The **right-based** disability model was the most popular (96 % agree - 84.5 % fully agree), closely followed by the **social adapted** model (also 96 % - 50 % fully agree). The **medical** and **expert** models were the least popular. Somewhat surprisingly, 77 % agreed with the **charity** view; persons with disabled as someone deserving aid and sympathy.

An interesting diverging disability view is indicated related to who should control treatment and assistance, as a moderate negative highly significant correlation show those agreeing with the **empowering** model (individuals with disabilities should have control) tend to disagree more strongly with the **expert** stance (medical professionals should be in charge).

Overall, the sample seemed to hold quite pragmatic and fluid views on disability, focusing on the societal responsibility to ensure participation and access despite individual limiting disabilities. We could not identify any effect of the disability views on the UD practices of the sample.

Epistemological and Methodological Connections

Some connections are found between epistemologies and methodological stances, but more varied than our Study 1 theory would suggest.

A Mechanical/Positivist stance was successfully identified in the sample. It appeared such views could be tied to a user-centered methodology using **limited** user contact. We call it the "**no-**

contact" approach. Agreeing strongly with no-contact approaches correlates moderately (0.4) to agreeing with mechanical worldviews and quantitative methods preference.

While non-mechanical views did not correlate to non-positivistic stances, the experts were consistent in expressing adherence to **high-contact user-involved** strategies versus a **no-contact** approach throughout survey items.

There were no clear relationship between the background of the experts and their stances. This is unsurprising due to the high degree of interdisciplinarity in the sample and the low N.

User-Involved versus No-Contact?

About half of the sample agreed with more user-involved and participatory design approaches, and 42.5 % agreed with a user-centered design strategy with low- or no-contact. As mentioned, quantitative preference correlated moderately with no-contact approaches, and cross-tabulations showed none preferring qualitative methods fully agreed with a no-contact approach. On epistemological preference, 61.5 % preferred qualitative and 38.5 % quantitative methods. However, only a very few survey respondents consistently gave answers reflecting a pure no-contact stance.

There seemed to be an acquiescence response effect to epistemologies; experts agreed (fully or partially) with romantic (89 %), mechanical (85 %) and interventionist (74 %) views. Simply put, the sample agreed with several theoretically opposing paradigm stances and worldviews **simultaneously**. Thus, **user-involved** and **no-contact** approaches could not be clearly distinguished from each other. The overall impression was experts agreeing with no-contact approach appeared a minority to those adhering to a user-involved strategy.

Agreement with Several Stances!

Our model from Study 1 did not fully separate between the two non-mechanical worldviews. As the survey was built on the model, it did not separate between romantic and interventionist stances, Advocate and Negotiator doxastic styles or critical and constructivist stances very well. It is unclear whether the second "user-involved" style was really 1, 2 or more doxastic styles combined. Perhaps there were connections between interpretive approaches and critical paradigm stances on one hand and romantic approaches and constructivist paradigm stances on the other. This may explain some of the acquiescence response.

Dong (2007) supported the idea of "idealists" versus "technologist", however she also points to a blending of the two views as the "UD of ICT" practice matures. The latter position could also help explain the data reflected from the Study 2 sample.

It may be that the sample was more interdisciplinary and pragmatic than assumed – utilizing a wide range of strategies from different epistemological traditions. For example, a cross-tabulation on relativism and quantitative/qualitative preference shows that the most common style is to prefer qualitative methods, but use method triangulation. The identified personal stances may as such be more fluent than originally assumed. Perhaps the experts hold several personal stances at once as tacit knowledge (of which they are unaware) or as methodological knowledge (on which they reflect), and move within different doxastic style in an agile manner.

Finally, the survey questions may be inadequately presented to the sample, or not formulated in such a way that they capture the intended information.

A Wide Range of Methods

The respondents used a broad spectrum of methods. More than 20 methods were reported on.

In order to investigate categories of methods, frequencies of usage were re-coded on three levels: seldom, occasional and often used. Spearman's rho showed high inter-method correlations; all methods correlated at least moderately with at least one other. There were no clear groups of methods. Next, only moderate to very strong (highly significant) bi-variable correlations were selected for a bottom-up emergent grouping. This categorization process resulted in three method groups. However, these emergent groups divided the methods across our pre-conceived theoretical traits.

The "no-contact" (Expert style/Positivist stance/Mechanical worldview) approach was assumed mirrored in techniques related to classical empirical research methods. UD techniques were assumed to reflect a "checklist" approach. This was not found to be the case. We could not find indications that methods such as summative user testing, eye tracking, surveys, marked research, expert analysis, and so forth indicated a positivist epistemology.

However, we could find correlations between methods and user-involved approaches.

Personal Stances Impact Choices…but are Not Sole Influencers

Though there are indications of connections between **personal stances** and methodological preferences, the theorized connections are not significantly identified. We found that personal factors affecting approach and method selection are not necessarily linked to epistemological or methodological stances, but rather to the importance placed on user-involvement.

Further, through an open item, the survey mapped **external factors** influencing methodological choices, such as **external constraints** (e.g. time, budget, competence and project goals) and **external influences** (e.g. company culture, team members' wishes and stakeholder interests). 73 % mentioned **external factors**. 69 % mentioned **personal factors**. The factors identified as the most influential on method selection were:

(1) Perceived fit for target user/problem; affecting (a) ethnographic methods, (b) user testing methods, and (c) user-centered specification techniques),
(2) Personal qualitative/quantitative preference; affecting use of interviews formative/contextual testing,
(3) Degree of user-involvement emphasis in design approach strategy.

Degree of adherence to user-involved design (3) increased the use of:

a) Ethnographic methods observation and interview,
b) User testing methods, particularly informal and exploratory techniques,

c) User-centered specification techniques, such as personas and scenarios/user stories.

Methodological approach did not affect:

d) Non-ethnographic user research techniques such as marked research, statistics and surveys.

Further, prototyping, sketching and workshops (the most frequently used methods) were not influenced by the methodological approaches or any other identified personal or external factors.

Interestingly, our results indicated personal factors and external values influence method selection more than external constraints. The main influencing external factor is normative emphasis on **UD values**. This strengthened our assumption that methodological competence is important for UD quality, and partly contradicted budget as the main key to ensuring UD. It also corroborated a hypothesis of resources being "**hygiene**" factors – limiting when not present, but not key effectors on approach choices once present to a sufficient degree.

User Group Focus

Visually impaired user groups receive the most attention (partially sighted, blind and color blind). This is positive, as persons with severely reduced sight are reported as among the four groups in danger of digital exclusion (Pett, 1997). However, the other three excluded groups received quite infrequent attention. Most user groups reported at risk of digital exclusion received focus "sometimes". Examples are elderly over 80 years, first-generation non-western immigrants, non-native speakers, persons with hearing impairments and children. The analysis indicated people not participating in the job marked (reported as highly vulnerable for exclusion) were seldom given attention. The same was the case for persons suffering from mental illnesses. Users with disabilities received more attention than marginalized users without disabilities.

Overall User-Involved Alignment

88 % of the sample agreed with the importance of empathizing with users. 73 % agreed with a "some-contact" UCD strategy to understand user needs. These approaches did not seem to represent any particular methodological style. Overall, UD methodology in the sample appeared varied, cross-method and overall user-centered, with personal factors (including adherence to external values) influencing method choices.

For More Details

Papers 2, 3 and 4 provide more details on sampling, survey design, pilot testing and data analysis. Hypothesized connections between paradigm stances, epistemological preferences, worldviews and doxastic styles were investigated in Paper 2: Begnum (2016) *Methodology for Universal Design of ITs; Epistemologies Among Norwegian Experts*. Methods used, reasons behind method choices and correlations between methods usage and other factors were discussed in Paper 3: Begnum (2017) *Universal Design Approaches among Norwegian Experts*. Paper 4: Begnum (2016) *Views on Universal Design and Disabilities among Norwegian Experts on Universal Design of ICT* explored disability views, terms usage and user group focus.

Study 2: Discussion

Study 2 researched practices employed by a selected sample of recognized Norwegian UD of ICT expert professionals. Papers report on key terms, epistemological stances and methodological practices in the sample, main factors influencing method and approach decisions, and the connections between stances, methods used, and key reasons for methodological choices.

Fuzzy Terminology

The sample did not agree on which UD terms are highly overlapping/synonymous. The respondents were largely unable to define what "UD of ICT" entails. The sample also held different disability views. As such, key terms were unclear – even among expert professionals.

UD as Discipline-Specific Expertise?

Based on the diverse personal stances in literature and the survey respondents' heterogeneity, "UD of ICT" did not seem to be one unified field.

If we do not understand terms the same way, have varied backgrounds, varied expertise and different tasks and approaches; do we share an understanding of what working in the field *universal design of ICT* entails in practice? Did the UD of ICT experts represent several UD of ICT sub-fields?

Creating ICT-solutions is a multi-disciplinary task, drawing on disciplines such as among others Ethnography, Design, Sociology, Ergonomics and Human Factors in addition to Computer Science (Pett & Sehy, 1996 in Pett, 1997, p. 256). Research and development on UD of ICT cover a broad interest area, spanning across different sectors and domains. As such there may not be a specific recommended way to go about to achieve UD, but rather divergent approaches reflecting cross-disciplinary efforts in the design and development of ICT-based services and solutions.

We started to suspect that "UD of ICT" was better viewed as specialized expertise within existing disciplines, rather than as an independent field on its own.

UCD and UD Overlap

Our results highlighted a large overlap between UD and UCD methodology, both in the overall strategies, the user-centered process approaches and in the specific methods and techniques used.

Move Towards the Edges?

As several user groups reported at-risk for exclusion where currently given somewhat infrequent focus based on our findings, we proposed increased edge-case recruitment of extremes in subgroups, for example among elderly and non-native speakers.

Different Stances, but Not Different Styles?

Our expectation was that underlying methodological views held by the experts would line up with their practical approaches, "profiling" the experts on doxastic styles relative to the Study 1 theoretical model. This was not the case. The questionnaire was unsuccessful in mapping a respondent to the model as a basis for best practice identification, which was intended as a basis for further investigations on the effects of methodology on UD quality.

Our findings indicated that different doxastic styles varied mainly with regards to the degree of user contact and attitudes towards active user participation. However, personal stance could only explain part of the methodological choices.

Still, the survey seemed to successfully measure positivist stances, and included statements from this style correlate. Further, the survey seemed to successfully separate mechanical views and a no-contact strategy on the one hand, and non-mechanical alignment and user-involved methodologies on the other.

To conclude, there are indications of opposing strategies in the field – however the stances are not necessarily as mutually exclusive. This could be indicative of tacit knowledge and acquiescent effects. However, it could also point to the sample being more interdisciplinary and pragmatic than initially assumed, utilizing a wide range of strategies and styles from different epistemological traditions as they fit.

Limitations of Study 2

The survey had a low number of respondents, even if the response rate was acceptable. In order to attempt a larger N, a redesigned study was launched internationally, but the response rate was very low with only a handful of replies. Thus, these data were not included.

A survey further exploring epistemologies and methodologies should redesign items to better separate between all the stances. Conducting an in-depth interview study prior to a survey, to better frame the items and focus of a survey was considered. Interviews might have clarified some issues; e.g. potential pragmatism or acquiescence response in the sample.

Sampling "expert professionals within UD of ICT" is not straightforward. Survey results showed expert professional were very diverse. A filtering question was used in the Study 2 survey in order to validate the sample. We believe this strategy will continue to be necessary moving forward, and we would consider adding a self-assessment on the depth of UD expertise.

Towards Study 3

The models in Figure 7 and Figure 8 were not verified when investigating a local sample of experts. Due to the above limitations, we moved forward by investigating factors influencing methodology in applied settings, starting with the effect of agile methodology.

Part 2

Applied Aspects

Executive Summary of Part 2 Applied Aspects

This section introduces and summarizes Part 2, and is followed by chapters detailing the Part 2 studies.

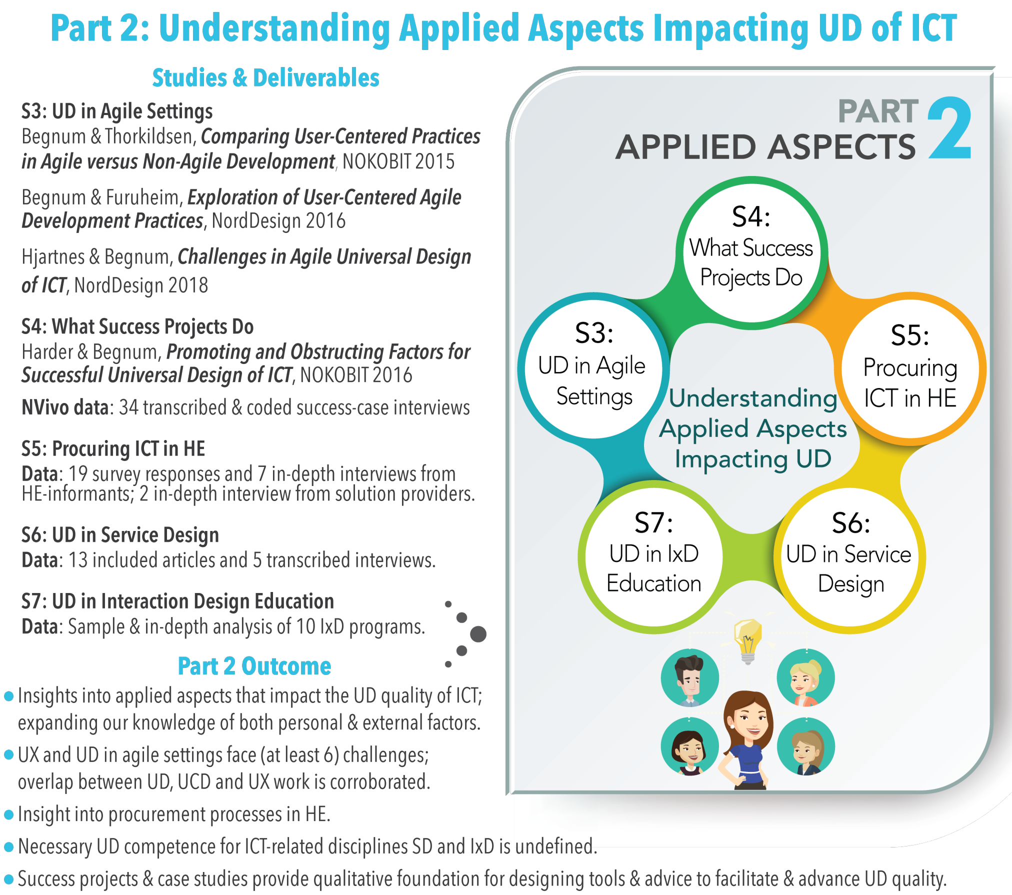


Figure 9: Overviewing the research in Part 2 – studies, papers and outcomes.

In Part 1, we built a theoretical model of UD methodological stances and design approaches, but discovered that the model did not fully fit empirical survey data. We now suspected there were underlying factors influencing the choice of methodological approach apart from personal ones.

Based on the findings in Part 1, the focus of the thesis thus shifted away from understanding personal stances on methodology, to a broader investigation of real-life practice factors impacting UD of ICT quality.

The underlying assumption was maintained that methodology – what we do – influenced the quality outcome of the resulting solution, but a new assumption was added; that any strategy to ensure UD applied in real-life and industry settings is influenced by aspects beyond personal stances, and thus that there may be key external factors influencing the UD approaches and quality of ICT solutions (as illustrated by Figure 10).

Further, we decided to move forward with the assumption that "UD of ICT" should be viewed as a specialized "expert" competence linked to professions involved in ICT-creation - instead of as a separate field. We moved away from struggling to define "UD of ICT", as we attempted for domain alignment purposes in Part 1. Instead, we applied a practitioner's perspective view. Our updated interpretation of UD of ICT was therefore now; "UD of ICT can be defined as the combined UD expertise of disciplines involved in the creation of ICT". This definition makes it important to ensure UD competence needed in each discipline involved in the creation of ICT solutions and services.

In Part 2, the research question therefore was: "What are applied aspects impacting UD of ICT?"

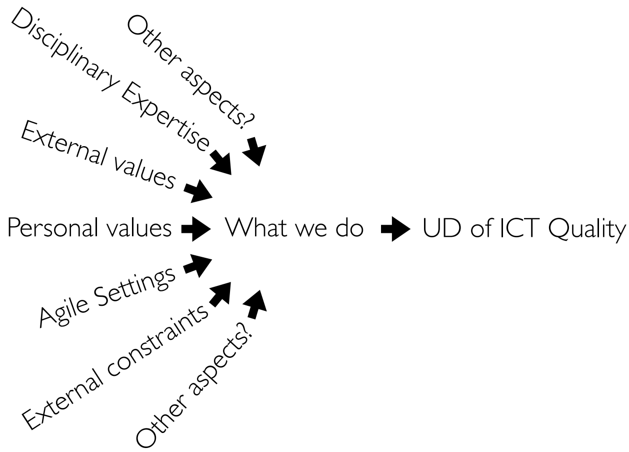


Figure 10: Part 2 research assumption

A series of collaborative, smaller in-depth studies were conducted. Each of the studies in Part 2 explored different suspected key aspects, and acquired qualitative in-depth insights on them.

In Study 3, we investigated (external) agile process settings, asking sub-question:

2.1. What influences user-centered UD work in agile development settings?

Literature reviews were used to investigate if there were any differences between user-centered work in agile and non-agile projects, and to map out key challenges for UD in agile settings. An interview study was used to explore whether diverging cultures between agile developers and user-centered designers could explain the user-centered methodology used in agile projects.

In Study 4, we used an empirically based interview study to answer sub-question:

2.2. What characterizes ICT-projects that have achieved "best-practice UD quality"?

If "success practices" were mapped, we could perhaps use these, rather than methodological approaches modeled in Study 1, as indicative of UD quality.

Study 5 investigated sub-question:

2.3. How is UD quality being ensured in procurement processes?

The insights into real-life practice gathered from experts triggered a further investigation into procurement practices; looking into our own domain of higher education (HE). Using the case of Uninett's work to collaboratively specify requirements for digital assessment solutions in Norwegian HE institutions, and understand their procurement processes through case study research. The study researched UD values and constraints in a case of acquiring ICT-solutions.

From the new view of UD as a specialized "expert" competence within established fields, we further saw the need to clarify what should be considered UD expertise within our disciplines. The high overlap between UD and UCD methodology was clear, but we needed to investigate what should be considered UD expertise within the areas of interaction design (IxD) and service design (SD). Studies 6 and 7 answered the last two sub-questions of Part 2:

2.4. What is the current UD expertise within the SD discipline?
2.5. What is the current UD expertise within the IxD discipline?

The answers to our research questions were as follows:

2.1 How may agile settings impact user-centered UD work?

Study 3 hypothesized key aspects influencing user centered UD work in agile settings are a) the overall process model (including prioritization of user-involved work), and b) the project's emphasis and competence on UD.

Six challenges were indicated by Study 3 research efforts: 1) collaboration issues, 2) diverging underlying principles, 3) UI focus, 4) mainstream focus, 5) insight elicitation and communication, and 6) skipping problem identification. These are discussed in Paper 5: *Comparing User-Centered Practices in Agile versus Non-Agile Development* (M. E. N. Begnum & Thorkildsen, 2015), Paper 6: *Exploration of User-Centered Agile Development Practices* (Miriam E. N. Begnum & Furuheim, 2016) and Paper 7: *Challenges in Agile Universal Design of ICT* (Hjartnes & Begnum, 2018).

We found that current user centered agile (UCA) work face challenges related to lacking interdisciplinary collaboration facilitation, process models that rely on generous constraints, a high risk for workload discrepancies and violations of user-centered design (UCD) principles related to early user focus and solutions based on understanding user needs. Currently, UCA processes are focused on low-contact user centered methods, and no or low user involvement. Any direct user contact is typically first done in the evaluation of early prototypes. In order to move towards UD best practice, we expect a broader range of user contact and user involved methods will be needed. Thus, we hypothesize current UCA issues would increase as we move towards agile universal design (AUD).

Agile settings seemed suited for problem **solving** but less fitting for problem exploration. Therefore, we propose to start agile development **after** the problem to be solved has been identified through appropriate approaches, instead of attempting to embed user research and problem **identification** within UCA/AUD projects. This necessitates an awareness of the appropriateness and limitations of agile methodology on management levels, and similarly the appropriateness of fitting problem identification approaches, such as design thinking for opening up the design space, lean UX prototyping, and service design thinking for holistic products and competition analysis. That being said, we do not regard e.g. Sprint 0 user research for mapping contextual user needs and pain-points as something outside the scope of UCA/AUD processes.

Second, we propose the agile team should be responsible for UX tasks, under the guidance of a UX mentor. As such, we tentatively advice against parallell tracks and cross-disciplinarity processes. Instead, we hypothesize a higher degree of interdisciplinary and transdisciplinary aspects lead by developers would be an improved approach. In short, instead of attempting to merge the UX designer into the agile development project, which has many challenges and ultimately disrupts the team, the UX/UD expert should focus more on facilitation and mentoring. This means UX/UD cannot be viewed as an add-on, but rather as an integrated part of the competence needed by modern agile developers, and extending technical accessibility.

Overall, Study 3 contributed to increased awareness on the possible frictions between underlying principles in UCD and agile methodologies, and should be useful in the ongoing discussions on integration of agile development and UD best practices. We call for more research on UDA challenges, and propose considering UX-mentorship and UDScrum in future efforts. These reflections are as far as we came in answering research question 2.1.

2.2 What characterizes ICT-projects that achieved "best-practice UD quality"?

Study 4 indicated current best practice for ensuring UD of ICT, through an empirical analysis of common characteristics of successful projects. Study 4 identified 84 common characteristics from a sample of 23 ICT-projects, that all achieved high UD quality according to current best-practice. They were categorized into 12 promoting and 10 obstructing main factor categories, and as Societal, Organizational, Processual or Personal factors.

Societal, Organizational and Processual factors are types of **external** factors affecting real-life practice. External factors are influencing the processes and settings under which any best practices can be initiated. They may be either obstructive (such as inadequate resources) or promoting (such as competence sharing and social anchoring).

Our findings provide new insight into factor relationships, and suggest that measures must to be taken at several levels in order for a single project to succeed. The large amount of non-personal factors identified corroborated our suspicion formed in Part 1 that external aspects are key for UD success, and not only personal methodological stances and styles.

Tentative findings in the identification and classification process are presented in Paper 8: *Promoting and Obstructing Factors for Successful Universal Design of ICT* (Harder & Begnum, 2016). The final categorizations of the full sample of 34 interviews across 24 success projects are presented in Paper 9: *Ensuring Universal Design: Towards Predicting Project Success through UD3C Critical Criteria Compliance* (Begnum, Harder and Hjartnes, in review). Together, the findings presented in the two papers answers research question 2.2.

2.3 How is UD quality being ensured in procurement processes?

Study 5 revealed that UD quality was not being ensured in the selected case procurement processes; UD was not prioritized in the procurement of digital assessment solutions by HE institutions. Qualitative case study findings are presented in Paper 10: *Universell utforming og digital eksamen i UH-sektoren: 5 anbefalte tiltakspunkter* (Foss-Pedersen & Begnum, 2017). Though not considered generalizable, we viewed Study 5 findings indicative of a HE sector practice. We considered the identified case study challenges as indicative of key issues related to organizational aspects. We made no claim as to how widespread these challenges are, however rather than researching this, we argue our next step should be to propose possible solutions to already identified issues.

2.4 What is the current UD expertise within the SD discipline?

Study 6 indicated the SD discipline had no established UD competence. We concluded the degree to which UD is included and researched in SD today was lacking. Tentative challenges were identified related to: lack of UD of SD awareness, knowledge, education, definition, methodology, legislation, and responsibility. Findings from Study 6 are presented in Paper 12: *Towards Inclusive Service Design in the Digital Society: Current Practices and Future Recommendations* (Bue & Begnum, 2018).

2.5 What is the current UD expertise within the IxD discipline?

Study 7 found that Norwegian HE IxD study programs were largely not educating interaction designers with the necessary UD skills, and were often completely lacking of or very low on UD focus. Based on Study 7, we could not identify UD expertise for interaction designers. Part 3 Paper 13: *Identifying archetypes of Interaction Design competence and their Universal Design expertise* (Begnum, Pettersen and Sørum, in process) presents findings related to the work of Study 7.

Contributions from Part 2:

The goal of Part 2 was to achieve a deeper understanding into applied aspects impacting UD of ICT, and we have identified these in real-life and industry settings. Based on our findings, we:

- Warn against current UCA/AUD models focused on cross-disciplinary coordination.
- Call for an increased UD focus in ICT-projects, especially in relation to UX QA.
- Call for an increased focus on ensuring usable accessibility in real-life contextual use.
- Hypothesize promoting factors must be present at several levels for project UD success.
- See a need to further explore critical factors and facilitate UD practices.
- Believe UD of ICT should be viewed as UD practices in relevant ICT-disciplines.

- See a need to propose UD competence needed in SD and IxD professions.

The assumption formed in Part 1 that user-centered and universal design work was overlapping, was strengthened during Part 2. Study 3 indicated that UD should be viewed as highly overlapping with user-centered design. Study 4 showed how important it is to have an early and continuous focus on users, UD, and usability/UX. Study 5 indicated how testing usability and usable accessibility is necessary to ensure UD in actual contexts of use, and that UX and UD quality is overlapping. This confirmed our stance that if achieving UD of ICT is the aim, UD viewpoints should be an integral part of UCD and UX work. Usable accessibility-focused UD work is viewed as UX/UCD work with a focus on marginalized user groups and edge cases.

Several Part 2 studies have made visible opportunities for developing tools to better facilitate UD, which was the focus in Part 3 of this thesis.

6 of the papers mentioned above were published completely or mainly from Part 2 works:

Paper 5. Begnum, Miriam E. Nes; Thorkildsen, Therese. (2015) *Comparing User-Centered Practices in Agile Versus Non-Agile Development.* Proceedings of NOKOBIT - Norsk konferanse for organisasjoners bruk av informasjonsteknologi, vol. 23 (1). Open Journal Systems.

Paper 6. Begnum, Miriam E. Nes; Furuheim, Lars. (2016) *Exploration of User-Centered Agile Development Practices.* DS 85-1: Methodology: Special Applications, Proceedings of NordDesign 2016. The Design Society.

Paper 7. Hjartnes, Øyvind Nordeide; Begnum, Miriam E. Nes. (2018) *Challenges in Agile Universal Design of ICT.* DS-91: DESIGN IN THE ERA OF DIGITALIZATION, Proceedings of NordDesign 2018. The Design Society.

Paper 8. Harder, Susanne Klungland; Begnum, Miriam E. Nes. (2016) *Promoting and obstructing factors for successful universal design of ICT.* Proceedings of NOKOBIT - Norsk konferanse for organisasjoners bruk av informasjonsteknologi, vol. 24 (1). Open Journal Systems.

Paper 10. Foss-Pedersen, Rikke J.; Begnum, Miriam E. Nes. (2017) *Universell utforming og digital eksamen i UH-sektoren: 5 anbefalte tiltakspunkter.* Proceedings of NOKOBIT - Norsk konferanse for organisasjoners bruk av informasjonsteknologi, vol. 25 (1). Open Journal Systems.

Paper 12. Bue, Oda Lintho; Begnum, Miriam E. Nes. (2018) *Towards Inclusive Service Design in the Digital Society: Current Practices and Future Recommendations.* DS-91: DESIGN IN THE ERA OF DIGITALIZATION, Proceedings of NordDesign 2018. The Design Society.

Study 3: "UD in Agile Settings"

In Part 2, we wanted to gather insights into real-life on goings affecting UD of ICT. The first breakout study, Study 3, looked into ICT development methodology; more specifically how agile processes may impact the design approach.

The agile framework is an extremely common development setting for the Norwegian IT-industry. Findings from Part 1 showed user-centered design approaches, methods and techniques are heavy utilized for UD. The questionnaire survey findings and literature review findings were consistent in this respect. We thus became interested in how user-centered agile UD work was conducted. The importance of ensuring UD work in agile settings was confirmed as the parallel Study 4 progressed. Here, nine of the first thirteen projects followed an agile development process, and a further two implemented agile elements (hybrid) into their development processes. Only two of the thirteen projects reported a non-agile (plan-based) process was used.

Our tentative results thus indicated Norwegian ICT-projects with UD success mainly apply agile development. In Study 3, we asked; "How may agile settings impact user-centered UD work?"

Study 3: Background

The term «agile» is typically applied to a software development process which follows a certain set of practices. Agile settings are exploratory and iterative in their approach to development, and viewed as opposing plan-based approaches. In real life, however, you always have some planning, and some exploration. With "agile-like" settings, our participants usually referred to a process that starts as plan-based, contractual and formal, then moves into an agile development setting. At the end, there may be a more plan-based and formal quality assessment and hand-off process.

A key difference when moving from plan-based into agile setting is the role of the agile team. The agile team members organize tasks and work amount in a more democratic manner compared to top-down deleagation. Further, agile development typically run short iterations focused on producing working code (Petersen & Wohlin, 2010). Team efforts are planned for shorter time spans, with the aim of incremental delivery. Through developing in short-time iterations with continuous testing and releases, the customer get immediate value output. The agile development process is ended when the customer is satisfied with the final delivery.

Agile methodology value individuals over process, interactions over tools, working software over documentation, customer collaboration over contract negotiations, and change response over following a plan. The Agile Manifesto (2001) declaration presents 12 agile principles: satisfy the customer, involve the customer daily, welcome changed requirements, use self-organized teams, use short iterations and deliver frequently, keep it simple, use face-to-face team communication, ensure team-member motivation, keep a sustainable pace, do regular team effectiveness reflections, continuous attention to quality, measure progress by working software. In short, self-organizing teams, iterative feedback loops, and incremental delivery of software are key.

Different types of agile methodologies have been, and still are being, developed. The currently most popular agile models in Norway seems to be variants of Scrum, Kanban and Scrumban. Further, the agile teams are often multidisciplinary.

How Agile relates to Lean

Compared to traditional plan-based top-down development, agile approaches are regarded as more effective in producing the "correct" and usable system, more quickly and reliably (Beyer, 2010, p. 1). The agile methodology also advocates documentation should be kept to a minimum, freeing time for production and testing (Manifesto, 2001). The agile methodology minimize the need for management with self-organized teams and direct customer contact. Focus is on achieving efficiency and reducing waste (Preece, Sharp, & Rogers, 2015).

Another methodology that focus on increased efficiency and reduced "waste", is the lean approach (Hines, Holweg, & Rich, 2004). In lean thinking, the idea is to move from a focus on resource utilization to also looking at efficient production. Lean thinking holds 5 principles: identify value, map value chain (stream), create stream flow, establish pull-based control and continous improvement (perfection) (Womack & Jones, 1997). Instead of a push-based system, where there is always work in the pipeline to keep workers busy, the idea of lean is to more efficiently create value and decrease overhead by focusing on finishing products.

To do this, one eliminates bottle necks and moves from a push-based to a pull-based system, even if this means employees sometimes have downtime. This pull-production strategy is used in the Kanban method, which is regarded today as agile but have roots in lean thinking. In a Kanban approach, the numbers of acceptable parallel tasks are defined, including the relation to the types of tasks, in order to make sure finished developments are delivered instead of the process holding a lot of non-finished code and design tasks. Kanban also strengthen the team effort and highlights any bottleneck problems in the team – e.g. that a second designer is needed.

Further, lean approaches also embed respect for employees and high levels of employee problem-solving proofing. As such, in the world of IT, the agile and the lean thinking have some overlapping aspects. However, as a whole, lean is more focused on organizational production.

How Agile relates to Design Thinking

The speedy iterations and requirement change willingness of agile development provide a sand box setting for more rapidly exploring technical solutions. The iterative approach facilitates a high change tolerance from one iteration to the next, involving the customer in iteration planning and incremental testing in order to continuously fix errors and change priorities (Constantine, 2001b). Still, the focus of agile development is on solutions production, not needs exploration.

Design thinking, on the other hand, is highly focused on scoping the design space and finding the right problem to solve. Design thinking (DT) emphasizes an open discovery phase prior to development. The DT approach is frequently represented as a "double diamond" process, see

Figure 11. The first "diamond" focuses on exploration, and containts to different phases. The first and divergent phase is focused on discovering insights into the problem area, and is followed by a second and convergent phase where the area to focus upon is strategized and selected. Their outcome is problem definition and design brief. This aspect of deep insights and questioning assumptions to define the problem is completely lacking from agile approaches.

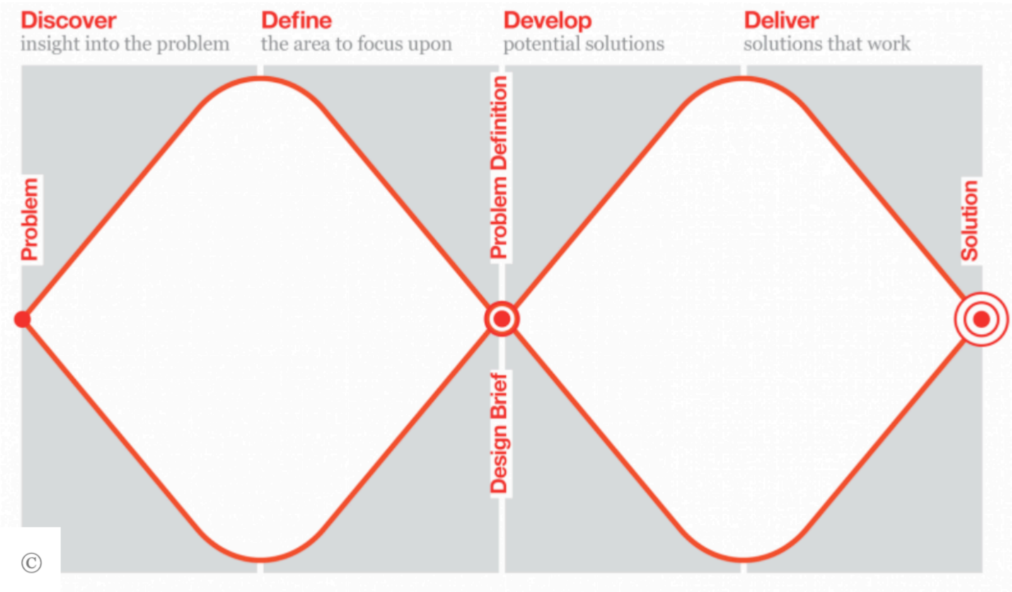


Figure 11: The "double diamond" design process, developed by the British Design Council[6]

The last "diamond" focuses on expecution; developing and delivering the right solution to the identified problem. The two phases "develop" and "deliver" focus on tangible outcome, and working results – just as agile development does. Though iterations are not modeled in the "double diamond" process, the second diamond overlaps well with the agile approach. Possible solutions are typically explored, prototyped and validated with users in a rapid manner. Further, DT and agile approaches are alinged in their disinclination for extensive documentation. Bicheno and Holweg (2016) claim the diamond concept is useful for lean has methodology as well, as lean thinking has extended into design.

How Agile relates to UCD

User-Centered Design (UCD) – also called Human Centered Design (HCD) – is a methodological approach where the user is in focus throughout the design and development process (ISO, 2010; Rubin & Chisnell, 2008). The main goal of UCD is to create solutions with high usability, fitting user needs and contexts of use. A key aspect of the UCD methodology is anchoring the project in situated user needs; thus (like DT) the UCD process starts off with user research and an exploration of the problem area.

[6] https://www.designcouncil.org.uk/news-opinion/design-process-what-double-diamond, 10.12.2018

The level of user contact and user involvement necessary in UCD approaches is unspecified, and there is no strong recommendations tied to methods and techniques for user research, specification and testing (Begnum & Thorkildsen, 2015). In UCD, having some direct user involvement is expected, in particular for testing prototypes, mockups, sketches, situated use and input in re-design efforts (Gould & Lewis, 1985; Preece et al., 2015). However, while some are comfortable using a low-contact approach, e.g. proxy-users and empathic design techniques, other emphasizes the importance of real end-user involvement. As such, UCD processes can draw only on indirect, low contact methods, or use high contact strategies with co-creation or participatory design techniques. We have attempted to illustrate the wide range of UCD strategies in Figure 12, moving from the left hand thinking about users (without direct contact) via different levels of user empathy to user involvement (directly asking users), and further towards designer-directed co-creation and participatory design on the right (users as designers).

Figure 12: Visualizing the range of low- to high contact approaches in UCD

The ISO 9241-210:2010 standard (ISO, 2010) is considered a best-practice approach for user-centered design processes; iterating the phases: 1) understand and specify context of use, 2) specify user requirements, 3) produce design solutions to meet user needs and 4) evaluate designs - until a solution that meets user requirements is designed. Unlike DT, UCD does not describe or include divergent and convergent stages of the design process (Tschimmel, 2012, p. 9).

ISO (2010) specifies the following six principles for UCD: 1) basing design upon an explicit understanding of users, tasks and environments, 2) involving users throughout design and development, 3) design driven and refined by user-centered evaluation, 4) design addressing the whole user experience, 5) iterative process, and 6) including multidisciplinary skills and perspectives on the design team. Gould and Lewis (1985) underline how early and continual focus on users, empirical measurement of usage and iterative design are key UCD principles.

Compared to agile methodology, UCD is a lot more focused on satisfying real life usage, while in agile settings the primary aim is to satisfy the customer. Agile approaches may blur the terms user and customer, while this is an important distinction in UCD. Thus, UCD principles 1-4 above does not necessary overlap with agile approaches. Though both processes are iterative, user-centered processes place emphasis on a discovery phase of understanding and specifying user requirements (which could be viewed as big design up front – BDUF). Agile approaches are based on the problem definition being known by the customer, and on detecting further customer requirements as you go (which can be described as little design up front (LDUF) and just-in-time (JIT) production). Thus, the agile production may be based on weak or faulty assumptions about users and context of use, create solutions fitting the business needs of the customer rather than users needs, and lack a focus on overall UX design (Constantine, 2001b).

UX Work

The term "UX" refers to the field of User eXperience (UX), viewed as "the joining of the different disciplines, and not particularly a discipline in and of itself"(Saffer, 2008, 2010). Saffer (2010) has developed a much-referenced illustration of the UX field. Saffer's illustration is somewhat simplified, while Precisely (2009 in Carroll, 2013) offers a more detailed visualization of the overlapping UX disciplines, shown in Figure 13. UX research is at the core of UX disciplines, and was described by the Interaction Design Foundation as "systematic investigation of users and their requirements, in order to add context and insight into the process of designing." (InteractionDesignOrg).

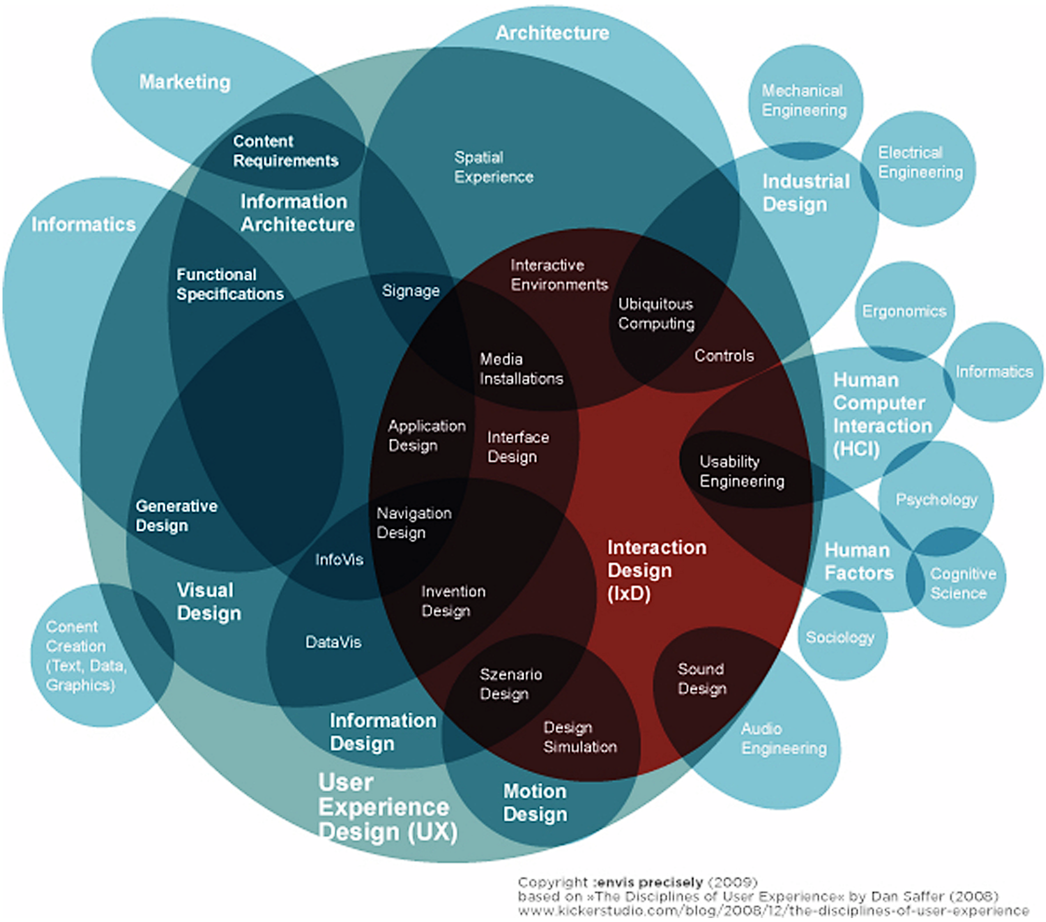


Figure 13: The UX field, Precisely (2009), based on Saffer (2008)

Merging Agile Development & UX Work

At least four different models exist for how agile development and UX work can be merged. They are not necessarily mutually exclusive.

Parallel model

The most prominent recommendation seems to be the parallel model. Here, UX work and development (coding) is separated, forming two different "tracks". As such, there are almost two parallel processes going on at the same time, with iterating deliveries from one track to the other. The interaction between the UX designers and the agile developers is structured and frequent. The model was proposed at the start of the century (Miller, 2005; Sy, 2007). It has also been referred to as the "dual track agile" methodology. Here, the UX team works at last one sprint ahead of the developers; typically conducting contextual inquiries, prototyping UIs and usability testing prototypes. As such, validated designs ready for implementation can be passed on to the development team. The key here is for UX resources to work ahead of development.

The workflow indicates the agile process must plan several sprints ahead, thus is less adaptable to change. Further, that the two teams are not pulling together, and UX may as such create bottlenecks for the developers. If the implemented designs needs user testing prior to release, the UX team would typically take on this task as well, thus working both ahead of and behind the developers. This has been described as exhausting by UX industry practitioners.

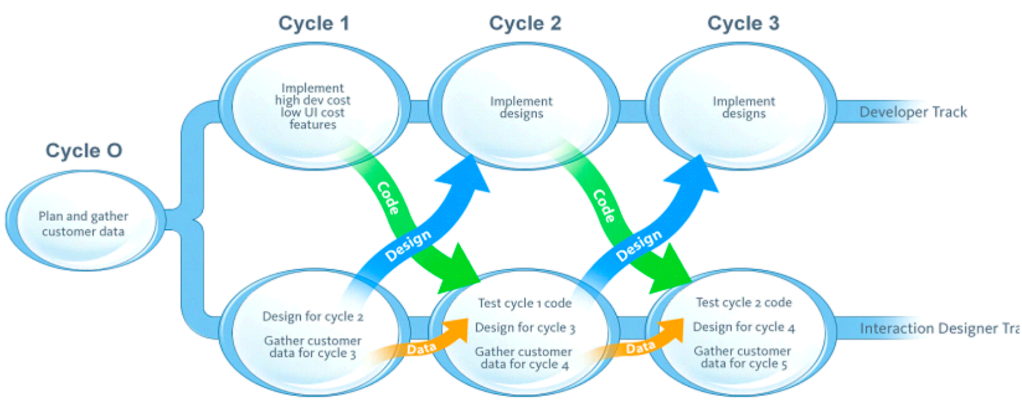


Figure 14: Agile UCD parallel tracks for development and interaction design, Sy (2007)

Satellite model

It appears Kollman coined the term in her 2008 master thesis, when one of her interview participants explained they used an UX person as a "satellite" – connecting UX teamwork to the development teamwork. The two teams are otherwise separate, and may work on completely different features (T. Øvad, 2014). As a single UX resource per development team may be exhausted or become a bottleneck, the idea is a full UX team does ideation, user involvement, prototyping and usability testing. A satellite UX person is co-located with the team, and focused on supporting the developers, e.g. with wire framing and facilitating collaboration with the UX team (Kollmann, Sharp, & Blandford, 2009). However, the UX team now visualizes the backlog items, including specifying and testing, while being disconnected from development. As such, a worry is incorrect assumptions may be made from the UX team or the developers.

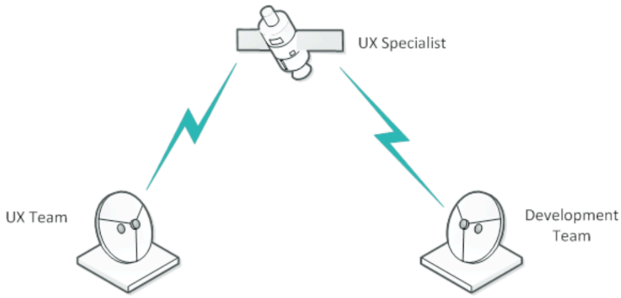


Figure 15: Satellite approach illustration, Øvad (2014)

UScrum model

Singh (2008) proposed adding an UX management role to Scrum, in order to combat three agile challenges. First, Singh notes that agile product goals are set without ensuring an adequate study of the user's needs and context. Second, MVP (minimal viable product) and just-in-time incremental deliveries makes it difficult for the development team to see the holistic user experience aspects. Third, user stories key for ensuring usability may not be prioritized enough. UScrum thus splits the Scrum product owner role in two, where one retains the traditional feature-focused customer role and the other takes on a usability-focus.

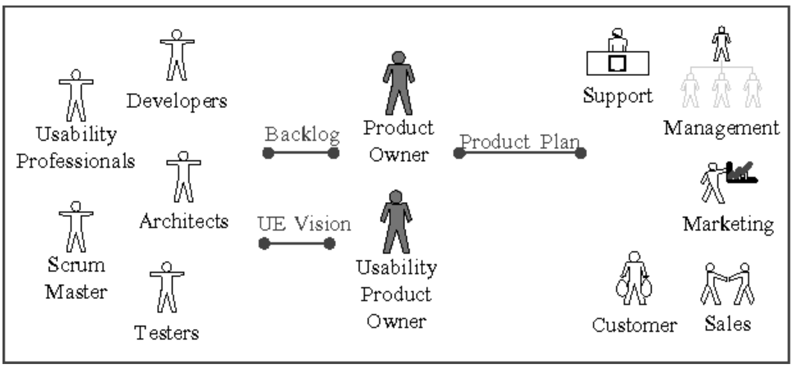


Figure 16: Key roles and interactions in UScrum, Singh (2008)

Lean UX

T. Øvad (2014) describes Lean UX as a forth integration approach, see Figure 17. A key issue seems to be to declare assumptions (step 1), instead of creating an established to-do backlog. This makes it clear that UX work or other types of decision points is needed for clarification. Further, Lean UX seeks to create a good process for facilitating cross-disciplinary collaboration.

Other than this, the Lean UX approach is similar to lean production approaches: reducing heavy documentation and increasing focus on efficient production.

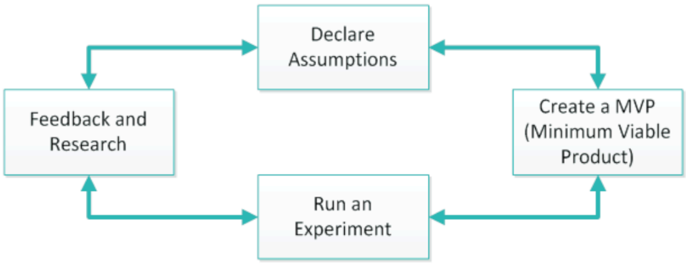


Figure 17: The four phases of Lean UX, Øvad (2014)

Study 3: Research Approach

Several students were interested in joint explorations into the topics of Agile UD and user-centered design practices in agile settings. Based on our efforts, we published the articles Paper 5: Begnum & Thorkildsen (2015) *Comparing User-Centered Practices in Agile versus Non-Agile Development*, Paper 6: Begnum & Furuheim (2016) *Exploration of User-Centered Agile Development Practices* and Paper 7: Hjartnes & Begnum (2018) *Challenges in Agile Universal Design of ICT*. Each piece of work build on assumptions and perspectives drawn from previous work, but also complemented each other in a hermeneutic manner; moving towards "grasping the whole" through the individual pieces, and interpreting individual pieces based on an understanding of the whole. More details on the research approaches (data analysis, inclusion criteria etc.) can be found in the three papers.

Comparing User-Centered Practices in Agile & Non-Agile Cases

Our first quest was a literature study into the use of methods in traditional UCD work versus UCD works in agile settings (labeled UCA; User Centered Agile).

UCA – User Centered Agile

We based our review research upon the existing systematic literature review of Silva da Silva, Martin, and Silviera (2011), which investigated practices used in **agile user-centered** processes reported by 58 papers. This review was updated, using the same search string – looking at agile user-centered method usage. We thus define the non-standardized terms "agile" and "user-centered" in the same manner as Silva da Silva et al. (2011). Note that at the time of the search, we did not have access to Scopus – one of the six databases used in Silva da Silva et al. (2011). We searched the remaining five databases: IEEE Xplore, Science Direct, CiteSeer, ACM and Springer Link. From our UCA search, 30 articles were published after 2011 – including Silva da Silva et al. (2011).

UCD – User Centered Design

For the literature search on traditional (non-agile) user-centered practices, we attempted to use the identical search for "user centered", but applying all the seven terms for "user centered" used by Silva da Silva et al. (2011) resulted in a too broad search. Thus, the search string was limited to only two terms, and asking both terms to be mentioned. Further, **non-agile** development was negatively defined, using excluding keywords identical to the agile keywords in Silva da Silva et al. (2011). We accepted the risk that the search string could omit relevant articles using the term "non-agile". For our user-centered search, we did not limit the search to a selected time-period. We however excluded two of the databases included in the agile user-centered search, as 129 articles were identified from only IEEE Xplore, Science Direct and CiteSeer.

Data analysis

Both authors went through the included articles independently for analysis and classification. Only peer-reviewed papers were included. Each article was read at least 3 times per researcher. As we did not have details on the categorization of Silva da Silva et al. (2011), we also went back to read some of their 58 papers in order to better understand their findings. Results were iteratively shared, discussed and aligned. We used the term "method" to cover specific methodological techniques, including "prototyping", "interview" and "persona" etc., but excluding process approaches such as "SDUF" and "one sprint ahead".

Exploration of UCA Developer Practices

In order to complement findings from Paper 5, we conducted an exploratory industry interview study. A fitting next step seemed to investigate potential explanations for the practice differences indicated in Paper 5. We hypothesized the different personal stances and the less rich UCD methodology used in agile projects could be due to diverging cultures between agile developers and non-agile designers, and explored this through an interview study. We wondered whether there was a lack of awareness of user-centered principles among developers, or if customers and users were viewed as synonymous terms – giving the product owner the role of the end-user.

Sampling

We used convenience sampling, and the inclusion criteria were software developers (or programmers), that had worked on agile projects in collaboration with user-centered professionals (e.g. UX designers and interaction designers).

Approach

We applied a semi-structured interview guide with three parts; i) background data, ii) participants' knowledge/experiences with user-centered and agile methodology (including developers' awareness of user-centered principles), and iii) participants' reflections/insights related to agile/UCD integration and collaboration.

Data analysis

Interviews were audio recorded upon oral consent. Thematic content analysis was used to analyze transcripts, emphasizing categorization of the developers' knowledge, terms usage and descriptions of UCD; to explore whether their perceptions covered core principles as described by ISO 9241-210:2010 and to investigate awareness of who the "user" is within UCD.

Challenges in AUD – Agile Universal Design

Our third and final exploration into how agile settings impact user-centered UD work, was investigated through a new literature review; this time a scoping review. Our aim was to map out key challenges for UD in agile settings, using the scoping review to investigate assumptions and as a starting point for future research efforts. The scoping review was based on M. E. N. Begnum and Thorkildsen (2015) and Harder and Begnum (2016). From Harder and Begnum (2016), we assumed successful UD required high-contact user-centeredness; methods that involved users directly. As M. E. N. Begnum and Thorkildsen (2015) found indications that UCA processes used less user contact and involvement than non-agile user-centered processes, we found evaluating the degree of user contact in AUD an interesting perspective

Scoping for literature

ACM, IEEE Xplore and Springer-Link were identified as the likely most relevant databases, based on our UCA search results for Paper 5. Our initial search string was (scrum OR "extreme programming" OR sprint OR agile OR lean) AND ("universal design" OR "inclusive design" OR "design-for-all"); drawing on the agile terms used by M. E. N. Begnum and Thorkildsen (2015) and Silva da Silva et al. (2011), and the overlapping UD terms discovered in Part 1 and described in M. E. N. Begnum and Thorkildsen (2015). This search returned 1 result from ACM, 165 from Springer-Link and 124 from IEEE. We asked the following questions to further guide our "scoping" search for literature: *Which practices emerge to ensure UD in agile ICT-projects? How does AUD practices compare to tentative promoting factors for UD success in ICT-projects?* We iteratively adapted the search, reviewing keywords used in relevant articles, for each of the three databases. This increased the relevance in returned searches, giving us 191 articles across the included databases.

Data analysis

We screened the returned articles, with the aim of selecting 10 to 15 peer-reviewed papers for in-depth analysis. Next, these were analyzed using the "SQ3R approach"; a survey, question-based and focused re-reading approach (Jesson et al., 2011). We iteratively analyzed, summarized and formed emergent theories on challenges within AUD, applying an open and interpretative analytic approach.

Study 3: Results

As described in the following, we found overlapping practices and challenges for UCA and AUD.

1. Literature Review on User-Centered Practices in Agile Settings

UCA

16 articles were included on UCA practices from 2011-2014. These aligned well with Silva da Silva et al. (2011) findings. The consistencies between our findings are described in Paper 5. Key discussions in UCA were on integrating user testing and UX evaluations iteratively throughout the agile process. This was done through lo-fi prototyping one sprint ahead. Main challenges seemed to be collaboration between developing team and designer, clarifying/merging the role of the designer on the team and allowing the necessary time and culture for UX work. "Little design up front" (LDUF) versus "some design up front" was also discussed.

Methods used: Regarding methods, UCA frequently discussed using user stories to capture usability issues, using low fidelity (lo-fi) prototypes and conducting usability evaluations. Overall, methods linked to understanding of users, tasks and environments were not used in UCA. Apart from user evaluation, methods did not involve users (low to medium degrees of user involvement) and did not reflect grounding in user needs and knowledge on contexts of use.

UCD

20 articles were included on non-agile user-centered practices. These papers used a wider range of methods, with 51 different methods identified. Further, while agile processes mainly used prototyping and user testing iteratively to ensure usability, non-agile processes placed more emphasis on user contact and user involvement, and on user-centered methods in earlier phases.

Table 12: Use of methods in agile vs. non-agile UCD

Methods used for:	Agile	Non-agile	Common Methods:	Agile	Non-agile
User Research (insight)	15 % (11:74)	65 % (13:20)	Prototyping	55 % (41:74)	80 % (16:20)
User-centered specification	35 % (26:74)	65 % (13:20)	Scenarios/user stories	35 % (26:74)	65 % (13:20)
User-involved design/PD	0 %	35 % (7:20)	Observations/field-studies	14 % (10:74)	45 % (9:20)
User evaluation	38 % (28:74)	70 % (14:20)	Interviews	15 % (11:74)	45 % (9:20)
Expert evaluation (inspection)	28 % (21:74)	25 % (5:20)	User profiling/personas	5 % (4:74)	35 % (7:20)

Comparison: Non-agile projects align well with traditional user-centered design methodology, incorporating early user contact and user-involved techniques. However, UCA systematically point to a decreased focus on core UCD principles related to user contact and grounding the process in an understanding of user needs. While UCA seemed to have low levels of user involvement, UCD spanned all degrees of user involvement, from low to high contact. A possible explanation may be that the **customer** (client) replaces the role of users in UCA, especially in early phases. We further hypothesized there might be discrepancies between the underlying **principles** of agile methodology and UCD methodology.

Based on the work, we published Paper 5: Begnum & Thorkildsen (2015) *Comparing User-Centered Practices in Agile versus Non-Agile Development*. Table 12 summarizes our comparison of agile and non-agile UCD practices (more details in Paper 5).

2. Exploratory Interview Study on User-Centered Agile Practices

Seven participants were interviewed. Their agile proficiency varied. All were between 20-40 years of age. Six were male, one female.

Developers' views on UCD

The interview study revealed developers viewed UCD positively. We initially wondered whether there were (two) different academic "traditions" or "stances" present – one by those primarily conducting or promoting technical accessibility work, and another by those primarily holding a more idealistic and human centered attitude towards UD. This idea rose out of the Study 2 questionnaire survey findings, as well as the indication of systematic differences in UCA and UCD practices. However, though developers could not precisely define UCD, they expressed basic knowledge, and did not devalue end-user needs in favor of technical aspects. Compared to ISO 9241-210, the most noticeable missing UCD insights was related to 1) phases typically involved in the UCD process, and 2) the principle of basing solutions on an understanding of user needs. On the other hand, 4 of the 7 participants mention user-contact or involvement, and of these 3 emphasize early involvement.

User awareness

Further, the participants easily separated the agile **customer** role from the **user**; however reported that in UCA practice, the two were often blurred. One participant described how the customer (project owner) could feel there was no need for user involvement – for instance due to confidence in already knowing end-users needs. A few participants stated end-user needs might be de- prioritized due to limited resources and organizational constraints.

Parallel Integration Model Issues

All participants emphasized resource constraints in relation to securing a successful integration of user-centered and agile methodology. They expressed positive attitudes to Thorkildsen's **parallel integration model**. Parallel models typically propose a Sprint 0 overall concept design phase in order to ensure "some-design-up-front", followed by designers working one (or more) sprint(s) ahead of developers. Based on the developers' experiences, it seemed a parallel merged model would fit larger projects, with comfortable constraints. The participants mentioned different aspects influencing whether such a process model is beneficial, such as: budget, project size and time-frame, type of customer and priority given user-centered work over other requirements, type of solution being built, type and size of company delivering the solution, human resources and project manager.

Agile development is all about multidisciplinary team efforts; people from different disciplines working together to reach common goals, ideally as autonomous self-driven teams. Developers expressed parallel models does not encourage **interdisciplinary** practices; integrating and synthesizing knowledge and methods from different disciplines in collaborative cross-task work (holistic). They only facilitate cross-disciplinary work; where people from different disciplines work together, each drawing on their disciplinary knowledge and perspectives to contribute to coordinated work tasks (additive). As such, they found the proposed parallel models could be disadvantageous to interdisciplinary collaboration in multidisciplinary teams.

Further, the participants noted the risk for **workload** discrepancies. A closer and continuous interdisciplinary collaboration throughout the project process was suggested, focused on cross-task workflows in order to create efficient processes for solving tasks and distributing workload. We also discussed the idea of increasing the inter-disciplinarily of team members, so that all agile team members could pull from the same backlog, instead of separating the tasks into two tracks.

Based on the work, we published Paper 6: *Exploration of User-Centered Agile Development Practices*.

3. Scoping review on Agile Universal Design Challenges

Finally, we completed a scoping review, based on the findings in Paper 5: Begnum and Thorkildsen (2015), and tentative Study 4 findings presented in Paper 8: Harder and Begnum (2016) (on factors promoting and obstructing UD). We set out to identify current practices and challenges reported from related research, including evaluating the "user-centeredness" of AUD.

Through a scoping literature reviews, we selected 14 relevant papers. We found that research on UD and agile settings are limited, and decided to draw on insights from UCA. Through in-depth analysis, seven issues emerged as key challenges to solve in order to ensure UD in agile projects.

1. Requirements are Hard to Elicit: When comparing the analyzed AUD literature with Harder and Begnum (2016) tentative success factors, AUD workflow issues were highlighted. We found some support for our assumption that early user involvement is important for UD. However, the AUD literature was also concerned with minimizing the cost of UD and usability work. We became increasingly aware of the importance of adequate resources. The need to anchor resource allocation and needs elicitation in early phases may be the driving force behind the importance of the tentative organizational level success factor "anchored UD-culture".

2. Limited Requirement Oversight & Stand-Ins: One of the main problems addressed was how changing requirements affect the development process of inclusive systems. Agile processes should be better suited to tackle changing requirements, and early user research of needs and contexts of use should help. However, when a proper understanding of user needs was needed in a timely fashion (relative to developers' needs) in order to not delay development, our impression was that "user representatives" were stand-ins for real users to a larger extent than desired.

3. Insights are Hard to Keep Track of: Keeping track of the ideas and requirements from stakeholders and users was a further challenge, not only eliciting needs. As requirements emerged, they must hold a manageable form fitting the agile process. The papers reported issues related to capturing, communicating and quality assuring requirements and insights from end-users with diverse abilities and disabilities. Techniques and tools facilitating continuous elicitation of end-user needs could thus be useful, in order to help document updated user insights throughout an AUD process.

4. Lacking Team Effort Undermines UD: Research on integrating UX and UCD into agile settings backed our view that a key challenge in AUD seemed to be collaboration within the cross-disciplinary team. UD work should be based on a common understanding of UD. Both UX and QA activities take time, and so the development team must adjust accordingly. We concluded that lacking team collaboration could also undermine UD efforts.

5. Quality Assurance Takes Time: User testing every cycle is reported as cumbersome and costly, but user feedback decreased the risk of inaccessible solutions. Several focused on including the entire team, including developers, in user testing with disabled users. Expert evaluation was considered efficient and timesaving. A general practice seems to be that experts and stakeholders test the solution before it reaches end-users, allowing the team to fix obvious usability and accessibility issues and as such save resources. It may be time-consuming and costly to do a user-centered project, and even more so when focused on UD and involvement of marginalized user groups. There was a need for more research on making quality assessment methods more fitting for AUD. Such initiatives are currently being discussed in the Norwegian IT-industry, e.g. building (and sharing) libraries with re-usable elements that are Universally Designed ("atomic methodology", "design-system").

6. User Involvement takes Time: The scoping review indicated the agile processes are suitable to emerging requirements and iterative design efforts. Findings were in alignment with Harder and Begnum (2016) on the importance of accessibility and UD throughout the process, early QA and evaluation work and interdisciplinary cooperation. In order to balance the agile rapid speed of development with the necessary degree of user-centered anchoring, trade-offs must however be made. As high levels of user-involvement and frequent quality control evaluations may be perceived as disruptive to the agile development, resources are recognized as important for AUD (agile UD integration).

7. No AUD Process Model to Guide: We found no general AUD process model in the literature. While Harder and Begnum (2016) found UD should be included in all phases, the AUD literature is less explicit about UD, and is focused on including user-centered and participatory methodology in all phases. Some researchers note the agile process is not fully compatible with UCD methodology, calling for more knowledge on how to more efficiently employ user-centered methods in agile processes, in order to reduce cost (Røssvoll & Fuglerud, 2013). Creating a recommended AUD process could provide guidance. A number of scoped articles dealt with how to avoid adding cost when integrating UD, usability and user-centred work into agile settings. These efforts were mainly focused on adapting the agile process to make room for the user-centered methods. There were however few attempts to also adapt user-centered and design methods to become more agile.

Study 3: Synthesizing Findings

Overall, our findings in Study 3 contributed to increased awareness on the possible frictions between user-centered UD work and agile methodologies. They form a useful backdrop for ongoing discussions on the integration of agile development and UD best practices.

Paper 5 indicated User-Centered Agile (UCA) values might break with the traditional principles of UCD, in particular basing the design upon an explicit understanding of users, tasks and environments, and involving end users throughout design and development. Thus, the term "user centered" may not carrying the same meaning in agile compared to non-agile settings. The breath of methods used, level of active involvement of users throughout the process and degree of user contact appeared to systematically decrease as UX work moved into agile settings.

In Paper 6, we achieved a deeper insight into how UCA developers view UCD. Our impression was that developers are generally positive to UCD. Participants validated identified challenges in Paper 5 and 7, but indicated these issues were not necessarily on an individual level (e.g. developer resistance to UCD). They instead appeared linked to organizational aspects (UCD de-prioritization of procuring customers ordering and controlling resources). In addition, interesting insights were made into developers' experiences on how parallel workflows may be counterproductive to efficient team collaboration and need generous constraints to succeed. The idea of larger academic overlap between the individual agile team resources was debated.

In Paper 7, we summarized important practice-related AUD challenges as related to: 1) capturing, communicating, keeping track of and quality assuring requirements from stakeholders and users, and 2) balancing the time spent on user-involved activities and development activities. Based on the review, further AUD research should focus on providing guidance on how and when to merge user-involved methods into agile settings; maximizing effect while minimizing disruption.

Based on the results from the different studies, we can synthesize key findings into 6 challenges:

Challenge 1: Collaboration in Low UX-Resource Agile Settings

A key challenge discussed by published literature in relation to UCA/AUD success is on the communication and collaboration between the designer(s) and the developers implementing the design. The role of management receives less attention, though this is where both process and resource decisions are made.

There were indications that parallel models may be counterproductive to interdisciplinary team collaboration, due to the strict separation of design and development decisions. Existing models did not seem to facilitate the team pulling together to complete tasks, limit the number of unfinished work in progress, encouraging collaboration to resolve congestions or distributing the workload.

Tina Øvad and Larsen (2015) indicate parallel and satellite models are both increasingly used in agile settings, corresponding to a strengthened UX-focus in industry. While the parallel model may better support UX resources integrated into the agile development team, the satellite model enables designers to have their own UX team and share the workload and responsibilities. As such, one may feel they are opposing each other. However, our industry practice impression is available resources guides integration more than model selection, e.g. how many projects a UX designer must work on at the same time, how many UX resources a single projects have access to, and the location, consistency, and availability of UX resources. A UX designer may be co-located as a part-time UX resource on one project team, while simultaneously being assigned as a satellite on others (Tina Øvad & Larsen, 2015). Through off-the-record comments, we form the impression that it is relatively common to be the single UX resource on 4-5 teams at the same time. This is described as adverse, leading to a heavy workload, lacking opportunities to receive UX peer-reviews and cross-disciplinary UI/design discussions and hindering project dedication.

On this issue, future research could explore some of the ideas expressed in Paper 6, related to; i) agile full-team members with overlapping interdisciplinary skillsets, and ii) adjusting AUD and UCA process models to be less focused on parallel (and cross-disciplinary) tracks, and moving towards facilitating interdisciplinary work. A larger disciplinary overlap could perhaps facilitate collaboration, especially related to UX and UI-design, and strengthen team affiliation and communication. Several researchers note that full integration of UX/IxD resource as team members as well as team co-location is important for successful merger (Bhrel, Meth, Maedche, & Werder, 2015; Raison & Schmidt, 2013; Silva da Silva, Silveira, & Maurer, 2013).

As UX resources are often a bottleneck, using the software developers for UX work by enhancing their qualifications seems an interesting approach (Tina Øvad & Larsen, 2014; Tina Øvad & Larsen, 2015), which the developers seems positive to (Tina Øvad & Larsen, 2015). We would suggest exploring how a UX "satellite" resource backed by a UX team could instead be a UX "mentor" for the team; perhaps with a role closer to the Scrum master in practical implementation. We envision a UX mentor present at each daily stand-up meeting to help assist the team with any UX issues, just as the Scrum master is present to assist with any management issues. We further envision the development team themselves are involved in as many UX tasks as possible under the guidance of the UX mentor, and at a minimum involved in visualizing user stories, wireframing, accessibility and usability QA inspections and user testing. This would free the UX design team up too assist the development team on more complex UX tasks, such as user research, visual design, design thinking, co-design or edge-case UX. It could also help industry and organizations make due with the limited available senior UX resources in the marked, which currently face a shortage of skilled workers.

However, frictions in agile and UCD integration appeared to run somewhat deeper than mere "collaboration issues", and may relate to principles and prioritizations in UCA.

Challenge 2: UCD without Adhering to UCD Principles

Though the iterative UCD and agile approaches have similarities, diverging principles and values may complicate a merger. In Study 3, we could not identify any rich reflections on how the core principles in UCD are attended to within the agile framework. Fundamental principles of agile and user-centered methodologies were not well merged in integrated approaches. There are indications that "user-centered" does not carry the same meaning and values when used within the agile framework compared to the traditional non-agile UCD methodology. In particular, in

UCA one does limited user research and do not fully base designs on explicit in-depth user-need insight. Papers 5 and 7 further found that agile processes appeared to utilize a more limited part of the traditional UCD methodology. This discrepancy could be of interest to the IxD/UX-community, as well as the agile community.

Challenge 3: Reducing "UX" to "UI"

We found that agile UCD is mostly focused on integrating visual design, user interface (UI) design and interaction design (IxD) into agile process, and not reflecting upon the differences between UI and IxD as only small parts of the larger field of UX (user experience). Initial Sprint 0 start-up phases appeared to be treated as a phase for expert work on overall design, which was related to visual design and interaction design, instead of being viewed as a phase for user research. Currently, there seems a consistent tension between UX rigor and UX efficiency in UCA projects, as the knowledge of UX and best practices for integration is still being developed. Future AUD research could thus focus on developing strategies to minimize team disruption when merging user-involvement and high-contact methods into agile development, as Paper 7 proposes. This could also lead to improved or alternative integrated process models for UCA-projects with limited available resources.

Challenge 4: From "UI for Some" to "UX for All"?

When examining the user-centered work reported from agile case projects, and comparing this work to the Precisely 2009 model of the disciplines in the field of User eXperience (UX), we assessed current UCA as focusing on UI design for mainstream use cases. This highlighted the discrepancy between UCA as integrating UI-work into agile settings, and AUD as integrating UD-work into agile settings. Instead of applying IxD & user-centered approaches focused on representative users and core cases to agile methodology, we would like to se a shift to UX & user-centered approaches focused on marginalized user groups and edge cases. It is interesting to follow initiatives such as UScrum. For AUD research, it would be exciting to do a natural experiment to test "UDScrum"; where the project owner split-out role is not solely focused on mainstream UX, but rather on universal design (thus we propose the term "UDScrum") and UX for all.

Challenge 5: Conveying Elicited User Insights

Based on literature and industry feedback, it further appears user-centered and creative methods used to "discover" the problem do not have a clear place in the agile setting. Examples are user research, user empathy mapping, ethnographic methods such as user interviews, and extreme use case and edge case discoveries. However, specifying methods used in the closing problem definition phase, such as personas, user stories, and storyboards, are utilized – at least in agile user-centered methodology. These specifying methods are indicated as important artifacts to convey the elicited user insights from UX work, and (along with prototypes, mockups and sketches) facilitate team (in particular designer and developer) communication (Garcia, Silva da Silva, & Silveira, 2017).

Challenge 6: Skipping the Identification of the Problem

As mentioned, user research and problem discovery metthods do not have a clear place in agile settings. Further, strategic business aspects, including comptetive analyses, is also not typically included in agile settings. Unlike most design approahces, agile methodology is thus more single-minded on delivering working solutions. Thus, agile methodology is reliant on the right problem to be solved already being correctly defined, at least in an overall manner, prior to agile initiation.

Our developer sample points to customers not wanting to prioritize user research activities. Perhaps this could be solved by framing the activities as "design thinking" activities; explaining we need to identify the correct problems to solve from a strategic business design perspective prior to start producing solutions. In recent years, several practitioners have started to merge the "double diamond" model with agile iterative and incremental models; where design thinking approaches moves to lean UX, which then feeds into an agile development process.

It could also be helpful with Lean UX and similar models that emphasize when back-log user stories are assumptions (or hypothesizes) of what is needed, thus underscoring UX work or decision points are needed in order to ensure solutions solve real problems and key needs.

Study 3: Discussion

We found that agile UD work is still under-researched, and proposed the definition "Agile Universal Design" (AUD) to denote the field.

We further concluded that agile UD work overlap with agile UCD work. The assumption from Part 1 on the inter-connectedness of user-centeredness and UD quality was strengthened through Study 3. We assumed that UD methodology is UCD focused on marginalized user groups and edge cases. For insights into the impact of agile settings on UD work, we draw on UCA research.

Our impression was issues related to conducting user-centered work in agile settings increased when moving from UCD towards UD, as a) more user groups and their (contextual) user needs must be considered, and b) because marginalized and edge case user needs are typically harder to understand and quality assure for the mainstream designer and developer. Thus, we believe challenges faced in UCA are likely to increase with a move towards AUD.

Management roles seemed under-researched, even through several identified UCA/AUD process challenges were linked to the projects process models and human resource allocations.

Towards Agile Universal Design (AUD)

Further research could approach these process challenges in at least two different ways: 1) Calling for attempts to change the product owner/organizational perspectives, in order to better safeguard principles related to user research within AUD processes. 2) Calling for safeguarding of principles related to (early) user research, but not necessarily within the UCA/AUD development processes, rather in earlier processes leading up to agile development initiations. We propose the second approach is the better one, and will discuss its hypothesized effects in the following.

General UCA Challenges

We found there was indeed indications of differences between UCD work in agile and non-agile projects, where agile processes appeared to utilize a more limited part of the traditional UCD methodology. In particular, UX research, user-involved, collaborative and creative methods used to "discover" the problem seemed to have no clear place in agile settings (challenge 6). This is diverging from traditional UCD, where one of the key values are to embedd the design/development process in user needs, and involving users in each project phase (challenge 2). Within agile settings, UCD and UX-work is instead largely reduced to UI-design (challenge 3). As such, fundamental principles of the agile and user-centered methodologies were not well merged in integrated approaches, nor is this reflected on in literature, which is likely a contributing factor to a consistent tension between UX rigor and UX efficiency in UCA projects (related to challenges 5 and 1). Based on these findings, we conclude that "user-centered" does not necessarily carry the same meaning when used in an agile setting compared to traditional UCD methodology.

The paragraph above outline the majority of the identified challenges, all typically related to UCA. One approach to solving these challenges is to try to embed more UX-work into agile settings, including a higher degree of user involvement. In our papers, we discuss opportunities for doing so; e.g. developing UCA value sets, developing strategies to minimize team disruption when merging high-contact methods into agile settings, improving process models for projects with limited available resources and moving towards better facilitating interdisciplinary work.

However, trying to change the UCA processes in this respect is not the only solution to the indicated challenges. Agile development settings fit UCD and UD work related to user testing and specifying user stories and UIs for a diverse set of users and contexts of use. However, agile settings do not support problem identification and in-depth insights into UX and users needs.

Possible Solutions to UCA Challenges

Problem identification work could be done outside the UCA development process. We hypothesize UCA projects struggle with most of the identified challenges because there is a lacking awareness of what UCA is **not**: an approach to identifying the right problem to solve. We agree there is a need to call for the safeguarding of principles related to user research and problem insights, but not necessarily **within** the UCA/AUD development processes. Rather, this could be done in separate, earlier processes, leading up to UCA development initiation.

Agile methodology is reliant on the right problem to be solved already being defined. Envision this has been done prior to UCA development initiation, , at least in an overall manner. For example through painpoint and business opportunities identifications, using UX field work and service design/design thinking techniques. This means challenge 6 is solved.

The starting point for the UCA team would thus be to specify. A Sprint 0 or other type of start-up phase for the UCA process already has a set of "proven" user assumptions through documented insights, and that the anchoring of the process in user needs (as well as business opportunities) is in place. Now, the team is already in a "closing problem definition phase".

Together with the project owner, they would typically specify the overall project, create an initial plan and backlog, estimate and determine key priorities. If user representatives, and not merely the project owner, are part of this process, the value fit between UCD and agile methodology is fully bridged. As such, challenge 2 is solved.

Our findings indicate "specifying methods" fit UCA. Methods such as personas, user stories, and storyboards, were both utilized and described as successful in our findings. The user-centered methods seems good for communicating and documenting previously elicitated insights, and as such, challenge 5 on conveying user needs elicitation may be largely solved.

In such a UCA project, it is not necessarily wrong to focus on UI aspects. The broader scope of UCD and UX has already been taken into consideration, and if UI is the main UX-focus in the UCA/AUD project, this decision is assumed based on a solid starting point and well-executed problem identification process prior to the agile setting. If some of the user-centered work is done prior to agile settings, it is not a problem that the "user-centered" scope within the agile setting is reduced. As such, the challenge 3 is probably no longer valid, as UX work has overall not been reduced to just UI work.

For both UI and user testing, we propose the UCA development team is responsible. This is not a new thought, and has been voiced for at least the last decade related to moving away from "UX reports" and towards ensuring team motivation for bug fixing. We however propose this approach primarily to solve challenge 1 – collaboration issues. This is due to our impression that limited UX resources lead to several designer/developer collaboration issues. The number of UX resources available in industry projects did not seem to fit the current process models in use. Project set-ups spread UX resources too thin, and on too many projects at once.

Current process models seemed to lead to the build-up of UX bottlenecks, and hinder interdisciplinary and trans-disciplinary collaboration. Both parallel and satellite process models are focus on cross-disciplinary tracks, and lack processual support for designers and developers pulling together as one team, to complete sprints/tasks, resolve congestions and distribute the workload. We thus propose moving away from cross-disciplinary models, and instead use the UCA team full-time members for the main bulk of UX work, under the mentorship of a UX resource.

With an interdisciplinary UCA team in the lead, we hypothesize improved project flow. The UCA team would get back the "power" and self-sufficiency they were ment to have based on the agile methodology**.** They are better equipped to improve the work distribution, limit the number of unfinished work in progress, and decrease bottleneck risk. If UCA teams become less reliant on heavy UX support, UX-resources would on the other hand be less overworked. UX designers could then be freed up to focus on more complex UX and UD issues – such as field work to pinpoint the problem-to-solve for future projects. This would reduce the current conflict between need for efficiency to not hold up the UCA process flow, and the need for rigour to be able to know what to solve next and be informed on how to solve it. The approach of a "UX mentor" could thus diminish many of the collaboration issues of challenge 1.

The mentor model would also increase interdisciplinary discussion. The approach facilitates inter-disciplinary settings, where the UX mentor and agile team discuss solutions and make decision together. Several developers in the Study 3 interview study mentioned this as beneficial to ensure high quality and on-time UIs. Note that we view UI design as typically based on some LDUF or "Sprint 0" outlined design guidelines developed by UX-designers. The UX mentorship would ensure the overall HCI, visual design and GUI quality.

Using the software developers for UX work under UX mentorship may enhance trans-disciplinary solutions. The mentor approach would lead to agile team members with an increased general UX expertise – covering basic UX skills. Thus, in addition to the decreased pressure on the UX designer, any developer/designer "rift" left could be partly bridged by overlapping interdisciplinary skillsets. Further, UX mentorship might facilitate an increased presentation of interactive designs to the developers, which should be discussed and improved in an interdisciplinary manner. As such, UX mentorship may enhance trans-disciplinary innovations – where developers extend to the UI and IxD specifications with their technological knowledge.

Iterative UX evaluation and improvement is part of team responsibilities. Putting the agile team in the lead should not imply less end-user testing – in fact there should be more user-involvement and contextual focus. Achieving incremental deliveries and iteratively improving previous releases based on user feedback is already an agile golden standards. Many participants in Study 4 mentioned user-testing involving developers is an efficient way to convey UCD values, motivate developers to fix issues and inspire developers on UX/UD topics. As such, the iterative user evaluation and improvement could likely be strengthened with increased team delegation.

Specific AUD Challenges:

Apart from the process challenges, ensuring a UD focus and UD competence on the team is also necessary. For AUD, an additional challenge is that the focus is still on mainstream users (challenge 4), even if developing solutions that fall under the UD legislation. It currently seems the developers are the more focused on UD compared to the designers, as developers must try to adhere to the technical accessibility legislations for ICT.

Possible Solutions to Specific AUD Challenges

The AUD projet needs basic UD competence and AT knowledge, related to ensuring both usable and technical accessibility. Aspects such as contextual interaction in real-life settings and usability for all users across contexts should also be included. It is important that AUD QA work includes not only mainstream user testing, but also testing with assistive techbologies, marginalized and disabled users. A focus change is believed needed in order to solve challenge 4.

This knowledge should be included in the specification process, i.e. in the discussion and methods such as personas, storyboards etc. Accessibility aspects should further be included in UI/UX design. UD inspections and accessiblitiy checks are described in Study 4 as easy and efficient QA practices, and developer/designer collaboration seems to strengthen the overall quality control – as well as peer competence sharing. User testing as early and frequent as possible, taking marginalized user group needs and assistive technology into consideration, seemed key for Study 4 UD success. UD experts on Study 4 projects successful on UD expressed how meeting real users in testing creates insights into their needs, and inspire efforts to meet their needs. Participants from Study 4, largely on agile or semi-agile teams, expressed they wanted to do more user testing with marginalized and disabled users, in real-life settings. If the AUD team lack UD competence, external evaluation assistance is recommended.

Limitations of Study 3

Study 3 has several limitations. First, the necessary search limitations for non-agile user-centered practice related to Paper 5 caused non-symmetry in our data. This may negatively affect the strength of the validity in our agile and non-agile comparison.

Second, our second study only interviewed 7 developers, thus the findings are not generalizable. Further, the study did not fully capture in-depth views on IxD, UCS and UX work among the UCA developers. Follow-up studies using questions that are more detailed; e.g. asking UCA-developers and UCA-designers to rank UCD principles and agile principles was recommended future research. This work is not yet completed. Still, we can extrapolate that reported collaboration issues are not necessarily linked to any disregard of user-centered values among developers. The sample confirms our identified key UCA and AUD challenges, but offers other reasons for these challenges than we initially assumed.

Third, we draw on UCA to inform AUD practice, based on the assumption from Part 1 that UD can be viewed as an inclusive extension of UCD methodology. If this assumption is false, Study 3 is still interesting for UCA, but cannot inform much on the impact of agile settings on UD work.

Towards Study 4

We chose not to continue the research into UD in agile settings, as based on our findings, the main contributions envisioned would be more focused on promoting UX in agile settings (UCA), rather than facilitating UD (AUD). Thus, the scope appeared not as aligned with the main goal of the thesis as other opportunities that presented themselves for UD facilitation.

The next study outlines research mapping the characteristics of UD-successful ICT-projects, where iterative and flexible process models is just one of the factors believed to influence the outcome.

Study 4: “What Success Projects Do”

Study 4, the second breakout study in Part 2, investigates applied aspects in ICT-projects that have successfully delivered solutions with high UD quality. We asked: “What characterizes ICT-projects that have achieved “best-practice UD quality”? We assumed that these projects could be a benchmark for current UD of ICT “best practices”, and further that synthesizing “success practices” could identify predictable UD quality attributes.

Part 1 finds some links between epistemological and personal preferences and stances on one hand and methodological approaches and views on the other. However, other underlying factors impacting the choice of methodological approach and UD quality are now suspected. In addition to internal, personal beliefs, we hypothesized different external factors and constraints exist, also influencing the resulting UD of ICT quality. By looking at “success practices” from real-life, we now gather further insights into applied aspects affecting UD of ICT.

We defined “high UD quality” based on industry awards and public assessment ratings. ICT-solutions receiving these awards, or nominations, or the highest assessment ratings, were selected as the population of relevant projects. From this population, we sampled and examined the practices of as many projects as possible. Thus, project practices were examined post-delivery.

Study 4: Background

There are ongoing efforts to improve knowledge on best practices for UD of ICT processes. Organizational barriers, competence barriers and awareness barriers are indicated by previous research. Our impression was literature recommended: 1) An interdisciplinary team and a holistic process, 2) based on user-centered design principles, 3) adopting and applying accessibility standards and guidelines, 4) using an iterative development, 5) focusing on users with disabilities, early on and throughout the project, 6) using empirical evaluations with various impairments represented and 7) focusing on the entire user experience (Fuglerud & Sloan, 2013; Schulz, 2014; Scott, Spyridonis, & Ghinea, 2015).

Study 4: Research Approach

We started the empirical mapping of different factors impacting UD in ICT-projects using a bottom-up, inductive, exploratory and qualitative approach. Semi-structured, in-depth personal interviews were used to maintain a solid foundation and framework, exposing the respondents to the same questions and themes – while simultaneously allowing for flexibility and follow-up questions (Rogers, Sharp, & Preece, 2011).

The interview guide was created based on assumptions created from Part 1 of the thesis, including the responses to survey questionnaire items. It held items from the expert questionnaire that based on expert responses are considered successful at mapping personal methodological stances and preferences. Parts of the guide were structured, using closed and quantifying questions based on the survey items from Study 2. With this approach, we had the possibility to compare the interview sample against the survey sample on identical questions. This work has not yet been fully completed, as exploring "success practices" seemed more pressing than continuing to understand methodological stances.

Further, the interview guide asked for the development process model used in the projects, as we were interesting in mapping whether agile or non-agile approaches were used in the successful projects (as discussed in Study 3). The entire guide consisted of 21 questions, where 5 questions concerns personal experiences related to practices for successfully achieving UD in Norwegian ICT projects, 10 questions concerned methodic style and epistemologies, and 6 mapped background variables.

Sampling

All participants were affiliated with an ICT project linked to UD success. We had some difficulties with the issue of what "success" should entail. There was no clear way of identifying universal design "success" in ICT-solutions (described in Paper 9). We decided to rely on external assessment of UD, accessible and inclusive qualities of the ICT quality of these projects end-results. We identified UD-related awards given ICT-solutions by independent and reputable juries and organizations. External design awards seemed to only use honorable mentions when there are several strong candidates to win among the nominees. The honorable mentions were thus considered equivalent to being a runner up.

These external design awards, honorable mentions and assessments used different criteria for "success". We thus analyzed their criteria, and verified that they all included UD as a central aspect. We defined a "success project" as a ICT-project that: a) wins a design award where universal design is a central criteria, or b) receives an honorable mention in a design award where universal design is a central criteria. Based on these selection criteria, we sampled projects from 2010 until 2017. In order to make our selection more transparent, a sample overview is presented in Table 13 and described in the following. Note for Table 13 that some projects were affiliated with more than one award. Further, two awards are unnamed, due to traceability concerns.

The Innovation Award for Universal Design and The Design for All Award were both specifically assessing UD. Design and Architecture Norway (DOGA) distributed both, with the latter co-distributed with the (then) "Delta Centre" (the national resource center for accessibility and social inclusion) within the Norwegian Directorate for Children, Youth and Family Affairs. The included ICT- projects that have won these awards did so in the competition categories "interactive design" and "interaction design".

DOGA also distributed the Badge for Good Design. The Badge has a broader design focus, but included universal design as a sub-criterion.

The Farmand Award had a category with specific UD criteria, targeted towards public services.

The ratings from public authority Norwegian Agency for Public Management and eGovernment (Difi) was also considered a reputable quality assessment authority. The professional community at Difi was viewed equivalent of an award jury and top Difi ratings as equivalent of a design award/honorable mention. Projects were viewed as successful if they received 5 or 6 stars out of 6 possible in Difi's Online Quality Evaluations. DIFI emphasized WCAG aspect and focused on public services and public websites in rankings and awards.

Table 13: Overview of awards and our 23 sampled success projects.

Award	Distributor	Projects
Innovation Award for Universal Design	DOGA	5
Design for All Award	DOGA/The Delta Center	3
Badge for Good Design	DOGA	6
Farmand Award	Farmand AS	3
Public Website of the year, Online Quality	DIFI	6
Digital Service of the year, Online Quality	DIFI	1
Unnamed: Young design	-	1
Unnamed: International	-	1

Data Collection

The averaged duration of an interview was 45 minutes. Interviews were audio-recorded, transcribed in verbatim and analyzed using NVivo. In addition to recordings, hand-written notes were made throughout the interviews. All participants received written information about the study, and gave their written consent for participation and for recording of the interview. Through an iterative and collaborative effort, 34 participants from 24 successful ICT-projects were interviewed for primary data collection. This is considered a strong dataset for qualitative content analysis.

Data Analysis

A thematic content analysis was selected for data analysis, and applied in an iterative three-step manner after converting the audio recordings into text-based media content in the shape of interview transcripts. The goal of qualitative content analysis is recognition of significant themes and categories within a body of content, typically to provide insights into particular phenomena (Leedy & Ormrod, 2014), and facilitate the development of new theories or validate existing theories (Zhang & Wildemuth, 2009). This is done through careful coding and interpretation, where by analyzing individual cases and comparing them, higher-level patterns can appear (Jonathan Lazar et al., 2010; Zhang & Wildemuth, 2009).

Initial analysis: In the initial analysis, emergent coding was chosen. While working on topics without established theories to build coding categories on in advance, emergent coding (also called conventional content analysis) is an appropriate approach (Hsieh & Shannon, 2005; Jonathan Lazar et al., 2010). Prior to coding, we familiarized ourselves with the transcripts and identified open items giving overlapping answers. Therefore, we decided to analyze the transcripts as a continuous text instead of questions consecutively. Results from the first 13 interviews from 12 success projects were published in Paper 8: *Promoting and Obstructing Factors for Successful Universal Design of ICT* (Harder and Begnum, 2016).

The two Paper 8 authors conducted emergent coding separately. Coding categories are derived directly and inductively from text data during the analysis (Yin, 2012), and subsequently structured into a nomenclature; a list of numbered categories that represent all the possible answers to a question (Jonathan Lazar et al., 2010). Begnum identified 104 codes: 75 promoting and 29 obstructive. Harder identified 103 unique codes across the 13 transcripts: 75 promoting and 28 obstructive. Inter-coder reliability was calculated, and found a 98 % overlap between promoting codes and 95 % overlap between obstructive codes.

88 % of the 150 promoting codes had a perfect or nearly perfect overlap, while a further 10 % were overlapping, but without an exact match. 3 codes clearly differ. Begnum had focused more on organizational culture and resource prioritizing, and thus had a code on AT access and another on the link between securing usability and UD. Harder had focused more on detailing codes related to understanding the concept of UD, and thus had a code on innovative abilities.

For the 57 obstructive codes there were also 3 diverging codes; Harder had a code on handling resistance, while Begnum had one related to lacking utilization of available UD resources and another on the challenge of frameworks and tools in violation of WAI. The high degree of overlap indicates a reliable analysis, as different people code the same text in the same way. In order to further increase the internal validity of coding and categorization, we discussed codes and their sorting while cooperatively categorizing them. More details on the initial analysis are found in Paper 8.

Extended analysis: Interviewing, transcriptions, coding, categorization and interpretation of the data was continued after preliminary analysis. We now had a set of codes and categories to apply to the data in a summative coding approach (also called "a-priori" or "deductive" coding) (Hsieh & Shannon, 2005; Jonathan Lazar et al., 2010; Yin, 2012). We moved from a focus on inter-rater consistency to a focus on test-retest in order to confirm external validity. Thus, we did not focus on separate coding. Instead, we shared the workload of iteratively transcribing and coding in NVivo. Harder's coding results are found in her Master thesis (Harder, 2017).

First, we applied the a-priori categorization scheme to the extended data set of 18 new participants from 9 new success projects. We used statistical inference to make sure background-variables were not significantly different (which they were not). The empirical data was converted from semantic to numeric, imported to SPSS and (as most variables are at nominal level) Pearsons Chi-Square was used to check significance. Next, we completed a manual frequency analysis of code categories based on NVivo output. Then, we compared the two samples.

Final (Full) Analysis: After sample comparisons, we re-analyzed the full sample using a directed coding approach, where a-priori codes and categories are used as a basis while still allowing new codes or categories to emerge (Hsieh & Shannon, 2005); first on N=31 from 21 projects and later on N=34 participants across the final 23 projects. By increasing the number of participants to 34 participants from 23 projects, the resulting overview of characterizing factors from success projects holds increased validity, reliability and generalizability. By adding codes, categories (nodes) and participants (cases) in NVivo, we linked relevant transcript sections to classifications. This allowed us to refine categorization iteratively, reflecting new insights, while simultaneously ensuring internal reliability (that each node is coded consistently across the cases).

Study 4: Results

An overview of the full sample is found in Table 14, presenting the profiles of the 34 participants and 23 projects. Participants 1-13 are from the initial sampling, 14-31 from extended sampling, and 32-34 from a final focus group interview. The full sample consisted of 16 designers (of which 14 interaction designers), 11 developers (both front-end and back-end), and 7 with other project roles (including project management).

The agencies where participants were employed, were categorized as Private, State or Consultant. 15 of the 23 projects are linked to the public sector, while 8 are from the private sector. Private agencies are privately owned companies, profit or non-profit. State agencies are organizations that the government at least partially own.

Experts that are hired out as consultants are categorized as coming from Consultant Agencies. The sample held 21 participants from consultancies (62 %), 9 from state agencies (26 %) and 4 from private agencies (12 %). The overweigh of consultants in the sample, is due to use of consultancies in public sector projects, where consulting participants are linked to their *employed* workplace even if affiliated with the success of a private or state *customer* company.

The participants were asked on whether the overall success project process was agile or non-agile, where non-agile were used synonymous with "plan-based" (i.e. sequential and structured across phases, e.g. in a waterfall style). Several mentioned a "hybrid" approach to agile development, using agile elements like an iterative process with continuous feedback, but without strictly adhering to a specific agile methodology. We considered this hybrid approaches as semi-agile, or agile-like, and decided to code them as agile. Thus, the "agile" process models are not necessarily following a concrete agile framework (such as XP, Scrum or Kanban), nor providing continuous deliveries.

There were no statistically significant differences between the initial and extended samples related to background variables (gender, age, years of UD experience, professional role, and type of agency). Further, no relationships were identified between these background variables and selected characterizing factors: interest trigger for UD, self-evaluated UD experience, and agile, hybrid or non-agile approach. We have not systematically investigated all possible relationship in the sample, merely looked into some potentially interesting hypotheses that were not confirmed.

Table 14: Participant overview - Full sample

No	Age	Gender	Role	Company	Project
1	30-39	Female	Functional Designer	Consultant Agency 1	5,11
2	<30	Female	Interaction Designer	Consultant Agency 1	5,11
3	40-49	Male	Interaction Designer	Consultant Agency 2	4,8,9,21
4	30-39	Male	Interaction Designer	Consultant Agency 3	10
5	40-49	Female	Graphic Designer	Consultant Agency 2	4,8,9
6	30-39	Male	Developer	Consultant Agency 4	1,12
7	50-59	Male	Developer	Consultant Agency 2	4,8,9
8	<30	Female	Developer	State Agency 1	1
9	40-49	Male	Web Advisor	State Agency 2	2
10	40-49	Male	Senior UD Advisor	State Agency 1	1
11	30-39	Female	Developer	Private Agency 1	3
12	40-49	Male	Developer	Private Agency 1	3
13	30-39	Male	Interaction Designer	Private Agency 2	6,7
14	30-39	Male	Developer	Consultant Agency 8	15
15	40-49	Female	Project Manager	Consultant Agency 8	15
16	40-49	Male	Creative Director	Consultant Agency 5	16
17	30-39	Male	Interaction Designer	Consultant Agency 5	16
18	30-39	Female	Interaction Designer	Consultant Agency 4	14
19	30-39	Male	Creative Director	Consultant Agency 4	20
20	30-39	Male	Developer	Consultant Agency 9	6
21	30-39	Male	Developer	Consultant Agency 7	2
22	40-49	Female	Interaction Designer	State Agency 4	8
23	40-49	Male	Communication Advisor	State Agency 4	8
24	<30	Female	Developer	Consultant Agency 4	14
25	50-59	Female	Interaction Designer	Consultant Agency 10	13
26	50-59	Female	Interaction Designer	Consultant Agency 10	13
27	30-39	Male	Interaction Designer	Consultant Agency 6	17,18
28	30-39	Female	Graphic/Interaction Des.	State Agency 3	20
29	30-39	Female	Interaction Designer	Consultant Agency 7	19
30	30-39	Female	Interaction Designer	Consultant Agency 7	19
31	30-39	Female	Project Manager	Private Agency 3	13
32	40-49	Female	Developer	State Agency 5	22,23
33	<30	Male	Developer	State Agency 5	22
34	30-39	Female	Interaction Designer	State Agency 5	22

Results 1: Initial Analysis

From the initial analysis, two overarching classifications were identified. The first is **promoting** aspects for UD of IT. The second is **obstructive** aspects. We sorted the 150 positive and 57 negative codes into 13 promoting and 6 obstructive categories. The code-categories were identified as on three different levels: Organizational, Processual and Individual. Paper 8 details the initial categories. Tables 9, 10 and 11 in Paper 8 summarize frequency of mentions for the three levels of promoting categories, while Tables 12, 13 and 14 in Paper 8 show category frequencies for obstructive levels.

All 13 participants mention how an understanding and anchoring of UD on an organizational level, and having an established usability culture at all management levels, is important for UD success. Further, all mentioned that UD competence is key, including team individual skillsets and enthusiasm, and stakeholders holding the necessary understanding. Further, there are some aspects *almost* all the participants mention. These are related to UD and usability focus (and prioritizing time to do user-centered and QA activities), interdisciplinary team collaboration, an iterative process model, doing early and frequent quality checks and user testing.

At this point, the interest in exploring the overlap between UD and usability, and how (inclusive) UX and user-centered work can be done in agile settings, was spurred.

Further, we started to suspect resources may be a so-called "hygiene factor", which must be sufficiently present for UD success to be possible, but is not necessarily a promoter for UD in and of itself. Even though all participants emphasized the necessity of resources (human, economic and time wise), resources were frequently described as a requirement for other promoting factors (often critical), and a lack of resources because of missing priorities (or presence of other obstructive factors).

Through the initial results, we acquired in-depth insights into the relationships between key promoting and obstructive factors shared by the success projects in the sample. We hypothesized 6 key promoting factors; 1) *UD anchoring*, 2) *UD competence*, 3) *focus* (on UD, users and usability), 4) *collaboration* (in interdisciplinary teams), 5) *iterative* approaches and 6) early and frequent *QA* and user testing.

We further saw that identified negative and obstructive factors were mainly due to an absence of corresponding positive factors. We interpreted this as a tentative confirmation that the key positive factors identified were in fact tentative "success factors".

Results 2: Extended Analysis

The focus of the extended analysis was on confirming the insights from the initial analysis, and strengthening the reliability (and generalizability) by increasing the number of participants (to 31), as well as the number of successful projects (to 21). We needed 7 new codes to analyze the extended sample, but no new code-categories. However, we did extend some code-categories in order to include the new insights. These changes, and detailed categories, are described in Paper 9: *Ensuring Universal Design: Towards Predicting Project Success through UD3C Critical Criteria Compliance*.

Frequency of mentions for each a-priori code-category was compared between the initial and extended sample. The same was done for the number of participants mentioning each code-category. Table 15 presents our findings. Note that the calculations in Table 15 were completed independently by Harder in her master thesis work. Based on the symmetry of the responses in the two samples, we did not continue the comparison using statistical inference, as we believed the likelihood for statistical significant differences were minimal (except mentions of Anchoring).

The overall conclusion was our tentative factors from the initial analysis were verified across a larger N, with similar or increased mentions for all categories. Overall, codes and categories remained consistent. We felt confident in the strength of our findings, as a local sample to the Oslo area in Norway. However, the extended data also encompass new insights, which spurred a re-analysis across the full sample.

Table 15: Summarized comparison between initial and extended samples

	Code-Category	Frequency: Mentions	Frequency: Participants
External	Legislation/Framework	Initial: 18 Extended: 41 Total: 59	Initial: 9 (69 %) Extended: 14 (78 %) Total: 23 (74 %)
Organizational	Anchoring	Initial: 17 Extended: 107 Total: 124	Initial: 10 (78 %) Extended: 18 (100 %) Total: 27 (90 %)
	Resources	Initial: 28 Extended: 49 Total: 77	Initial: 11 (85 %) Extended: 18 (100 %) Total: 27 (87 %)
	Top-level Understanding	Initial: 18 Extended: 35 Total: 53	Initial: 8 (62 %) Extended: 18 (100 %) Total: 26 (84 %)
	Reputation	Initial: 12 Extended: 6 Total: 18	Initial: 3 (23 %) Extended: 6 (33 %) Total: 9 (29 %)
Processual	User Focus	Initial: 53 Extended: 78 Total: 131	Initial: 12 (92%) Extended: 18 (100 %) Total: 30 (97%)
	Quality Assurance	Initial: 37 Extended: 49 Total: 86	Initial: 12 (92%) Extended: 18 (100 %) Total: 30 (97%)
	UD Focus	Initial: 59 Extended: 76 Total: 135	Initial: 12 (92%) Extended: 17 (94%) Total: 29 (94%)
	Cooperation	Initial: 37 Extended: 31 Total: 68	Initial: 11 (85 5) Extended: 14 (78%) Total: 25 (81 %)
	Simplification	Initial: 6 Extended: 23 Total: 29	Initial: 5 (38 %) Extended: 9 (50 %) Total: 14 (45 %)
	Agile	Initial: 10 Extended: 16 Total: 26	Initial: 5 (38 %) Extended: 9 (50 %) Total: 14 (45 %)
Individual	Personal Qualities	Initial: 25 Extended: 32 Total: 57	Initial: 13 (100 %) Extended: 18 (100 %) Total: 31 (100 %)
	UD Competence	Initial: 34 Extended: 51 Total: 85	Initial: 11 (85 %) Extended: 15 (83 %) Total: 26 (84 %)

Results 3: Final Analysis

After increasing the sample size (N) from 13 to 31 to 34 participants (and from 12 to 21 to 23 projects), we examined whether the classifications and categories should be altered, combined or renamed to better reflect the extended insights. Further, when conducting the comparative analysis, similar codes from coding researchers were merged into categories but kept as separate codes in order to preserve detail and transparency. This means there were overlapping codes within some categories. In the directed analysis, overlapping nodes (codes) were merged, improving the internal reliability of frequencies of mention.

The final analysis showed we should alter the factors levels; classifying factors on four levels instead of three. The final levels were labeled Social, Organizational, Processual and Personal. Societal and Organizational factors point to the context in which the ICT-projects take place, while Processual and Personal aspects point to the activities and mindsets in the project team.

The final analysis resulted in the identification of 84 characterizing factors, of which 53 promoting and 24 obstructive. These 84 characterizing factors were grouped hierarchically into 22 main categories, across the 4 levels. The 22 main categories in turn contained 45 sub-categories, of which some held the 9 identified sub-sub-categories, see Figure 18.

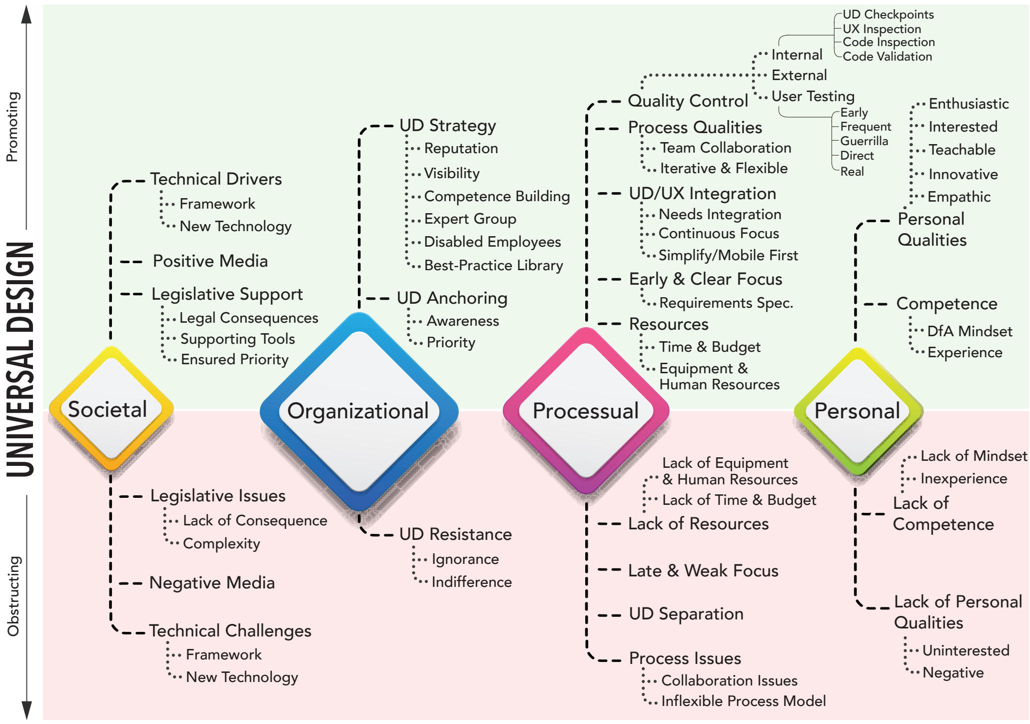


Figure 18: Overview of identified characterizing factors

Study 4: Discussion

Study 4 in Part 2 asked: "What characterizes ICT-projects that have achieved 'best-practice UD quality'"? 84 characterizing factors were identified, through non-probabilistic sampling of 23 projects regarded as successful based on current best practices, and emergent coding of 34 full textual transcribed in-depth interviews, supported by interview audio recordings. These were grouped in a hierarchical manner, across 2 the overarching classifications of "Promoting" and "Obstructing" factors, on 4 factor levels (Societal, Organizational, Processual and Personal).

They were further grouped into 22 main categories within these levels, with 45 sub-categories and 9 sub-sub-categories. The hierarchical factor categories are presented in Figure 18.

Societal, Organizational and Processual factors are types of **external** factors affecting real-life practice. The large amount of non-personal factors identified encouraged our suspicion that such external aspects are key for UD success. External factors are influencing the processes and settings under which any best practices can be initiated. These may be either obstructive (such as inadequate resources) or promoting (such as competence sharing and social anchoring).

The participants' descriptions of the practices of the successful projects highlight a link between collaborative user-centered approaches, usability efforts and UD success.

At this stage in our research, findings particularly points to how organizational factors influence other factors. In particular, management and client anchoring of UD are emphasized as influencing other factors (on other levels). It appears an anchoring of UD on Organization level "triples down", and enables e.g. UD priority aspects on the Processual level.

Further, we found links between organizational dedication, individual competence and project success. In addition to having a UD focus anchored at management levels, it seems having the correct competence and personal qualities among team members is important. This is corroborated by related research. For example, Khang and Moe (2008) report that competence is important, however, if the team and project management are not dedicated to project success, the competence level of team members, which still is an important factor, becomes less significant.

Our findings provide new insight into factor relationships, and suggest that measures must to be taken at several levels in order for a single project to succeed. This does not mean the Part 1 model is invalid or useless. Rather, it may be argued that epistemologies and methodological approaches are indeed confirmed as key success factors, as we find a strong user focus, high usability/UD overlap and direct contact methods are indeed linked to UD success. However, these methodological aspects seem to be determined on a Processual level in industry related ICT-projects, and not on a Personal, as assumed in Part 1. Personal factors as influencers for UD success in industry ICT-projects were not linked to specific paradigm stances or doxastic styles, but rather to competence and personal qualities held among individual project members.

7 tentative UD success factors indicated from our initial analysis are presented in Paper 8 (Harder & Begnum, 2016), coincided well with related literature. It appears an anchoring and top-level understanding of UD allows for proper resources, which allows for an early and continuous UD focus and UD QA throughout the development process. This QA should include frequent user testing, alongside various methods of internal and external quality assurance. Further, good interdisciplinary team collaboration is important for the QA process, and one should use an iterative process model with frequent quality assurance and user contact. Study 4 continuous in Part 3, where we assess which of the 84 factors should be considered the most critical for UD success. Part 3 then uses this knowledge as a starting point for prototyping tools facilitating UD practices in ICT-projects, and iteratively assessing and refining the tools.

Our findings extend the organizational, competence and awareness barriers indicated by previous research, by providing rich qualitative data on how Societal, Organizational, Processual and

Personal aspects influence each other. These qualitative insights are explored more in Study 8 (Part 4 of the thesis), with a focus on investigating the types of and relationships between factors.

Limitations of Study 4

Most of the identified factors are closely linked to the levels on which our participants are closest to. This is first the Processual level, followed by Organizational and Personal factors. These results were not anticipated, thus measures were not taken to highlight all levels influencing projects in an adequate manner. In hindsight we thus see the potential that the Processual level emphasis may be due to the context in which the participants execute their profession, as well as the focus of our interview guide. If our sample had been comprised of more participants on Organization level and in management positions (currently less than 12% of the our sample), one could speculate more factors on Social and Organizational levels could have been mentioned.

Towards Study 5

Alongside Study 4 on ICT-development projects, we also investigated ICT-solution procurement, and how UD quality aspects were handled here. The next chapter will present Study 5, which investigated the case of digital assessment solution procurement in the HE sector.

Study 5: "Procuring ICT in HE"

This third breakout study continued the processual focus from Study 4, but now a specific case was explored in more depth. In 2017, the educational sector was included under UD of ICT legislation. It went into force January 1st 2018, and specified digital learning tools must adhere to accessibility regulations (BLD, 2017) - by January 1st 2019 for new tools, and January 1st 2021 for tools already in use. In 2015, we saw this legislative change coming, and started to study UD of ICT practices in higher education (HE).

We selected the case of digital assessment solution procurement, as this was a large and cross-disciplinary digitalization effort in the Norwegian HE sector at the time, with digital assessment solutions were being piloted, procured, implemented, and adapted for the sector. Study 5 Part 2 explored how UD aspects were ensured in these ICT-procurement processes. We asked: "How is UD quality being ensured in procurement processes?"

Study 5: Background

UD and eLearning tools

The legislative term "digital learning tools" overlap with the more established term "eLearning tools". It referred to web-based tools used for educational purposes, or to assist in educational purposes. As Paper 10 outlines, we found limited research on UD aspects in relation to institutional use of digital assessment solutions and other eLearning tools.

Instead, UD research within the HE sector seemed to emphasize physical learning environments, which may still hold a major challenges related to orientation, mobility, focus, and mental health. We thus continued to draw on background and literature review insights that UD of ICT solutions needs to cover both usable accessibility and technical accessibility aspects.

HE and eLearning tools

ICT-solutions introduced to the HE sector are often assumed to lead to change – applying positive technological deterministic views (Cuban 2001 in Krumsvik, 2006). Often, the results of ICT implementations do not meet these expectations. This notion was supported by (Khemani, Hagen, Ross, & Jamjoum, 2013), arguing that in order for a productive and constructive utilization, one needs to set guidelines for how and why an ICT-solution is acquired. A similar best practice was recommended by Granić and Ćukušić (2007): to emphasize the purpose of the solution, the pedagogical tasks it is meant to solve, as well as the general and specific student needs. This is in conflict with Krumsvik's observations that teachers were rarely consulted when new technological solutions were procured, and that the terms of ICT introductions were often decided by bodies external to the HE institutions (Cuban and Tyack, 1998 in Krumsvik, 2006).

Disability in Norwegian HE

Many surveys define "disability" by self-assessment from respondents as a permanent physical or mental health issue that limits everyday life. Based on a cross-survey analysis, The Norwegian Directorate for Children, Youth and Family Affairs estimated in 2018 15-20 % of the Norwegian adult population have disabilities[7], of which are 4.5 times more likely to be employed if they have a HE degree (Bufdir, 2015). Statistics on the necessity of HE for employment may hide underlying aspects, such as general health and aptitudes. Still, the importance of offering inclusive eLearning environments is evident.

In a 2012 survey, 15 % of Norwegian HE students reported having a disability or impairment that affected their study progress. This may be related to usable accessibility issues over technical accessibility issues, for example in the cases of neuropsychiatric challenges (such as dyslexia, autism-spectrum or attention deficit disorders), asthma and allergies, or mental health issues (Bufdir, 2015), as the term "disability" was used to cover all types of health issues.

The Norwegian HE Sector

In 2015, there were 48 institutions in the Norwegian HE sector: 1 university hospital, 8 universities, 5 state specialized universities, 3 private specialized universities, 18 university colleges and 12 other HE institutions. A governmental initiated reorganization process merged 15 of the universities, university colleges and other HE institutions, resulting in 36 Norwegian HE institutions by 2016. Thus, at the time of the survey, the population held 48 institutions; while at the time of the interviews the population was 36 institutions.

Digital Assessment Solutions

Digital assessment solutions are tools to digitalize the examination process. Study 5 focused on aspects related to taking the exam, and not on grading, feedback, complaints or exam preparation. From 2014-2016, Uninett led a cross-institutional national project on HE digital exams. Uninett runs Norway's research and education network (NREN), and is owned by the Norwegian Ministry of Education and Research. 27 of the 48 HE institutions (pre-mergers) were part of the digital exam project.

Study 5: Research Approach

At the start of the study, we held no particular assumptions related to the case, and so an exploratory case study was used to elicit information on knowledge, practices and approaches to ensuring UD in ICT-solutions in the HE sector. The aim of exploratory approaches is to explore conditions or phenomena that fully or partly unknown. Our purpose was to understand practices related to ICT-procurement and implementation in the HE sector, to identify challenges and opportunities and as such contribute to the overall thesis aim. By acquiring knowledge on how to ensure Universally Designed IT solutions, we wanted to strengthen UD QA and specifically address any issues or best practices concerning the acquisition and use of digital exam solutions.

[7] Please refer to https://www.bufdir.no/Statistikk_og_analyse/Nedsatt_funksjonsevne/Antall/

The case study was initiated by a survey, and extended by semi-structured in-depth interviews of administrative, accessibility or procurement-project involved personnel from the HE institutions. These were extended by interviews with representatives for solution providers, in order to get their viewpoints on collaborative aspects and triangulate the information. The case study mainly relies on qualitative data to iteratively construct inter-subjective meanings and insights.

Figure 19 visualizes the overall research process for case study data collection.

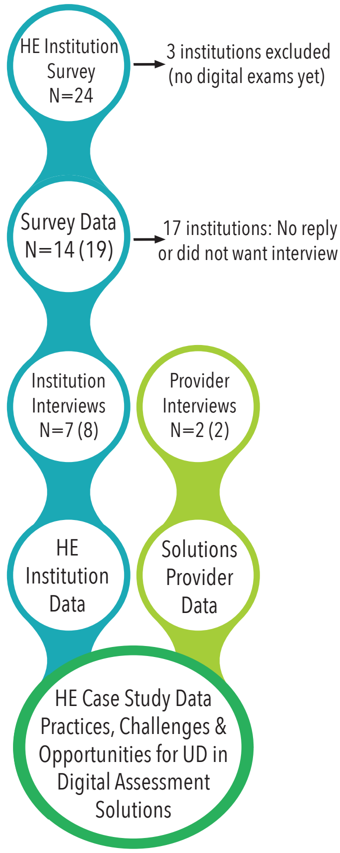


Figure 19: Case Study Data Collection

Survey

The survey had two main aims. First, we wanted to get an overview of key aspects related to the case. This included an indication of the UD competence held by the institution administrations, and current implementations and usage of digital assessment solutions. Second, we wanted to identify interview participants and starting points for conversations.

Sampling: One might argue that we applied a census approach in the case study survey, as we contacted **all** 27 institution-representatives in the digital exam project. On an institutional level, we could also calculate the margin of error: of the 27 institutions, 3 did not want to participate. This made our sample 24 institutions. With a 95 % confidence level, we thus reached a +/- 14 % margin of error.

However, the contacted representatives were asked to forward the survey-link within their institutions to individuals fulfilling a set of inclusion criteria: 1) working with ICT-solution procurement, 2) working with educational support-systems, 3) being a part of the project group for digital exams, or 4) disability facilitators. Thus, in terms of the individual recipients asked to respond to the survey, these were found through non-probabilistic targeted sampling.

Distribution: An online survey was used, distributed via e-mail. E-mails included an introductory letter that informed respondents, and establish credibility. We used a multi-step contact approach, reminding and encouraging non-respondents to increase response rate. Duplicates were blocked, to ensure each respondent only responded once. The survey was piloted prior to distribution, as the Research Design chapter explains.

Design: The survey asked 21 questions and covered four topics: 1) background information, 2) current assessment practices, 3) current UD practices, and 4) UD legislative knowledge. As we wanted summarizing and comparative frequencies from the responding institutions, our survey mainly utilized closed questions collecting quantified data. All reply categories were mutually exclusive. Unlike in Study 1, where we were willing to push the respondents to take a stand, in

Study 5 we sought information about organizational practice. As such, we did not want to lead respondents into giving answers they did not feel knowledgeable about. Thus, "I don't now" or "other" categories was used to make sure all relevant answers were covered. We noted that the use of "I don't know" is debated (TNSGallup, 2012).

Institution Interviews

The institution interviews focused on UD quality assurance (QA) and organizational awareness aspects, related to digital assessment solution procurement and implementation.

Sampling: The survey selection criteria helped ensure we got in contact with persons related to a) the acquisition or use of student support-systems and b) current facilitation for students with disabilities at the HE institutions. As part of the survey, we mapped whether the institutions had entered into a pilot-agreement or contract with a digital assessment provider or via Uninett, thus were in an active process of developing, piloting or implementing an assessment solution. Further, respondents were asked if they were willing to do a follow-up in-depth interview. 8 persons related to the process of developing and implementing the ICT-solutions, from 7 HE institutions that had started an active procurement process, were willing to be interviewed.

Design: The semi-structured interview guide covered seven topics. These were: 1) participant's personal stances on UD, 2) institutional UD focus and responsibilities, 3) participant's UD knowledge, 4) main aim behind procuring digital assessment solutions, 5) choices made and current status of solution acquirement, 6) wrap-up on UD obstructive and promoting aspects, and 7) summarizing interview key points and correcting any misinterpretations. The guide also included an open question on any other aspect the participant felt was relevant to talk about.

Each topic had between one and four questions. The guide held mainly open questions, though one question used a Likert-scale – asking participants to rate the emphasis on UD compared to other aspects when procuring ICT-solutions. Most questions had pre-defined prompts to guide follow-up questions. We focused not only on understanding current practices, but also on developing insights into potential areas of improvement.

Provider Interviews

From the survey and institution interviews, we identified two different cloud-based digital assessment solutions were being procured: Inspera Assessment (Inspera) and WISEflow. In addition, some institutions used Learning Management Systems for digitalized exam delivery, and a few had developed their own in-house digital assessment solutions.

Sampling: The two identified solution providers were contacted for interviews. Both made a relevant employee available. This made up our provider sample.

Design: Again, we used semi-structured interviews, with a thematic guide holding mainly open questions. We included six topics: 1) participant's personal stances on UD, 2) participant's UD knowledge, 3) company UD focus and responsibilities, 4) current work on UD in solution development and QA, 6) specific status on UD in current digital assessment solution (including a Likert scale item on UD quality), and 7) wrap-up on UD obstructive and promoting aspects. The guide included an open question on any other aspect the participant wanted to talk about. We also included a similar Likert-scale item as for institutions: asking provider participants to rate the emphasis on UD compared to other aspects when developing digital assessment solutions.

Data Analysis

For quantitative and quantified survey data, **descriptive statistics** were used to capture response frequencies on the different questions. The interview data was however qualitative, and was transcribed and analyzed through thematic **content analysis**. The aim of the data analysis was to generate insights and descriptions of the case study, highlighting current practices and challenges.

Document analysis is a systematic procedure for reviewing or evaluating documents (Bowen, 2009). The documents can be either printed or electronic material. In our thematic content analysis, the individual interview responses were combined, through careful reading, in order to arrive at a holistic summary – in accordance with recommendations from (Jonathan Lazar et al., 2010). We considered our analytical approach inductive (Patton, 1990 in Braun & Clarke, 2006), as we read, coded, categorized and combined the replies in a step-wise process. Further, we applied a semantic approach, as we largely looked at the explicitly stated content to identify themes, instead of interpreting the replies.

Numerous scholars note it is difficult to **generalize findings** derived from case studies. While a large N enables statistical generalizability, qualitative methodology provides a set of categorical assumptions. These assumptions should be arrived at through sound analytical logic. Yin (2012) used the term "analytical generalization" to clarify the contrast of qualitative inferences from "statistical generalization." The positivistic view on generalizability is highly fitting for hypothetic-deductive approaches, where testing of hypotheses with a small N is problematic. Study 5 had a low number of participants relative to all levels of administration and collaboration, thus the logical and analytical inferences of the study can hardly be said to be generalizable (S. S. Andersen, 1997; Jonathan Lazar et al., 2010; Leedy & Ormrod, 2014, p. 160; Yin, 2012).

However, in an inductive-deductive approach, the view that equates the generalizability of data with its volume is not the only possible stance to take. The aim is no longer to confirm or reject a knowledge claim, but to ask questions that produce **non-statistical answers**, such as understandings of why and how elements are interrelated. Through our qualitative analysis, we were able to arrive at descriptions that we believed accurately reflected the status of the work on the topic of digital assessment solution in interviewed Norwegian HE institutions, and the interaction with their providers, at the time.

Study 5: Results

Case study findings are largely presented in Paper 10: *Universell utforming og digital eksamen i UH-sektoren: 5 anbefalte tiltakspunkter*. As this paper is in Norwegian, key points from this paper were repeated in the following sections. Note that UD self-assessments and other interview data from solutions providers are presented in English in Paper 11: *Digital assessment in higher education: Promoting universal usability through requirements specification and universal design quality (UD-Q) reviews.*

Survey

The response rate on the survey was 50 %, with 19 respondents from 14 HE institutions (including Uninett) responding. The survey showed the following:

1. The digital assessment solutions varied: Different HE institutions used different solutions. Most used external solutions, with 7 using WISEflow and 5 using Inspera. Some have signed agreements through Uninett and others have signed agreements directly.

2. Individual facilitation over universal solutions: Current UD practices are homogenous; the institutions rely on individual student facilitation. The most common adaptations are extended examination time, separate rooms with specialized equipment and use of computers and software facilitating students with dyslexia and other reading and writing challenges.

3. Fair UD knowledge: 84 % of the respondents reported their institutions have medium to very high UD knowledge. Two replied they did not know, and only one a very low UD competence. 52 % stated they knew of the then legislated UD regulations (KMD, 2013), as well as how it affected their work. Further, 13 respondents reported their 11 institutions (79 %) include UD in requirement specifications, though only 5 based these on legislated regulations.

4. Unclear responsibility: Almost 40 % of the respondents did not know who was responsible for UD in ICT procurement. 47 % reported everyone procuring solutions had equal UD responsibilities. Only 3 respondents described someone actively ensuring UD.

5. Weak quality assurance (QA): Finally, the survey revealed user-centered QA were lacking. 63 % had never used checklists or standards for usability or accessibility quality assurance in ICT acquirement processes. 58 % had no experience with approaches to usability or accessibility test ICT-solutions, and only one institution had used external experts to QA the solutions. Those with experience on user-centered QA had focused on WCAG 2.0 and technical inspections.

Institution Interviews

Table 16 presents the 8 institute participants. Of these, four were project managers, while the rest were other administrative employees. Most had used a digital assessment solution for about a year, and most used WISEflow.

Table 16: Overview of institution interview participants

Participant	Institution	Position	Assessment Solution	Usage
1	University 1	Project manager	Inspera	1 year
2 & 3	University College 1	Project manager & Advisor	Inspera &WISEflow	1 year
4	University 2	Advisor	WISEflow	1,5 year
5	University College 2	Consultant	WISEflow	0,5 year
6	University College 3	Head of Section	WISEflow	1 year
7	University 3	Project manager	WISEflow	3 year
8	Uninett	Project manager	N/A	

The interviews explored tasks and processes, UD views and perceived challenges in more depth. Our overall perception was a need to increase the practical UD expertise of key personnel. Main themes were the following:

1. Combine competence: Institutional UD competence was spread throughout the organizations. Persons with UD competence were not necessarily involved in digitalization and procurement processes. Participants discussed how merging UD competencies in relation to managing student-targeted digital processes would be beneficial, including establishing UD QA.

2. Feature-focus: Participants were aware of how technology may enable inclusion, or be exclusive. Project managers described the relevance of UD to digital assessment procurement on a general level. However, features were the focus of needs analysis. We perceived a gap between general statements on the importance of ensuring UD, and the lack of concrete UD focus – e.g. in requirements specifications.

3. Lack of technical insights: More specifically, the interviews revealed the HE institutions were not aware of what type of accessibility requirements were possible to implement in digital assessment solutions. Due to lacking insights, the complexity of ensuring accessibility were perceived as high, and the stance of the institutions was that explicit UD requirements were not a reasonable demand to procurers.

4. External regulations welcomed: Participants agreed legislated regulations for the HE sector would be promoting for UD. They also commend students with disabilities for contributing to increased awareness, and encourage increased demands and input from students.

5. Individual facilitation over universal solutions: Current facilitation for students with disabilities was done on an individual level, which is a time-consuming and costly process for students and institutions. New digital assessment procedures being developed were described as disadvantageous and difficult to use for students with disabilities. Improved ease-of-use, learning outcome, efficiency and QA aims were formulated for non-disabled students use only.

Provider Interviews

From the two solution provider participants, the following main themes were identified:

1. HE institutions did not ask for UD: Both providers perceived UD as an overarching desirable feature from the HE institutions, but as de-prioritized relative to feature requirements. They reported to deliver feature-rich solutions, as this was what the institutions asked for. Though the HE institutions expected providers to ensure UD aspects in all features whenever possible, the providers did not take on this responsibility. They correctly pointed to the legislated responsibility of the service-providing **institutions** to specifically ask for UD, including UD QA.

2. Ability to deliver UD: Both service providers were aware of the aspects of their solutions that did not support UD – including technical accessibility requirements not yet reached. Both providers expressed abilities to meet regulated technical accessibility requirements and usable accessibility aspects. They explicitly welcomed increased focus on UD as well as general usability.

Study 5: Discussion

We asked: "How is UD quality being ensured in procurement processes?" The answer was, unfortunately, that in the selected case of digital assessment solution procurement to the HE sector, UD was not prioritized or ensured in new solutions. QA activities, both of UD and on general usability, were overall lacking – both from solutions providers and HE institutions.

J. Lazar, Goldstein, and Taylor (2015) stated a shortcoming in accessibility regulations is they leave out organizational aspects – like enforcing the implementation of compliance monitoring and process guidelines. Our Study 5 study largely corroborated this insight, as it documented how the quality control of contextual, usable accessibility was lacking due to lacking competence, focus, prioritization and quality control on organizational level (reported on in papers 10 and 11).

Study 5 found that lacking HE sector competence resulted in no explicit UD requirements being set, based on false assumptions and incorrect perceptions that the providers would then not be able to deliver, and that providers was responsible for ensuring UD. Providers' feedback emphasized they were not only willing, but also ready to increase UD and usability aspects, and would welcome a re-prioritization in this respect. The lack of institutional UD competence led to an unfortunate focus on delivering feature-rich assessment procedures mainly catering to non-disabled students. Potentials for cost-efficiency through Universally Designed standard solutions remained unexplored, maintaining non-inclusiveness in standard solutions, and continuing the need for costly individual facilitation.

Limitations of Study 5

In relation to the overall research question of Study 5, the case study explored was not generalizable. Rather, it informed us on specific issues that we could move to resolve in order to contribute to the overall thesis aim of facilitating and advancing UD of ICT.

Further, the digitalization processes in the HE sector is rapidly changing, as is the legislation on UD in the sector. This creates a need for continuously re-examining and updating the best practice recommendations made, as well as the effect of legislations on current practices.

Specifically, we would recommend case studies or natural experiments investigating our assumption that increased inclusiveness in standard solutions could be cost-reducing both in terms of decreasing the need for costly individual facilitations and increasing the study efficiency (throughput) of students with disabilities.

Towards Study 6

Part 2 addressed the need for a better understanding of how real-life settings influence universal design methodology and practice. Study 4 was regarded as the most successful in providing a solid qualitative foundation on promoting and obstructive factors influencing best-practice UD quality outcome.

Through Study 4, we also strengthened a matured view on “UD of ICT”, as viewed from practitioner’s perspective. Our new stance was that in order to reach (and educate) industry practitioners, we should apply a definition of “UD of ICT” that makes sense for the practice-field. In order to investigate this “practitioner’s perspective” view on UD of ICT, we included a question in Study 4; asking industry practitioners if they viewed “UD of ICT” as an independent field of competence, or as an add-on expertise in their specialized fields. All but two of the 34 participants viewed UD as a specialized "add-on" competence within their expertise.

The two who viewed "UD of ICT" as an independent field where interaction designers consulting on UD and specifically focused on UD R&D (participants 25 and 26 in Table 14, from Consultant Agency 10, consulting project manager participant 31 on Project 13). Their sole focus on UD aspects may explain their view of "UD of ICT" as one, independent field of expertise.

Researchers and experts particularly focused on UD within ICT-related fields might thus share this view of "UD of ICT" as an independent field. However, the large majority of industry practitioners seem to view UD as discipline-specific expertise.

Based on this altered view on UD of ICT, Study 6 explores what UD entails in service design.

Study 6: “UD in Service Design”

Study 6 was the forth breakout study in Part 2. Here, we researched the UD focus in the relatively new discipline of service design (SD). The reason for the study grew out of a change in how we viewed “UD of ICT” as a research field, and thus what teaching UD should entail in combination with the development of a new course in SD to be taught in the Spring of 2019.

Re-framing UD of ICT

Both Study 1 and Study 2 indicated “UD of ICT” was a fragmented field, with regards to stances and with regards to expertise. Although a high degree of “case-specificity” was identified, as early as in the background literature, this did not automatically spur a reflection on whether “UD of ICT” was composed of different subfields, or should be viewed (as we did initially) as one academic field.

At the start of Part 2, we hypothesized a more practical understanding of “UD of ICT” would be beneficial. As we moved forward in our Part 2 research efforts, we slowly started to view UD as a specialized competence within respective disciplines – rather than a discipline on its own.

This **practitioner’s view** on UD helped explain why the term was hard to define for surveyed experts in Study 2 (Part 1). The re-framing of what “UD of ICT” entails also fit our empirical findings – for example on the importance of not separating UD from UX/UCD work.

Applying this view, we hypothesized UD in the field of visual design is something different that UD in IxD and so forth (though some core expertise may be shared). We thus adopted the view that UD should be re-framed as **discipline-specific expertise** during Part 2, sometime after Study 4. This view triggered a need to embed UD competencies in **all** ICT-related disciplines.

“UD of ICT” is now viewed as trans-disciplinary, with a need for UD perspectives from all disciplines involved in the ICT-creation.

As we were in the process of planning a new SD course to IxD- students, the issue of what UD entails within SD became important. In order to reach the ideal of creating a (digital) society for all, we needed to ensure future service designers were taught how to make Universally Designed services. Study 6 therefore asked: “What is the current UD expertise within the SD discipline?”

Study 6: Background

SD may be defined as the merge of digital, intangible and physical touchpoints to form a holistic experience from the customers point-of-view. The service designer typically suggests improvements in order to enhance the service value for the end-user, or to save costs without decreasing the service experience for the end-user. This skill is becoming increasingly important in Nordic countries, as and we increasingly utilize digitalize services both in public and private sectors (Bue & Begnum, 2018).

SD as a Mindset, Not a Discipline?

It is currently common to see job advertisements asking for IxD, UX, UI and SD skills (for the same position). There is no established definition of service design yet (Stickdorn & Schneider, 2011, p. 34). Recognizing this, some do not view SD as a separate design discipline. These so called "lumpers" consider SD an interdisciplinary UX approach taking on a certain mindset.

As a mindset, SD is described as pragmatic, co-creative and hands-on, attempting to balance technological opportunity, business relevance and human needs (Stickdorn, Lawrence, Hormess, & Schneider, 2018, p. 20/21), and combining methods and tools from various disciplines to reach this goal (Stickdorn, Lawrence, et al., 2018, p. 20/21).

Literature expressed the SD mindset in the following key "attitudes" and "principles": 1) Human-centered: consider peoples experiences, 2) Collaborative: engage stakeholders, 3) Iterative: explore and experiment, 4) Sequential: visualize interrelated actions, 5) Real: research, design for and test in time and context, and 6) Holistic: consider the entire service ecology (Polaine, Løvlie, & Reason, 2013; Stickdorn, Lawrence, et al., 2018, p. 28).

SD is highly user-centered, thus employing a design methodology fitting within a constructivist paradigm (as reflected on in Part 1). However, SD also applies critical thinking approaches and appears overall more interventionist than the traditional UCD approaches.

SD as a Discipline based on its Specific Set of Techniques?

Contrasting the "lumpers" are the "splitters", who focus on the differences between SD and related UX approaches (Stickdorn, Lawrence, et al., 2018, p. 20/21). Some such "splitters" view SD as a separate design discipline based on the SD-specific toolkit of specialized techniques.

A lot of the methods used in SD are drawn from ethnography, such as field interviews and shadowing technique participant observation, and from design thinking, such as canvas mapping, research walls, and sensemaking. Workshops, user participation and empathic design techniques are also common and user-centered approaches are well established.

However, SD also has a set of specific techniques for service mapping and specification – such as (customer) journey charts, UX journey mapping, service safaris, service blueprints, touchpoints matrixes, and service ecology mapping. These SD-techniques aids the service designer in creating consistent service experiences and experiences that are more positive, or invent new services.

SD as a Discipline based on its Use of Boundary Objects?

SD-specific techniques typically construct "boundary objects" – visualizations that facilitate cross-silo communication through co-created and visualized common insights (Stickdorn, Lawrence, et al., 2018). Through the boundary objects, service designers document service chains as they are experienced by **end-users**, across "silos" such as departments or organizations, service steps and touchpoints. By bringing research data and sensemaking to the table, service designers utilize these boundary objects to establish a common use of terms across silos.

SD as a Discipline based on the Process Applied?

Other "splitters" do not see the techniques used as the main diverging point between SD and other UX-disciplines. SD is drawing on a common pool of user-centered methods and design research techniques, and is methodologically highly overlapping with other UX disciplines even if of having SD specific techniques. Instead, some emphasize the SD process as a key difference.

SD typically utilizes a "double-diamond" process, in line with design thinking approaches – and not the ISO model for human-centered design (ISO, 2010). Further, SD values collaboration and co-creation to a much higher degree than "traditional" UCD, and emphasizes visualizations of ideas and insights – including in boundary objects.

A SD process usually starts with questioning what is to be created, thus entering into a diverging and exploratory phase. The insight research phase typically involves user interviews, contextual research, and field observations. Here, a SD-specific field technique is "service safaris", where service journeys are experienced first-hand by designers.

From the explorations, one moves on to data analysis, synthesis and problem definition. In-depth data from the exploratory phase is typically visualized or collated. Here, common design techniques such as affinity mapping, personas, and storyboards are used. These are usually extended by SD specific techniques, in addition to co-creative workshops utilizing these SD techniques.

The second diamond starts with exploring iterative ideation and visualizations, which moves the process over to prototyping and testing one (or a few) service idea(s). Service proposition development, concept sketches, storyboards, service blueprinting and experience prototyping is common methods. For testing, theatrical techniques (including Wizard-of-Oz), and new forms of visualizations and tangible representations are utilized alongside more traditional user evaluations.

A common criticism of SD is that the process sometimes ends here, after the first diamond process, with the delivery of empirical insights and problem identification. The delivery is thus mainly untested, visualized ideas and improvements based on the problem definition. If a double-diamond SD project is fully completed as intended, there is a final converging into service ideas ready for implementation (or further piloting or development).

Study 6: Research Approach

A qualitative and exploratory study was launched to investigate the degree of UD awareness in current SD methodology and practice. The original intention was for a literature study to form the base for formulating interview questions, and that the main part of the data collection would be exploring individual lived experiences through in-depth interviews. However, the research process faced several challenges, as we found the topic of UD in SD to be under-researched. Part 2 Study 6 thus reports from a limited interview study, followed by a literature study.

The study mixed a "basic research" approach (aiming at extending knowledge) and an "applied research" approach (aiming to improve practice within a specific discipline) (Merriam, 2009, p. 3). The following sections briefly outlines the research methods applied. More details on the research process and methodology can be found in Paper 12: *Towards Inclusive Service Design in the Digital Society: Current Practices and Future Recommendations*.

Exploratory Semi-structured In-depth Interviews

We used exploratory interviews, which can be used to research complex and multifaceted situation (Jonathan Lazar et al., 2010, p. 181). Our interview guide consisted of 17 questions, asking participants to: 1) report on current UD awareness and practice, and 2) reflect on how to strengthen UD awareness and practice (see Table 17). The pilot indicated a 60-minute in-depth interview time frame. Convenience sampling was used to reach Norwegian service designers.

Audio-recorded interviews were continuously transcribed, anonymized and transferred to NVivo for emergent coding, applying an inductive content analysis approach to the data (Jonathan Lazar et al., 2010). After only 3 of the planned 15 in-depth interviews, we saw the categories and their content (codes) was already consistent. The next 2 interviews provided limited added understanding, but aligned well with the data so far. After 5 interviews, the interview study was ended, as we did not expect to get further key insights.

Table 17: Interview guide overview

	Interview focus	**Question**	**Data**
1. Current Practice	Self-rated service- and universal design competence.	3,4	Quantitative
	How is universal design included in current practice?	5,6	Qualitative
	Methods and processes utilized in current practice.	10,11,12	Both
	Which users are involved (if any) and how.	13,14,15	Both
2. Envisioned Practice	Ideal manner to do universal design in service design	7	Qualitative
	What promotes universal design in service design	8	Qualitative
	What obstructs universal design in service design	9	Qualitative
Background	*Education, age, workplace, title, experience*	*1,2,16,17*	*Both*

Literature Study

In our first attempt at conducting a literature study on UD in SD, we searched for research articles on the topic in a structured manner. We more or less identified only one relevant article through this initial search: Santana et al. (2018). This article attempted to merge the 7 design principles for UD into a formalized "service development" process. "In the absence of literature" Santana et al. proposes the "Universal Design Service" model - which is utilizing a "checklist-approach". Santana et al. (2018) does not mention the double-diamond and design thinking approach currently at the core of SD, and it is unclear wether they view this as a contribution to the SD discipline, or to a more structured service development approach without initial problem identification in a "first-diamond" phase. Our key take-away from the initial search was thus that the field was under-researched.

Drawing on the interview study, we were however able to re-iterate the literature search, framing the aim of the literature study as: a) identifying established SD practices with regards to methods and process approach, and b) identifying inclusive/UD aspects in established SD practice – including types of users receiving focus. We used a combination of citations and publication year to identify recent and high-impact literature, and identified 175 articles with 45 citations or more published since 2000 (and until the 4 database search dates at the very end of 2017, see Table 1 in Paper 12). The screening inclusion criteria were a) articles within/about SD, and b) reporting on SD practice (not purely theoretical). The literature analysis approach was structured, mapping the topics: 1) methods used, 2) process approach, 3) user group focus, and 4) inclusive/UD aspects.

Study 6: Results

Overall, our findings showed that UD awareness is lacking in the field of SD. There was no clear definition of what universal or inclusive services should entail. There were no established inclusive practices in service design and development. There was almost no research in the area.

Interview Study Results

Our 5 participants describes SD processes focused on the generalized main user – and none focus on UD in their work though all have worked on public service projects. The SD processes are highly qualitative, and methods utilized vary from project to project. The service designers seek to understand the user, and develop positive service experiences matching user needs. They do not typically include marginalized users, though two participants always consider visually impaired and non-native speakers. They express UD is not a priority, is sometimes viewed negatively and is not checked for the overall customer service journey. The only current UD focus is adhering to the digital touchpoint UD legislation (KMD, 2017). The self-rated UD competence averaged at 3.1 on a Likert scale from 1 (insufficient) to 7 (outstanding). In comparison, self-rated SD competence averaged at 5.3. The participants express uncertainty as to what UD entails in SD.

Reflecting on how to strengthen UD awareness and practice, four of the participants welcome more knowledge, competence, and guidance on UD in SD, and was generally enthusiastic about the study and the topic. New tools were mentioned, showcasing how to integrate inclusive aspects into current practice. The four SD consultants expressed the customer should be aware of and provide resources for UD. All expressed the need for a clearer definition of "UD in SD".

Literature Review Results

Post-screening, 13 articles made up our sample. The literature focused on understanding users, and on user-centered processes. 61 % emphasize co-creative processes. None included marginalized (non-generalized target) users, and none mentioned UD or inclusive design. However, 23 % (three articles) stated it is important to consider special needs/include all users.

More details on our findings are presented in Paper 12.

Study 6: Discussion

Our exploratory study provided insights into a design field where designers enjoy a large degree of methodological and conceptual freedom. Based on our limited insights, the norm is to utilize holistic, cross-silo co-creation in order to provide value to customers as well as businesses. However, we discovered UD aspects are not included in current SD practices, not yet attempted defined, legislated or assigned responsibilities for, not taught, reflected on, prioritized, researched, or facilitated by current tools and methods.

Challenges were identified related to UD of SD awareness, knowledge, education, definition, methodology, legislation, and responsibility. These are presented in Paper 12, and summarized as:

Challenge 1: Awareness

Our exploratory study showed that UD awareness is lacking in the field of SD. Through inclusive aspects were not completely absent, and several service designers were enthusiastic of the topic, UD is not at all integrated into current professional practice.

Challenge 2: Knowledge

Our participants did not have any clear opinions about what UD in SD should entail in practice. It seems the current UD expertise in the SD discipline is very low.

Challenge 3: Education

None of our participants had learned about UD related to their SD studies.

Challenge 4: Defining UD for SD

All participants asked for a clear definition of UD in service design. We could not identify any such definition from literature.

Challenge 5: Methodology

In current methodological SD practice, marginalized user groups and edge-case scenarios do not receive focus. There is further a lack of systematic checkpoint accessibility assessments related to different special needs, as well as a lack of holistic journey accessibility evaluations.

Challenge 6: Legislation

Current Government white papers and legislation emphasizes the importance of promoting UD on a societal level, however the regulations only cover the digital touchpoints of a service journey (KMD, 2017).

Challenge 7: Responsibility

In the current professional practice, no one holds the responsibility for whether a finalized service is inclusive overall. The only established UD responsibility is in relation to digital touchpoints; where the service provider is the legally responsible for ensuring accessibility, and usually delegates this through requirements specifications to UI designers and developers.

Limitations of Study 6

The nature of qualitative research makes reliability problematic because the results are directly linked to the complexion of the phenomena and the researchers review of the observations. To ensure transparency and dependability (Shenton, 2004), we have endeavored to describe our study in detail. The main validity threat to our findings is our low N – with only 5 participants in the interviews, and only 4 searched databases. Thus, our ability to draw conclusions was tentative. What we could conclude, was:

1) Using our current interview guide and participant inclusion criteria, we could not identify any established practices for ensuring UD in current Norwegian industry practice. One would generally expect a higher number of participants to strengthen external validity of an interview study. Thus, our assumption on the 6 key challenges is only tentative insights.
2) We found very limited UD focus in the reviewed SD literature. When generally searching for SD articles that consider UD or inclusive aspects, a lot of irrelevant articles were returned. The included 13 highly cited SD articles from the final search supported our interview study impression that UD is not established in SD practice. From this, we made the assumption UD is an under-researched topic in SD, and seemed not to be defined in relation to SD.

Towards Study 7

Study 7 continues the work on making sure disciplines involved in the creation of ICT consider UD. The next chapter reports on work related to investigating UD in the field of interaction design – more specifically what should be considered UD expertise for interaction designers.

Study 7: “UD in IxD Education”

As Study 6 outlined, Study 2 and Study 4 findings triggered a view of UD as a specialization within disciplinary practices involved in ICT-creation. Our matured thesis assumption and updated interpretation of UD of ICT is now; “UD of ICT can be defined as UD within each disciplined involved in the creation of ICT”.

Taking this perspective, all disciplines involved in the creation of ICT-solutions needs to embed UD as an added expertise. A lot of different UD competence is necessary in ICT creation. As we educate interaction designers – both on bachelor and master level – it became important to investigate the recommended UD competence for the discipline of interaction design (IxD).

So far, there has been limited research into the skillsets provided to IxD-professionals through higher education (HE) as well as on studying UD competencies needed for interaction designers. The readiness of academic training to address UD as part of IxD education is thus uncertain.

Study 7 looked into the current focus on UD in Norwegian HE educations on IxD, and asked: “What is the current UD expertise within the IxD discipline?”

Study 7: Background

Professionals in the field of IxD and related design disciplines seem invested in ensuring digitalized solutions meet the criteria for UD (Jonathan Lazar et al., 2010, p. 118). Legislations have triggered increased UD awareness and focus both in the general public and in ICT fields, such as front-end development, visual design, IxD and UX. Raised awareness has inspired beyond legislated criteria; focusing on achieving awards, securing company reputations and ensuring good UX for all users, on all devices, in different contexts of use.

What is IxD?

A challenge to the discipline, is that there is no commonly agreed upon definition of IxD or shared understanding of the type of competences required by interaction designers . The title of “interaction designer” is not protected (Fallman, 2008). Currently, interaction designers have diverse and often interdisciplinary backgrounds (Sørum & Pettersen, 2016).

Buchanan (2001, p. 112) offers a highly cited definition of the field of IxD, explaining that IxD is the design of “action” – focused on how human beings relate to other human beings through the mediating influence of products. IxD plays an important role in facilitating high quality and accessible user experiences. Interaction designers typically construct opportunities at the interface level for the tasks and processes that users encounter in software and information systems(Rosenfeld & Morville, 2002). Thus, interaction designers contribute to shaping how the end-user understands where to find information and how different information components interrelate. Attention to design, UX, user-centeredness, accessibility, and inclusivity do seem to be on the rise with the increase in digitalized services delivered to the public through web and mobile interfaces.

Recruitment Challenges

Rosenfeld and Morville (2002) reveal how the random use of the IxD title creates recruitment challenges in the Norwegian industry. It may also lead to recruitment difficulties to IxD study programs, even through the Norwegian software industry is currently reporting a serious shortage in the availability of interaction designers (F. Matheson, 2017; F. Matheson, 2017; Monteiro, 2015; NUCAS, 2017).

There are indications that problems of recruitment are due to a lack of knowledge of the IxD discipline. Research indicates that many companies struggle to identify and utilize the full skillsets of designers, and integrate designers at hand into development practice (Miriam E. N. Begnum & Furuheim, 2016; Constantine, 2001a; Kuusinen, 2015; Salah, Paige, & Cairns, 2014; Sørum, 2017). A study by (Sørum & Pettersen, 2016) found that the students in programs covering IxD struggle to define the role and tasks they will be expected to perform within the industry.

IxD Methods

Within IxD, methods borrowed from social sciences such as ethnographical approaches and in-depth qualitative investigations are often employed to build the necessary understanding of contexts of use and user needs (Liu, Lee, Kascak, & Sanford, 2015; Mustaquim, 2015). For evaluating systems, more analytical and quantitative strategies are common – including comparison testing, assessment testing, verification testing or expert inspections such as heuristic evaluations, hierarchical task analysis, web-accessibility inspections and cognitive walkthroughs. Thus, approaches from both mechanical and romantic paradigms are used in the field.

Study 7: Research Approach

Study 7 Part 2 analyzes the educational content of HE programs to map the skillsets the study programs state to deliver, and investigate to what degree (if any) UD expertise is included. Since our aim involved gaining a better understanding of the kind of IxD programs offered, in order to provide a clearer understanding of what kind of UD competences the students are taught, a qualitative multiple case study design (see 3.4) was considered the most appropriate approach for our study. We used document analysis as our main methodological tool, and studied online texts about IxD study programs. Figure 20 overviews our research process.

Document Analysis

As described in relation to Study 5, document analysis mostly serves to complement other research methods. However, it can also be used as a stand-alone method (Bowen, 2009). For example, in Wild, McMahon, Darlington, Liu, and Culley (2010) a diary-study investigated engineers' information needs and document usage. They used the data to generate new "document use" scenarios and a "proof of concept" test for a software system.

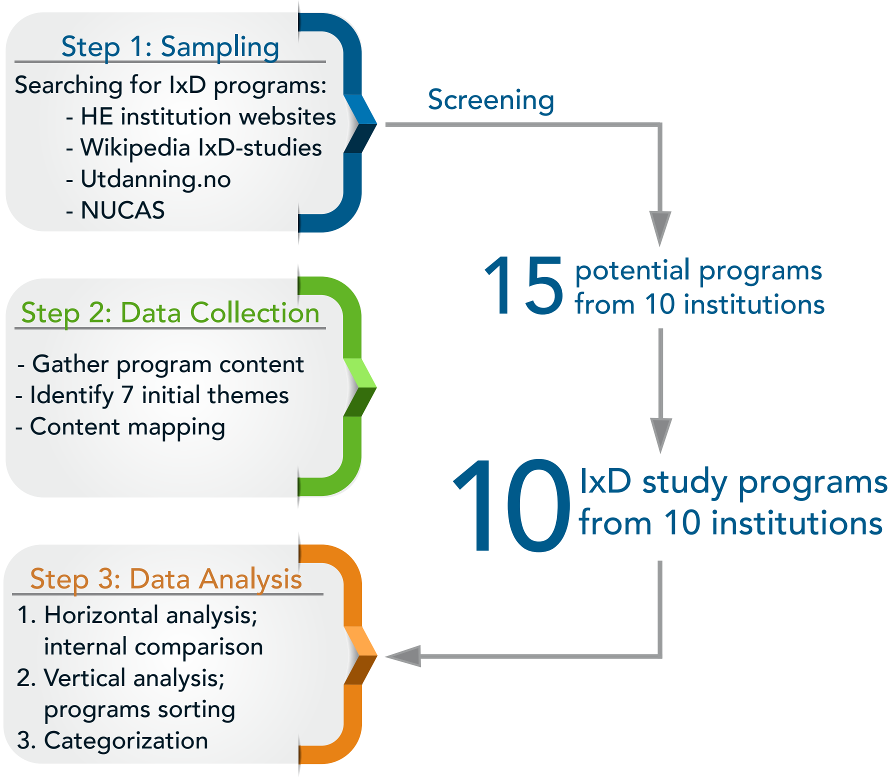


Figure 20: Methodological approach for Study 7 Part 2

Sample

In a qualitative study, the sample is typically small, which makes it possible to first study each program in depth, and then to study them comparatively. The first step in our study was to get an overview of all the study programs in IxD offered at universities or university colleges in Norway. As the Norwegian higher education (HE) sector strives to meet the industry demand for more interaction designers, the number of relevant study programs has increased. There are however no commonly agreed upon denominations or study program classifications for the IxD studies (NUCAS, 2017).

Searching

The search for Norwegian IxD programs was initiated by entering the websites of all HE institutions in Norway. The HE institutions were searched for available studies within all relevant departments, such as the departments of media studies, design, and computer science, and all available programs were screened to identify programs with a strong component of IxD. The program's name, a general description and the presentation were used for the screening.

Further, the in-site search feature, with the search string "interaction design," was used for each institution. We also searched for "design," to make sure we did not overlook any programs. Next, we checked the IxD education available in Norway as listed in Wikipedia[8]. Finally, we also searched for IxD programs at utdanning.no, which is the official Norwegian national education and career portal, and includes an overview of education in Norway and about 600 career descriptions[9]. All programs identified through this approach between March 1st and April 18th, 2017, were included – also those that would run for the first time from the autumn of 2017.

Screening

Our second step was to screen the programs against our understanding of IxD as focused on how to design users' experiences when interacting with various products, over time and in their context of use. Any study programs identified as having an IxD focus were included in our sample, regardless of whether the content was focused on digital interfaces, physical products, interactive technologies, media channels or on services, regardless of focus on experiences or products, and regardless of focus on their design or their development. For example, if a program listed key elements such as "design, "user", "usability", "interface", "web development", "prototype", "testing" or other constructs that are characteristic for IxD (as described in the theoretical section of this paper), the study program was included in the sample. Study programs that were obviously related to other disciplines were excluded. Studies perceived as related only to the single-discipline of informatics were excluded, e.g. programs involving coding, programming, web and IT development but lacking any design perspective. Likewise, we ignored study programs that were clearly related to specific single-disciplines within design (e.g., interior design) and programs that were specializations within IxD (e.g., service design).

Finalizing the sample

For HE institutions offering several studies within IxD, the decision was made to select the study track with the strongest IxD component. Further, one-year study programs that could be extended into a BA or MA degree were viewed as parts of the other programs. Combined BA+MA tracks, with recruitment to an MA with an identical name and shared research groups, are also analyzed as a single study program. The final sample (shown in Table 18) consisted of 10 programs offered by 10 HE institutions in Norway. Five of the HE institutions are located in the capital of Norway, Oslo. Of the remaining five, one is in Halden, one in Grimstad, one in Gjøvik, one in Bergen, and one in Volda.

Data Collection

After the case sampling, study programs were overviewed by a close reading of their profiles, course descriptions, study aims, and other program details. For three programs, content or course descriptions were not fully stated online. The institutions offering these study tracks were contacted by email and the requested descriptions were sent to us via email (HE Institutions 2, 9

8 Please refer to https://no.wikipedia.org/wiki/Interaksjonsdesign

9 Please refer to https://utdanning.no/tema/om_utdanning.no/about_utdanning.no

and 10). Not all had yet finalized all course descriptions. Even so, the content available online together with the received descriptions were considered sufficient for the study in relation to the intent, main content and focus of the programs.

Against this background, we revealed interesting themes that we wanted to explore systematically and in depth in accordance with our research questions. The themes were organized into seven categories, which enabled us to implement consistent data collection with each of the programs: (1) whether part time or full time, (2) admission requirements, (3) web profile, (4) content themes in modules and syllabus, (5) teaching methods, (6) reflections (methodological/academic) and (7) UD focus and content. The 10 study programs were organized into categories as suggested by (Labuschagne, 2003). Consistency in data collection through structured categories was important not only because it controlled for validity and both internal and external reliability (Shadish, Cook, & DT., 2002), but it also made it possible to compare the study programs with one another at a later stage of the data analysis.

Data Analysis

The data analysis process took place in phases, as described in Paper 13. After initial screening, a full-day workshop with in-depth collaborative content analysis and discussions were executed on April 18, 2017. As part of the workshop, each program was first analyzed internally (horizontally) along the seven theme categories. Here, interesting patterns of coherence and discrepancy between the respective programs were investigated to consider the programs' internal heterogeneity and homogeneity.

We then analyzed each of the seven categories (vertically) across the programs. This was important so we could get an overview of how similar or different the IxD study programs were. From the vertical analysis, we were able to compare and sort the programs relative to each other. During the analysis, we continuously coded the findings into themes and key characteristics. Thus, our coding of the data emerged as we moved back and forth between the data and our conceptualization of it.

In the workshop, 11 programs were analyzed, of which 8 were included. Four more programs were sampled after NUCAS launched their yearly list of study programs in May 2017, of which two were included. These two programs were analyzed after the workshop across the seven mapping categories and against the patterns that emerged from the workshop.

Study 7: Results

The analysis revealed that the 10 programs (Table 18) could be sorted along (A) two overall orientations (Societal or User oriented), and B) which industry the programs were aimed at (Media or IT industries), and (C) a didactic emphasis axis on theoretical knowledge versus practical experience (Theory or Realism). Further, we rated the programs based on (D) overall content focus (Technology or Design, Values or Industry) and (E) UD focus (high or low).

Table 18: IxD program sample (GSC = general study competency, eqv. = equivalent)

Pseudonym	Study program characteristics	Institution	Admission Requirements
HE Institution 1	Informatics Degree: 3 year BA, full time.	University College, Private	GSC
HE Institution 2	Informatics Degree: 3+2 year BA, full time + MA full/part time.	University, Public	GSC (for BA), C+ average & BA with 80+ ECTS in Computer Science (for MA)
HE Institution 3	Informatics Degree: 2 year MA, full/part time.	University College, Public	BA in Engineering (or eqv. BA with 80+ ECTS in Computer Science)
HE Institution 4	Design Degree: 5 year MA, full time.	University College, Public	GSC + Passed admission test
HE Institution 5	Media Degree: 3 year BA, full time.	University College, Public	GSC
HE Institution 6	Media Degree: 3 year BA, full time.	University, Public	GSC
HE Institution 7	Media Degree: 3 year BA, full time.	University College, Public	GSC
HE Institution 8	Technology/Media Degree: 3 year BA, full time.	University, Public	GSC
HE Institution 9	Design Degree: 3+2 year BA, full time + MA, full/part time.	University, Public	GSC (for BA), BA with 80+ ECTS in Computer Science, design or media (for MA)
HE Institution 10	Design Degree: 2 year CG, Full time.	University College, Private	GSC or vocational skills

(A) Societal or User Orientation

Two overall orientations were detected explaining why students should be educated on the IxD programs. Societal needs were emphasized in some program descriptions, for example highlighting an industry need for the competence taught or for discipline-specific societal opportunities or challenges. These were classified as having a Societal orientation. Other programs emphasized human aspects more, e.g., highlighting the need to stay user centered and motivating students to make innovations to meet the needs of end-users. These were classified as having a User orientation. The orientations were also combined – thus the categories were not considered mutually exclusive. Figure 21 presents orientations identified in the IxD programs: 4 IxD programs focus on Societal needs, 4 on User needs and 2 on both Societal and User needs.

(B) Industry Aim

Figure 22 illustrates how four programs were mainly directed at the Media industry, four targeted the IT-industry, while two programs educated for both industries.

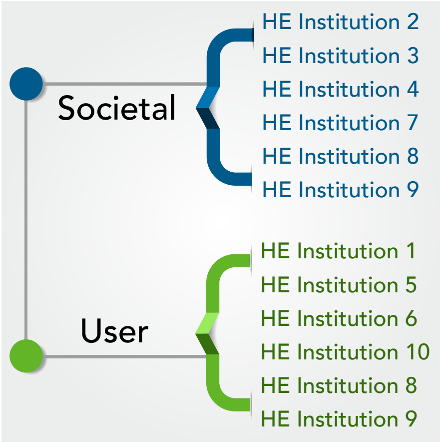


Figure 21: Overall orientations of IxD programs

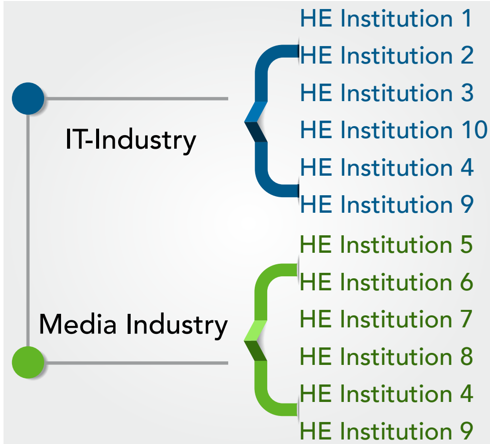


Figure 22: Industry aims of IxD programs

(C) Didactic Emphasis

The didactic approach axis looked at the way content is taught. "Theoretical" teaching refers to a focus on traditional academic training, with oral and written skills—for example, writing academic essays and discussing fictional cases. "Realism", on the other hand, points to teaching in realistic settings, such as through internships or utilizing real-life scenarios – and often involves the industry, which typically provides real cases, supervises work, or evaluates student results.

The programs were categorized into four didactic approaches, based on the analysis of (a) course teaching and evaluation methods, which would denote nurturing practical or abstract skills (e.g., oral exams, portfolio based exams, and so on) and (b) the amount of focus on methodological or academic reflection. The findings are summarized in Figure 23.

The two programs most Theory-oriented in their didactical approach were both MA. None of the four MA programs were classified in among most Realism-oriented. This indicated a shift toward theoretical aspects in the MA tracks compared to the undergraduate tracks, as was to be expected. However, this was not a clear trend as the programs take quite different didactic approaches, and so there is a large spread in the teaching styles on both graduate and undergraduate programs. Most programs mix Theory and Realism approaches.

There was a near-perfect overlap between the didactical approaches identified in the Universities compared to the University Colleges, with one of the four University-level institutions falling into each of the four didactical categories. This indicated there were no didactical differences between the institution types. Only HE institutions 1 and 10 were private institutions, which did not provide enough insights into potential private versus public differences in didactics.

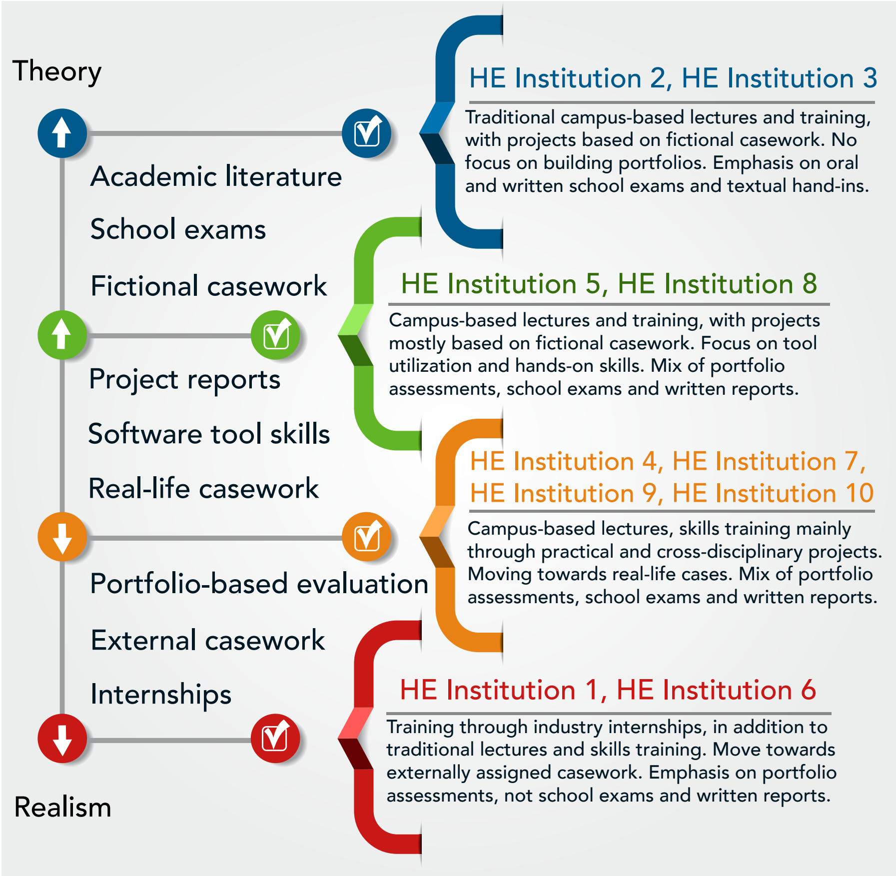


Figure 23: Didactic approach

(D) Overall Content Focus

The programs were further categorized along two axes based on academic content. The first axis spanned from an emphasis on Industry to an emphasis on Values. "Industry" refers to program content that emphasizes industry-relevant practical skills. "Values" refers to exercising ethical and value-based considerations, such as an emphasis on user-centered, socio-technical, or societal aspects. Some programs were clearly more Values or Industry focused, while others highlight both (and are placed in the middle of the horizontal axis).

The Industry versus Value axis is somewhat related to the Realism versus Theory axis, but while the former refers to the academic content of the study programs, the latter looks at the way in which the content is taught. For some the two overlap, for example utilizing a close collaboration with industry both to teach industry-relevant skills and teach those skills in a realistic manner. Other studies have an **Industry** focus in the industry-relevant and practical skills, but teach these in a traditional classroom setting (Theory). Likewise, programs may emphasize user-centered, and ethical socio-technical **Values** and teach these through solving external real-life cases (Realism).

The second axis spanned from emphasis on Design to Technology. Technology-focused programs provided strong technological and IT competencies to the IxD students. They typically emphasized ability to code and providing front-end or full-stack skills. More Design-focused programs to a larger degree emphasized creative skillsets and design process knowledge. Studies focusing on utilizing IxD for communication or mediating were classified as more Design than Technology focused. The vertical axis shows whether programs focus on Technology or Design abilities – or emphasize both (in the middle)

Figure 24 shows the placement of the study programs in relation to the key differences emerging between the programs based *only* on the impression from their online profile presentations. Online profiles were identified through an analysis of what was stated in the online study descriptions and any other official texts posted online by the HE institutions describing the overall programs.

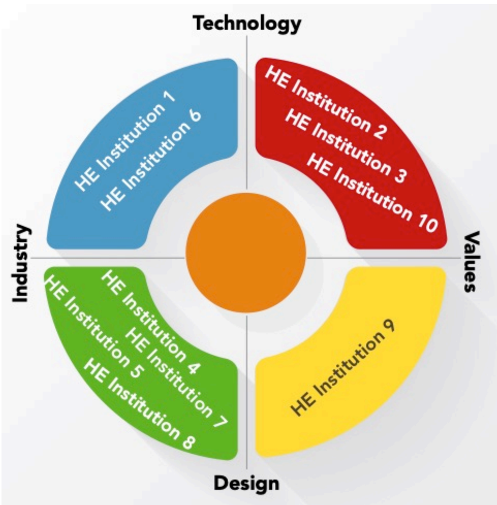


Figure 24: Program categorization from profile

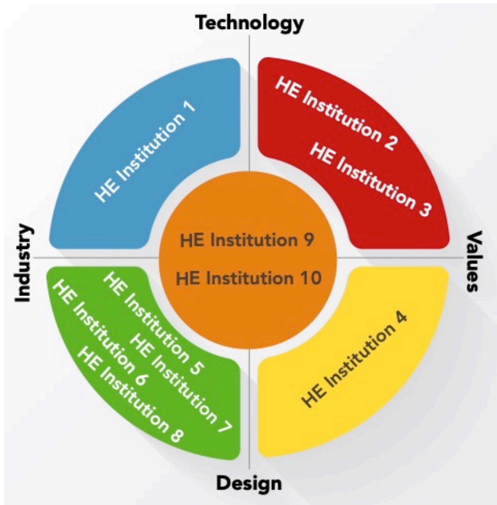


Figure 25: Program categorization from profile & content

Profiling vs. Content: It is important for both the potential students and the industry to know what kind of skillsets the interaction designers will have, and the description of the programs on the HE institution websites is the best place to find such information. We therefore also did a systematic thematic content analysis on the fit between online profile presentations against the content. Content was considering by looking through the course tables, course descriptions, and topics in the mandatory courses (including courses mandatory for IxD specialization tracks), information on approaches to teaching and assessment, and learning outcomes (what students are expected to achieve in knowledge, skills and general competences) for each course and for the study program as a whole.

When we analyzed the study programs comparatively for their internal homogeneity between online profile presentation (what they say) and the actual content (what they do), we found that for eight of the ten programs these corresponded well. However, four programs differed somewhat in their profile and actual content (HE institutions 4, 6, 9, 10). Potential students and the industry normally rely on a program's description as offered by the institution in the recruitment process, so this can be problematic. The programs were re-categorized to reflect deeper content insights. Final program categorizations are shown in Figure 26.

(E) UD Focus

Looking at the focus of UD within the program content, we found most programs had a weak or absent UD focus. Examples of "UD focus" are: knowledge of UD terminology, standards, and regulations, defining disability (e.g. doing gap analysis), understanding aging trends and demographics, the inclusion of marginalized users in the user research, design for elderly, disabled or marginalized users, inclusive approaches in design methodology, empathic modeling in UCD, mobility aspects and emotional aspects in UX design, design principles of UD, color blindness and visual impairment aspects in color, contrast and UI design, extreme users and edge-cases as innovative strategies, web accessibility topics in courses on web development, assistive technologies and interaction styles in HCI. The programs were rated along a scale based on their degree of focus on UD, accessibility and inclusiveness (Figure 26). There were no indicated differences between Universities and University Colleges on the degree of UD focus.

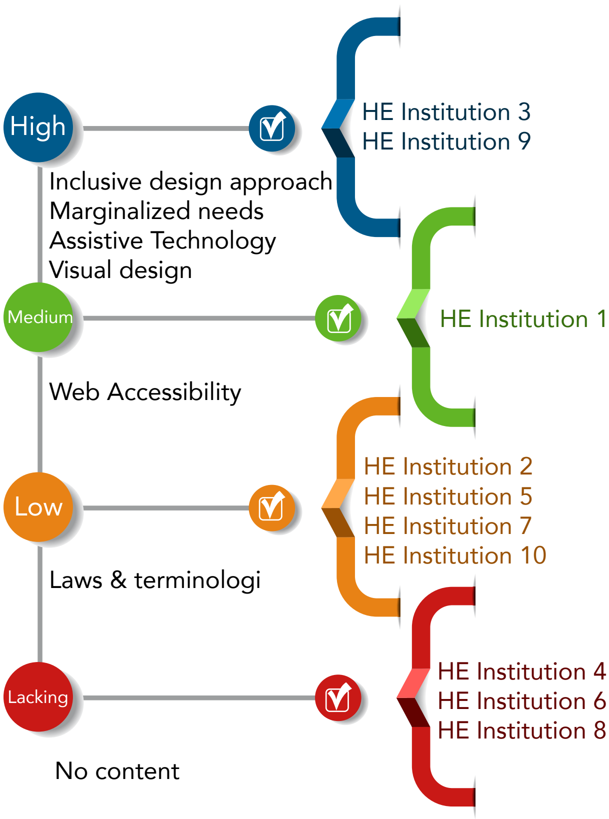


Figure 26: UD focus of IxD programs

Three IxD study programs were completely **lacking** any focus on UD. These studies did not mention any ethical considerations, regulations and laws, or any other related knowledge, skills or general competences related to UD, whether at a course level or at a program level. All these programs included courses where UD aspects was needed in order to educate professionals who would be able to deliver legal solutions to the market, e.g. web development and visual design.

In addition, four tracks had a **low** UD focus. In addition to displaying very limited attention (typically, one single-sentence competence goal within one of the courses), included learning aims are only focused on theoretical knowledge. None of the programs categorized with a low UD focus mention WCAG, other WAI criteria, or UD principles.

One program is regarded as having a **medium** focus on UD. This program explicitly mentioned WCAG (as an example of UD guidelines). Further, the program included an expectancy of ability to apply UD – extending theoretical awareness. Still, the UD focus was limited to two courses on web design and web development, with three competence goals related to UD in total.

Finally, two study programs had a **high** level of UD focus. These programs had UD perspectives embedded in several of their courses, and whenever this was relevant to the topics at hand. Further, they included learning aims on actual skillsets as well as on theoretical knowledge.

Study 7: Discussion

The low presence of UD in study programs in IxD in Norway is an important finding and one that is highly critical for educational institutions to address, in order to contribute to decrease (instead of increase) the digital gaps in a society where the digital development moves fast.

Educating IxD Lawbreakers

The analysis revealed that many of the IxD programs lack a focus on UD, including the teaching of web accessibility. This is worrying and somewhat surprising, as usability and accessibility are concepts well integrated into IxD and user-interface design (Petrie & Kheir, 2007), and both national and international legislation is in place to ensure a minimum level of accessibility in our societies. Our study revealed that three out of the ten programs are completely lacking in attention paid to UD, while a further four study programs have only a low focus on the topic. Only three programs seemed to educate IxD professionals that have the skillsets to comply with current legislations.

Not Ensuring Legislated Technical Accessibility Expertise

Web accessibility is regarded as a key component if all users (citizens) in our digital society are to be included, and it is legislated in Norway as a mandatory part of all new IT-solutions targeting to the general public (KMD, 2013). From 2021, accessibility will also become mandatory for existing IT-solutions in Norway, both public and private (KMD, 2013).

Accepting the fact that inclusion of UD is also manifest in worldwide guidelines and standards (ACCESS8878, 2010; Hosein, 2004; UN, 2006b; US, 2008), we could expect that educational institutions serving the media and IT industries would pay more attention to this in their study programs and course plans. At the very least, one would expect HE institutions to make sure that newly educated interaction designers possess the necessary competence to adhere to current Norwegian and international legislation.

Not Teaching Universal, Inclusive or Edge-Case Perspectives

UD perspectives are vital when designing products for a wide variety of users (Bergman et al., 1996; Connell et al., 1997), and therefore they were expected to play a more central role in the study programs that cover design and product development. Innovative companies, for example Apple, have learnt that designing devices and systems that are easy for everyone to use is a business opportunity. From a business perspective, it should be equally important for future entrepreneurs and start-ups that their designers have skills in UD if they are to target a large audience.

Not Promoting Professional UD Responsibility

Currently, the general manager of a private or public company, or other organization, is legally responsible for adhering to the law. This makes sense as this person is in control of the budget. However, it is reasonable to expect that procurers will be advised of current legislation by service providers so that plans and offerings from the media- or IT-industry will comply with current legislation—just as an architect must comply with building regulations. Knowing that procurers often lack the necessary expertise in UD, we argue that it is an ethical matter to ensure that professionals are adequately educated so that they can advise providers regarding their legal responsibilities.

It should also be noted that in 2015 the European Commission proposed a European Accessibility Act (EAA) to ensure that various products and services in the EU are accessible for persons with disabilities and similar challenges, thereby allowing for a more inclusive society and facilitating independent living (EU, 2016b). This proposal is a working document, but current content that specifies that all "economic operators" are responsible for the accessibility compliance of products and services in relation to their respective roles in the supply chain is likely to remain. The definition of "economic operators" includes, in addition to procurers, distributors, and service providers, "any natural or legal person who manufactures a product or has a product designed or manufactured" (§2) – in other words: designers and developers.

Accessibility is here understood as achieved by the removal and prevention of barriers, preferably through a UD or "design for all" approach (§25). The aim is to complete the EAA work before the end of 2017. There is therefore reason to believe that interaction designers may soon be held legally responsible if they disregard UD legislation in their professional work. This adds to the importance of Norwegian HE institutions ensuring that their IxD students receive the necessary competence and knowledge, and understand both their current and potential future legal responsibilities.

In this regard, we express our concerns regarding future solutions created by students of the IxD programs. If students are not taught the importance of adhering to existing regulations as part of their education, and are not even informed that these regulations exist, we perceive that it is unlikely that they will discover them on their own—and they may even be resistant to taking these regulations seriously in their professional work. However, if UD standards, regulations, best practices, and quality control are taught as part of an IxD education, we consider it likely that newly educated interaction designers will suggest and share these in their places of work.

We urge the HE sector to take responsibility for ensuring that there is an adequate UD focus in IxD education. This is supported by §47 of the 2016 EU directive on the accessibility of websites and mobile applications, which states that members should: *"take the necessary measures to raise awareness of, and promote web training programs relating to, the accessibility of websites and mobile applications, for relevant stakeholders and in particular staff responsible for the accessibility of websites or mobile applications"* (EU, 2016a). Norwegian IxD studies do not appear to be contributing to the intended shift toward a more inclusive society as set in motion by national and international legislation.

Organization of the Study Programs

The findings showed that IxD programs do not provide a straightforward set of competences or skillsets in the way professions such as dentistry, photography, or social science would do. The findings indicated Norwegian IxD study programs and tracks vary greatly in terms of:

(1) Length of the program (2-5 years) and degree achieved (college graduate/BA/MA)
(2) Depth of the program; IxD may be an elective track or a core program component;
(3) Content and emphasis of the programs:
  (a) From IT/technology focus to emphasis on design and creativity processes
  (b) From complete lack of UD perspectives to including this in all relevant topics
  (c) From value-based problem-solving to ensuring industry relevant skillsets;
(4) Contribution of the program;
  (a) Whether oriented toward meeting users needs or societal needs
  (b) Whether educating professionals for the IT- or media-industry
(5) Didactics of the program; applying a theory-based academic approach or aspiring to achieve as much realism as possible.

In most programs, the depth of IxD is limited. Since most of the study programs offer IxD only as an elective focus area or a study track branch, many students achieve an Informatics degree or a Media-degree. Only three programs give the students a Design degree, and of these, only two programs (in tracks three) have IxD as a core component (CG/BA/MA in IxD). These programs are perceived as highly interdisciplinary.

The results revealed no clear differences between Universities and University Colleges across the educational dimensions analyzed, nor were there vast differences between the undergraduate (CG and BA) and graduate (MA) levels.

The programs were investigated for internal consistency. The analysis looked at the internal consistency between the program profiles and their actual content, and then looked at the differences in content focus and educational aims between the programs. We found that 4 of 10 program profiles did not closely match the actual content offered, which is problematic. Both potential students and for the industry are assumed to rely on the online program descriptions provided by the institutions in their recruitment process.

Increased visibility of the skillsets required by interaction designers and a clarification of current educational profiles is believed to be useful for increased agreement on what competences are relevant for interaction designers and the inclusion of UD as an additional expertise. Continuing these efforts will be a focus in the Part 3 of Study 7.

Limitations of Study 7

An in-depth text analysis of all educational programs in IxD in Norway was performed. In-depth analysis is a time-consuming and extensive research approach, prioritizing building rich and deep understanding of a limited data set over a limited and generalizable overview. Thus, an international mapping of all IxD programs in the world was unfeasible. Dependent on the amount of programs detected, looking at the region of Scandinavia (Denmark, Finland, Norway and Sweden) was considered. However, the complexity of the analytical approach and the amount of textual document analysis identified as necessary to answer the research questions restricted the feasibility of an international approach. Our investigations and analysis should instead be repeated for other local samples in later studies, offering the opportunity for tailoring to local and timely needs as well as textual interpretations by native speaking researchers.

A known weakness with document analysis concerns epistemological issues. Documents are produced by the respective educational institutions, and we need to be aware that texts are written as "sales documents" (Atkinson & Coffey, 2004) to attract students. However, because we compared the programs' profiles with an in-depth analysis not only of texts, but also of what the programs offer in terms of courses, we were confident that we had gained a reliable picture of the content of the programs.

Towards Part 3

Each of the studies in Part 2 investigated real-life practices and explored suspected key aspects. From this work, qualitative in-depth insights were acquired. The next section focuses on utilizing the insights to facilitate and advice the practice field on how to impact UD quality.

Part 3

Designing Tools

Executive Summary of Part 3 Designing Tools

This section introduces Part 3, and is followed by a presentation of the work from Part 3 studies.

Part 3: Advice & Tools to Facilitate UD of ICT Practice

Studies & Deliverables

S4: What Success Projects Do
Begnum, Harder & Hjartnes, ***Ensuring Universal Design: Predict Project Success through UD3C Critical Criteria Compliance***, in review

Tool: UD Critical Criteria Compliance (UD3C) self-assessment predictor on likelihood of UD quality outcome

S5: Procuring ICT in HE
Begnum & Foss-Pedersen, ***Digital assessment in higher education, Promoting universal usability through requirements specification and universal design quality (UD-Q) reviews***, UAIS 2017

Advice:Process model for ICT-procurement processes in HE sector case

Advice: Improved UD requirement specification for case

Tool: UD Quality (UD-Q) expert assessment method for case

S6:UD in Service Design
Begnum, ***Inclusive Service Design – for edge-case and mainstream users***, 3min blogpost, 2018

Begnum & Bue, ***Inkluderende Tjenestedesign: Hvordan sikre universell utforming?***, GGDO broadcast, 2018

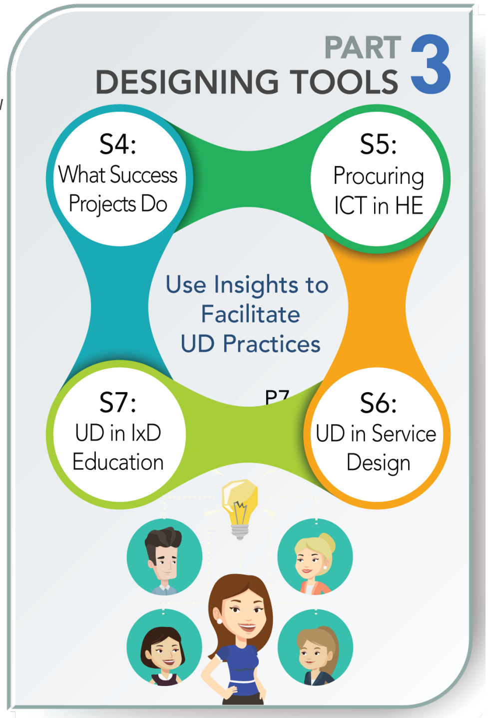
Advice: Definition of UD in Service Design

Tool: Inclusive Core-Personas

Tool: Empathic Service Safari

Tool: UD Touchpoint Matrix

Tool: Service UD Evaluation



S7: UD in Interaction Design Education
Begnum, Sørum & Pettersen, ***Identifying Five Archetypes of Interaction Design Professionals and their Universal Design Expertise***, accepted for publication in Interacting with Computers

Advice: UD expertise needed by Interaction Designers

Part 3 Outcome

- 84 UD impacting factors mapped and categorized, of which 15 identified as Critical Success Criteria (CSC) and used to propotype UD3C tool. Insights into CSC factors as predictive indicators of UD quality of ICT, through compliance evaluation of10 failed and 16 successful ICT-projects.
- A range of tools & advice proposed to facilitate UD of ICT in applied settings.

Figure 27: Overviewing the research in Part 3 – studies, papers and outcomes.

Based on the previous studies, we identified possibilities for improved UD practices. In Part 3, the research question therefore was: "How can we create advice or tools to facilitate UD of ICT?"

The term "tool[10]" is used to encompass any instrument helping you perform a job – both tactile implementations you hold in your hand, and intangible intellectual aspects you hold in your mind. Papers 9-13 present a variety of such tools: paper-based forms, definitions, methods, and models, and provides advice. Some presents **propositions** without further testing. Some present **proof of concepts**, where methods have been implemented to prove our ideas (demonstrate feasibility and make decisions regarding possible next iterations). Finally, some present **prototypes**, where tools have been tested in a pilot approach (testing assumptions and capturing user feedback).

Empirical-based insights from Part 2 Studies 4, 5, 6 and 7, informed design-based and generative research.

Study 4 provided possibilities to hypothesize generally UD promoting practices for ICT-projects, drawn from successful cases. We asked:

3.1. How can characterizing ICT-project success criteria be used to predict UD quality?

Related to Study 5, we investigated:

3.2. How can UD quality be better ensured in procurement processes?

Based on Study 6 and Study 7 findings, we asked:

3.3. What should be regarded as "best practice" UD expertise in the SD discipline?
3.4. What should be regarded as "best practice" UD expertise in the IxD discipline?

The answers to our research questions were as follows:

3.1 How can characterizing ICT-project success criteria predict UD quality?

Study 4 Part 3 indicated characterizing success criteria could be identified and extrapolated into a set of Critical Success Criteria (CSC). These CSC were expressed as questions, and used as a way to measure "best practice" adherence by self-assessment. We demonstrated how adherence to the extrapolated best practice – measured by the UD3C self-assessment tool – successfully indicated UD quality outcomes in the sampled projects. As such, characterizing ICT-project success criteria could be used to tentatively predict UD quality through self-assessment questionnaires.

The work done in Study 4 Part 3 is presented in Paper 9: *Ensuring Universal Design: Towards Predicting Project Success through UD3C Critical Criteria Compliance.* (Begnum, Harder and Nordeide, in review).

3.2 How can UD quality be better ensured in procurement processes?

In relation to the Study 5 case study into the HE sector, we hypothesized that clarified UD responsibilities, improved UD requirements, and processes including focus on real-life usable accessibility and contextual end-user needs and usable accessibility quality assurance prior to acceptance testing would contribute to this end. Further, we encouraged inclusive main solutions as cost-effective measures.

[10] https://en.oxforddictionaries.com/definition/tool

The work done in Study 5 Part 3 is published in Paper 10: *Universell utforming og digital eksamen i UH-sektoren: 5 anbefalte tiltakspunkter* (Foss-Pedersen and Begnum) – along with Part 2 work, and in Paper 11: *Digital assessment in higher education: Promoting universal usability through requirements specification and universal design quality (UD-Q) reviews* (Begnum and Foss-Pedersen).

3.3 What should be regarded as "best practice" UD expertise in SD?

In Part 3 we defined what a Universally Designed service should entail, and developed inclusive SD methodology facilitating the creation of inclusive services and UD evaluation of services. Paper 12: *Towards Inclusive Service Design in the Digital Society: Current Practices and Future Recommendations* (Bue and Begnum, 2018) mainly presents the Part 2 Study 6 work, but includes the beginnings of our Part 3 work and our proposed UD of services definition.

3.4 What should be regarded as "best practice" UD expertise in IxD?

Study 7 created a base for discussing and communicating UD expertise relevant for interaction designers. Paper 13: *Identifying archetypes of Interaction Design competence and their Universal Design expertise* (Begnum, Pettersen and Sørum, in process) presents the work of Study 7 Part 3.

Contributions from Part 3:

The aim was to create advice and tools to facilitate UD in ICT. Some studies identified best practices for UD, and we created advice and tools to support current best practice. Some studies could not find best practices for UD, and we proposed best practices to promote UD.

We consider our key contributions to facilitate **current** UD practices to be:

- Prototyped UD3C tool indicating compliance to identified Critical Success Criteria for UD success, and early prediction of UD quality outcome likelihood of ICT-projects.
- Suggested process model for increased and clarified UD awareness, focus, responsibilities and quality control in HE sector digital assessment/ICT-solutions procurement.
- Proposed improvements to UD requirement specification for digital assessment solutions, and a benchmarking of current technical accessibility levels and opportunities.
- Proof-of-concept introduction of UD-perspective in current SD methodology tools.

Our key contribution to promote **future** UD practices were:

- Proof-of-concept UD-Q expert assessment method for digital assessment/ICT-solutions.
- Increasing awareness on UD in SD, by generating four new methods supporting the design and evaluation of inclusive services, as described by our UD of service definition:
    - Inclusive Core-Personas
    - Empathic Service Safari
    - UD Touchpoint Assessment Matrix
    - Service UD Evaluation
- Increasing awareness on UD in IxD, by discussing UD expertise for IxD professionals:
    - On web accessibility for the IxD archetype Front-ender
    - On technical accessibility for the IxD archetype Full-stacker

- On visual design for the IxD archetype Design Tinker
- On content creation for the IxD archetype Communicator
- On inclusive design for the IxD archetype User Empath
- On common UD expertise for all IxD archetypes

We now started to see the connections between discoveries from the different studies. Thus, we wanted to spend some time reflecting on the overarching findings across the PhD thesis. This was the motivation for the grounded theory approach in Part 4.

1 paper were published:

Paper 11. Begnum, Miriam E. Nes; Foss-Pedersen, Rikke J. (2017) *Digital assessment in higher education: Promoting universal usability through requirements specification and universal design quality (UD-Q) reviews.* Universal Access in the Information Society. Springer.

2 papers are still in review:

Paper 9. Begnum, Miriam E. Nes; Harder, Susanne Klungland; Hjartnes, Øyvind Nordeide. (in review) *Ensuring Universal Design: Towards Predicting Project Success through UD3C Critical Criteria Compliance.* Manuscript submitted for review to Interacting with Computers.

Paper 13. Begnum, Miriam E. Nes; Sørum, Hanne; Pettersen, Lene. *Identifying archetypes of Interaction Design competence and their Universal Design expertise* Manuscript accepted for publication to Interacting with Computers; in process.

Study 4, Part 3: “What Success Projects Do”

Study 4 continued in Part 3, where we explored how to utilize the identified positive practices to aid projects in assessing their ability to achieve UD. We now asked: “How can characterizing ICT-project success criteria be used to predict UD quality”? Our assumption was that a practical contribution to measuring project-level practices critical for success would facilitate UD planning and management on ICT-projects, and help transfer research insights into the practice field.

Study 4, Part 3: Background

Defining criteria to measure and indicate a project's success can be a challenge (Khang & Moe, 2008). Reichling and Cherfi (2013) suggested that in order to manage, measure and implement accessibility during a project, a model should be followed and integrated into the existing process. They proposed a method to measure process goals early and continuously.

E. S. Andersen, Dyrhaug, and Jessen (2002) proposed using Critical Success Factors (CSF) as indicators of individual aspects that are either absent or present in a project, affecting the overall success or effectiveness of the implementation process; including the team's performance and ability to follow the given time frame and budget. Further, they suggested that CSF could be used both to evaluate and predict the overall project success, and to provide a view of the current state of projects, so that problems and opportunities may be identified early on (E. S. Andersen & Jessen, 2000). They proposed the Project Evaluation Scheme (PEVS) tool for project success evaluation of both current project status and possible future outcomes.

A. PROSJEKTDEFINISJONEN

Om prosjektets formål og mål		Helt uenig					Helt enig	Vet ikke
1.	Prosjektet har klare og entydige mål	1	2	3	4	5	6	☐
2.	Prosjektets formål (hensikt, begrunnelse) er klart beskrevet	1	2	3	4	5	6	☐
3.	Prosjektets formål og mål er akseptert av alle som er involvert i prosjektet	1	2	3	4	5	6	☐
4.	Hvis prosjektet når målene sine, gir det en særdeles ønsket utvikling i den virksomheten som skal bruke resultatene fra prosjektet	1	2	3	4	5	6	☐
5.	Alle sentrale aktører i prosjektet har hatt anledning til å gi uttrykk for sitt syn på prosjektets hensikt og ambisjon	1	2	3	4	5	6	☐
6.	Det er helt klart definert hva som er prosjektets avslutningspunkt	1	2	3	4	5	6	☐

Sum: ________ **Antall svar:** ________ **Gjennomsnitt:** _____ ,_____

Erling S. Andersen

Figure 28: PEVS questionnaire excerpt (from Slideplayer, 2015)

Figure 28 shows an excerpt from PEVS, which is a questionnaire with five main categories, each split into two subcategories. This results in 10 subcategories. For each subcategory, there are 6 questions, resulting in 60 critical success factors. In order to measure compliance, the scheme adopts a Likert scale, ranging from 1 (disagree completely) to 6 (agree completely) per CSF. Each CSF is given a score between 1 and 6 (up to two decimals are used). A project can also be profiled for each CSF in relation to four percentiles (visual presentation of 0-100 % compliance).

Study 4, Part 3: Research Approach

Study 4 increasingly takes on hermeneutic and interpretive qualities through the iterations of data collection, analysis, design and evaluation.

First, we investigated the 84 characterizing factors from our 24 sampled successful projects to determine which should be considered the most critical for UD success. We labeled these "Critical Success Criteria" (CSC).

Second, we explored how to measure the CSC, starting the generative tool design.

Third, we iteratively developed a score model to measure Critical Criteria Compliance (C3) and continued the "Universal Design Critical Criteria Compliance" (UD3C) assessment form design.

Fourth, we tested the predictability of the C3 score model on projects unsuccessful in UD quality achievement. At this point, we moved from generative to design-based research in our tool design.

Finally, we piloted the UD3C as a self-assessment tool in order to evaluate our assumptions on how such a tool could support UD practices in ICT-projects, and captured user feedback.

1. CSC Analysis

We defined which factors should be considered CSC by looking at the frequency of characterizing factor mentions in the interview transcripts. We defined a tentative limit as to what constituted enough mentions for a category to be classified as a CSC. Our decision was to regard a factor as "critical" if more than ⅔ of participants mentioned it (i.e. more than 22 of the 34 sources), and in addition the factor was being mentioned more than 50 times in total (i.e. more than 2.2 times per project). Paper 9 provides more CSC analysis details.

2. CSC Measurability

To explore the measurability of the CSC, we prototyped a question-based assessment form based on PEVS. The formulations of the questions were discussed and iterated twice prior to CSC compliance score model design, attempting to increase clarity and minimize ambiguity and possible overlap between questions. Paper 9 provides details.

Tool design

We decided to focus on how the insights from Part 2 could be utilized to facilitate UD planning and management in ICT-projects. Thus, the design process was initiated with the project manager (or Scrum master) in mind as the primary user, and team members as secondary users. At this point the design process is generative (Hanington & Martin, 2012) – focused on generating ideas and early prototypes, informed by empirical data from exploratory research, and moving towards evaluating research.

3. CSC Compliance Score Model

The score model was informed by Kitchenham's feature analysis score model design (B. Kitchenham, 1996; B. A. Kitchenham, 1996a, 1996b; Kitchenham, 1997; M. E. Nes, Ribu, & Tollefsen, 2008). Initial assessment of the scoring based on the model was done through expert assessment for each question against the success sample case data from Study 4 in Part 2. The first score model resulted in expert assessment points ranging from 9 to 17 per ICT-project UD success case, with a mean of 13.5. Thus, all success cases produced high scores in the relation to the formulated questions. However, we wanted to further improve the score model based on the qualitative data.

Tool design

By comparing the questions to the frequencies of mentions of different aspects in the qualitative NVivo data, the score model was iteratively improved and re-tested, as was the design of the assessment form. We are now moving towards design-based research, with a performance-based multistep design approach based on iterative modification and evaluation.

Maximizing the score for success-sample CSC compliance was believed to provide higher model accuracy. In order to do so, we examined which questions influenced the scores the most and changed the form correspondingly.

The final CSC compliance score could as such give a minimum of 0 points and a maximum of 18 points to a project. If the score model was valid, not only should UD-successful projects receive high scores, but unsuccessful projects should also receive low scores.

Based on the final score model, the success-case mean was 14.3, with scores ranging from 12 to 17. See Paper 9 for more details, in particular on the score model assessments and prototype development.

4. UD Prediction based on CSC Compliance

The tool was labeled **UDC3**, as an acronym for **Universal Design Critical Criteria Compliance**. We hypothesized the tool would have the ability to make UD success prediction levels, based on CSC compliance. In the forth UDC3 tool version, based on the score results of the final score model, three such predicted levels were hypothesized; 1) if a project was likely to struggle to achieve UD, 2) if a project could be expected to achieve high UD quality, or 3) if the project was somewhere in the middle.

Sampling of unsuccessful projects:

We sampled unsuccessful projects to test our hypothesized UD prediction levels against the final score model. Due to time and scope restrictions, we chose not to evaluate ICT-projects ourselves, in order to identify ones that had low UD quality. We instead looked for external assessment of lacking UD. We specified the inclusion criteria for an "unsuccessful" ICT-project as having received negative press for their UD efforts by a reputable source on UD quality.

We identified a private company that had recently received a negative UD review by Funka AB.

Funka AB is highly specialized in UD quality evaluation, and has measured web accessibility on many large-scale projects in Norway, USA, Canada, Australia and Europe – including assessing web accessibility for all EU member states on behalf of the European Commission.

The private company had, to the best of our knowledge, never received an award, nomination, honorable mention or high rating related to UD quality. Based on an internal contact in the company, we utilized a non-probabilistic convenience and snowball sampling process to identify specific ICT-projects that was likely lacking in UD quality within this company.

Using our personal connections, we were able to identify 20 individuals within the sampled private company, that all came from completed ICT-projects which had not had a UD focus, nor achieved UD success as defined in this thesis. Among the 20 individuals, 11 were employed within the company, while 9 were consultants on the relevant projects.

The assessors could be any interaction designer, designer, developer, project manager or person in a similarly role closely associated with the project work. Of the 11 internally employed, 1 was an interaction designer, 2 were digital designers, 3 were content producers or advisors, 3 were project managers, and 2 were developers. The consultants came from two different consultancies, and represented 3 interaction designers, 1 digital designer, 2 project managers and 3 developers.

5. Piloting the UD3C tool

The 20 potential assessors were approached via email, and asked for participation. Paper 9 provides more detail. We now moved beyond author expert assessment inspections of the score model, to checking the understandability of questions and form design. Thus, the assessors from the unsuccessful projects not only tested the internal validity of the score model, but also if the UDC3 assessment form measured what was intended, when used as a self-assessment tool.

This piloting of validity and understandability was continued by asking participants from the success sample to also self-assess their projects, using the UDC3 tool and final score model. Unsuccessful and successful user assessor scores were gathered and compared to each other, and to expert assessment scores. Ideally, all projects in the UD-unsuccessful sample should get between 0 and 5 points, and all successful projects above 12 points.

Data Collection & Design-Based Research

By implementing and evaluating the UD3C form as a self-assessment tool, we were now doing design-based research (Leedy & Ormrod, 2014, Table 4.2). User feedback was gathered from the assessors, via e-mail (for the unsuccessful sample) and via phone interviews (for the successful sample; where all participants were asked to participate in tool evaluation by phone). Follow-up questions were used to either clarify or ask more about potential contexts of use, both via email and phone. For the success sample, a semi-structured interview guide was also used to get feedback on the perceived usefulness, including if any of the questions were unclear or difficult to answer.

In addition, a focus group interview was initiated with three added success-sample participants, representing 2 added UD success projects. Again, Paper 9 offers more detail. Tool improvement and modifications were continued based on the results and feedback.

Study 4, Part 3: Results

15 Critical Success Criteria

We identified 15 Critical Success Criteria, summarized in Table 19.

Table 19: Critical Success Criteria overview

CSC	Level	Category	Description
1. Legislative Support	Societal	-	
2. Awareness	Organizational	UD Anchoring	
3. Priority			
4. Competence building		UD Strategy	
5. Requirements Specification	Processual	Early & Clear Focus	…on UD
6. Needs Integration		UD/UX Integration	
7. Continuous Focus			
8. Team Collaboration		Process Qualities	…cross-disciplinary
9. User Testing		Quality Control	Real, Frequent, Early, Direct and Guerrilla user feedback
10. Internal (evaluation)			UD checkpoints, UX inspections, Code inspections, Code validations
11. Time & Budget		Resources + Lack of Resources	
12. Equipment & Human Resources		Lack of Resources	
13. DfA Mindset	Personal	Competence Lack of Competence	
14. Interested		Personal Qualities	…in UD
15. Enthusiastic			…about UD

11 Critical Criteria Compliance Questions

Our final CSC compliance measurement model contained 11 questions relating to 14 of the 15 CSC – excluding measuring the social level CSC of legislative support. Further, the score model included questions and scores for three non-CSC aspects; on external UD QA evaluations, general team UD competence, and the project process model. Questions and corresponding scores are displayed in Table 20.

Table 20: Final CSC compliance measurement questions and score model

Questions	Measured CSC	Possible Scores
1	2) Organizational UD Awareness Anchoring 3) Organizational UD Priority Anchoring	0, 1 or 2 points per question. 0-14 points in total.
2	14) Personal UD Interest Qualities 15) Personal UD Enthusiasm Qualities	
3	11) Processual Time/Budget Resources 12) Processual Human Resources	
4	13) Personal DfA Mindset Competence + Team UD competence	
5	6) Processual Needs Integration UD/UX 7) Processual Continuous Focus UD/UX	
6	9) Processual User Testing UD QA 10) Processual Internal Evaluation UD QA	
7	8) Processual Team Collaboration Qualities	
Bonus questions		
a	4) Organizational Competence building UD Strategy	0 or 1 point per bonus question. 0-4 points in bonus. 0-18 points in total.
b	5) Processual Requirement specification UD Focus	
c	+ An iterative & flexible project process model	
d	+ Processual External Evaluation UD QA	

Version 7 – The final UD3C Design

The final UD3C assessment form is presented in Figure 29.

UD3C EVALUATION - UNIVERSAL DESIGN CRITICAL CRITERIA COMPLIANCE

Step 1. Indicate if your project fulfills the UD critical success factors on the scale:	Disagree		Agree
1. There is a common understanding of UD in the project team and at all management levels (including any customer), and achieving UD is supported and viewed as positive.	**0**	**1**	**2**
2. The team has at least one person enthusiastic about UD, having a personal interest and motivation for ensuring universal usability.	**0**	**1**	**2**
3. The team has all the resources needed to ensure UD criteria; adequate time, budget and human resources; including access to assistive technologies, users and external competence.	**0**	**1**	**2**
4. The team has relevant UD competence and experience, e.g. UD principles in coding, IxD, content & visual design. Focus is on making design accessible and usable for everyone.	**0**	**1**	**2**
5. UD perspectives are integrated into all project activites; design, coding, UX/UCD & needs.	**0**	**1**	**2**
6. UD aspects are early and continously evaluated throughout the project, both through expert inspections and through user testing and real-user feedback including persons with disabilities.	**0**	**1**	**2**
7. The team embraces cross-disciplinary collaboration, open discussions and dialogue.	**0**	**1**	**2**

Step 2. Recieve 1 bonus point for:		
a) A strategy for developing the UD competence in a team or organization.	**0**	**1**
b) Requirement specification includes criteria for UD, ensuring early and continuous focus.	**0**	**1**
c) An iterative or flexible process model, utilizing feedback from UD evaluations.	**0**	**1**
d) Extending internal evaluations with external inspections adds to UD quality control.	**0**	**1**

Step 3. Summarize your total: ____________ **point(s)**

0-5 points: Your project is not fulfilling critical success factors for universal design, and is likely to struggle to achieve universal design.
6-11 points: Your project mostly fulfills critical success factors for universal design, but is unlikely to win universal design awards.
12-18 points: Your project fulfills most or all critical success factors, and is expected to achieve excellent universal design quality!

Figure 29: Final UD3C– Universal Design Critical Criteria Compliance evaluation (Version 7)

UD3C Assessment Scores

We arrived at three levels of prediction based on the assessment results, which is summarized in Table 21 and Table 22.

Table 21: Final CSC compliance score model applied to ICT-projects with UD success

Successful ICT-Project	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Qa	Qb	Qc	Qd	Total Score
Internal Expert Assessment												
1	2	2	1	1	1	2	2	1	1	1	0	14
2	2	2	2	2	2	1	1	0	1	1	1	15
3	1	2	2	1	1	1	2	1	0	1	1	13
4, 8, 9, 21	1	2	1	2	2	1	2	0	1	1	1	14
5, 11	1	2	1	2	1	2	2	0	1	1	1	14
6, 7	1	2	0	2	2	2	2	0	0	1	0	12
8	1	2	2	1	1	2	1	0	1	1	0	12
10	1	2	0	1	2	2	1	0	1	1	1	12
1, 12	1	2	2	2	2	2	2	1	1	1	1	17
13	2	2	2	2	2	1	1	0	0	1	1	14
14	2	2	2	2	2	2	1	1	1	1	1	17
15	2	2	1	1	2	2	2	1	1	0	1	15
16	2	2	2	1	2	2	2	0	0	1	1	15
17, 18	2	2	2	1	2	2	1	1	1	0	1	15
19	1	2	1	2	2	1	2	1	1	0	1	14
20	2	2	2	2	2	2	1	0	1	1	1	16
Average scores	*1.5*	*2*	*1.4*	*1.7*	*1.8*	*1.8*	*1.6*	*0.4*	*0.8*	*0.9*	*0.8*	***14.3***
External Phone Interview Assessment												
1	2	2	0	2	1	1	2	0	1	1	1	13
1	2	2	2	2	2	2	2	1	1	1	1	18
1	1	2	2	1	1	1	2	0	1	1	0	12
2	2	2	2	1	2	1	2	0	1	1	1	15
3	2	2	2	2	1	1	2	1	1	1	0	15
3	1	2	1	2	1	2	2	1	1	1	1	15
4	2	2	1	2	2	1	2	0	1	1	0	14
6	2	2	2	1	2	0	2	0	0	1	0	12
7	2	2	2	1	2	0	2	0	0	1	0	12
8	1	2	0	2	1	0	0	0	1	0	0	7
8	2	2	0	2	2	1	2	1	1	1	0	14
9	2	2	2	2	2	2	2	1	1	1	1	18
12	1	2	0	2	1	0	1	0	0	1	0	8
13	2	2	2	2	2	2	2	1	1	1	1	18
14	2	2	0	2	1	1	2	1	0	1	1	13
15	2	2	1	1	2	2	2	1	1	1	0	15
15	2	2	2	2	2	0	2	1	1	1	0	15
16	2	2	1	2	1	2	2	0	1	1	1	15
20	2	2	2	2	2	2	2	1	1	1	1	18
24	2	2	2	2	2	1	2	1	1	1	1	17
Average scores	*1.8*	*2*	*1.3*	*1.8*	*1.6*	*1.1*	*1.9*	*0.6*	*0.8*	*1*	*0.5*	***14.2***
External Focus Group Self-Assessment												
22	0	2	0	1	1	0	1	1	1	0	0	7
22	0	2	0	1	1	1	1	0	0	0	1	7
23	2	2	1	1	2	0	2	1	1	1	1	14
Average scores	*0.7*	*2*	*0.3*	*1*	*1.3*	*0.3*	*1.3*	*0.7*	*0.7*	*0.3*	*0.7*	*9.3*

For the success sample, 16 participants agreed to phone interviews, representing 14 projects assessed by phone. Four projects had more than one assessor, and we could compare their assessments. The assessors did not always agree, but assessments were usually overlapping. The success sample participants and expert assessments also fit fairly well, with similar averages of 14.3 and 14.2.

In the three focus group self-assessments, the average score was lower than for the larger success sample. The reason was likely that project 22 received an honorary mention based on UD efforts, not resulting UD quality.

Table 22: Final CSC compliance score model applied to ICT-projects unsuccessful on UD

Unsuccessful ICT-Project	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Qa	Qb	Qc	Qd	Total Score
A	1	1	0	1	0	1	2	0	0	1	0	6
B	0	2	0	0	0	0	2	0	1	0	0	5
C	1	1	0	1	0	0	1	0	0	0	0	4
D	0	2	0	1	0	0	1	0	0	0	0	4
D	0	1	1	1	0	0	2	0	0	0	0	5
E	1	2	1	2	2	0	2	0	1	0	0	11
F	0	0	0	1	0	0	1	0	0	0	0	2
G	1	2	0	1	0	1	2	0	0	1	0	8
G	0	2	0	1	0	0	2	0	0	0	0	5
H	1	2	0	0	0	0	2	0	0	0	0	5
I	1	0	0	0	0	0	2	0	0	0	0	3
J	1	2	0	1	1	0	0	0	0	0	0	5
Average scores	*0,6*	*1,4*	*0,2*	*0,8*	*0,3*	*0,2*	*1,6*	*0*	*0,2*	*0,2*	*0*	*5,25*

12 of the 20 approached unsuccessful-sample assessors responded to our e-mails, assessing 10 projects. For the two projects that had two assessors, we could compare their assessments. Their assessments were similar, though not equal. For the unsuccessful sample, the project average is 5.25 points. 9 projects received 0-5 points, but project A, G and E scored 6-11 points.

Hypothesized Prediction Thresholds

We hypothesized a prediction score of 0-5 points indicating the project is likely to struggle to achieve UD as it does not comply with best practices as indicated by the CSC, and 6-11 points in total indicating the project mostly fulfills CSC and has fair success predictions. Finally, 12+ points indicating the project is expected to achieve high UD quality – as it complies with most or all CSC, and thus current UD-best practices are overall followed.

These prediction threshold score levels fit fairly well with resulting assessment scores.

UD3C User Feedback

All emailed assessment from unsuccessful-project assessors were replied to by us, in order to mirror back to the assessors their final score and overall project strengths/weaknesses for validation, and thanking them for their participation. Through this mirroring process, it became clear that several assessors had overlooked the bonus questions. Further, one assessor had misinterpreted the summarizing line. A dialogue was initiated, misunderstandings were clarified, and final scores corrected for all the assessments. Based on the feedback, question formulations were clarified and the visual layout altered to make the scoring model easier to understand.

These changes were implemented prior to the phone interviews, in order to see if the new question formulations had better understandability – in line with formative-iterative development. All participants had received the UD3C form by email; however they did not necessary visually use the form during the phone interview. Thus, the understandability of the UD3C design was not tested. The phone assessments were conducted as structured interviews. Question clarifications and explanations were allowed, and were noted down as feedback on the understandability of the questions and the participants perceived usefulness of the tool.

The focus group utilized the tool as a self-assessment form, and had the following key feedback:

1) The tool could be a discussion facilitator in a workshop with project owners and team members, where one could sit down and discuss goals, opportunities and needs.
2) The tool could be an awareness facilitator and start-up checklist, to communicate aspects that could advance or disrupt UD efforts on project level to management levels.
3) The need for digitalization was rejected, as paper-based was preferred for workshops.
4) The tool could be improved by adding more detail to some of the criteria/questions, as this would increase understanding, and improve fit for agile tool integrations (tasks).
5) An informative website could be created separately, providing more detail and real-life best practice examples related to the criteria (assumed audience had UD responsibilities).

Our quite extensive efforts on prototyping and testing UD3C are reported on in Paper 9: *Tool for Ensuring Universal Design: Towards Predicting ICT-Project Success through UD3C Critical Criteria Compliance* (Begnum, Harder and Hjartnes, in review).

Study 4, Part 3: Discussion

In Study 4 Part 3, we used our understanding of applied aspects related to UD success, to prototype a tool that provided the means for projects to self-assess against identified best practice for UD success in ICT-projects. The UDC3 (Universal Design Critical Criteria Compliance) tool was developed in an iterative design-based research process.

The first contribution of Study 4 Part 3 were theoretical, determining key influential factors for securing UD in ICT, providing practitioners. Through identifying 15 Critical Success Criteria (CSC), researchers and politicians are provided added knowledge on current key influencers.

Our second contribution is the prototyped UDC3 tool, which summarized the best-practice insights made from research in an accessible manner. Here, we implemented a CSC compliance scoring in the form of a self-assessment paper-based tool. We were able to formulate 11 questions to measure compliance to the identified applied best practice, based on CSC. In addition to internal expert assessment, 19 participants assessed 16 UD-successful ICT-projects and 12 participants assessed 10 UD-unsuccessful ICT-projects in order to check the preciseness of CSC compliance scoring and UD success predictions based on compliance assessment. In total, 46 participants have participated in Study 4, representing 24 success projects and 10 failed projects. UDC3 testing successfully indicates the project compliance to "best practice" for ensuring UD in ICT-projects.

Third, based on the test-scores overall compliance to critical Processual, Organizational and Personal success criteria, the UDC3 tool showed potential for tentatively predicting the likelihood of achieving UD in a resulting ICT-solution, both prior to, at the end of and during an ICT-project. As such, we have developed a proof of concept related to measuring UD quality beyond technical accessibility guidelines, and piloted an approach to predict the likelihood of achieving UD in end-results, and plan accordingly, **prior** to completion. If considered adequately valid by the community, UD3C assessments could be used as a benchmark for measurement of UD quality beyond technical accessibility.

Finally, the tool was targeted to ICT-projects, and was hypothesized to facilitate the management of UD-positive projects practices. 16 participants were interviewed via phone on their views on the prototyped tool, and 3 focus group participants were interviewed on the tools usability and usefulness. Supporting sketches and wireframes of possible digital implementations were developed to assist in interview probing. We attempted to make a minimum viable product (MVP), but were not completely successful in this regard. We now recommend the UDC3 tool to be used as a communication tool in the project planning phases, to be collaboratively assessed by project owner, management and team, rather than to support continuous project management.

Overall, preliminary UDC3 validation and end-user feedback were optimistic, and the UD3C tool was considered valuable as an early project planning and communication tool within a team and towards stakeholders; in order to clarify UD understanding, promote end-user focus, and leverage resource decisions for improved UD success predictions.

Limitations of Study 4, Part 3

On the Critical Success Criteria, tentative comparisons with related research indicates key aspects coincide with previous research (e.g. Fuglerud and Sloan (2013), Røssvoll and Fuglerud (2013), Schulz et al. (2014), and Scott, Spyridonis and Ghinea (2015)). However, a more systematical comparison is needed to further strengthen the validity of our findings.

Further, the design of the tool must be expanded on in future work, by adding more detail on criteria assessment, and how to utilize the tool. Feedback indicated more work is needed to confirm the UD3C usefulness related to practical usage scenarios. Future work could e.g. conduct natural workshop experiments in ICT-projects to assess how the tool works for planning, communication, evaluation and discussion.

Towards Study 5, Part 3

The next section will describe contributions made based on empirical insights from the HE case study.

Study 5, Part 3: "Procuring ICT in HE"

While Study 4 strived to measure UD quality, ensuring overall UD competence and focus, Study 5 focused more on contributing to solve specific identified issues. Our aim in Study 5, Part 3 was to propose advice and improved practices for the HE sector in relation to ensuring UD when acquiring and implementing digital assessment solutions.

Study 5 Part 3 focused on solving the key challenges identified from the researched case on procuring ICT-solutions. These mainly related to issues on Organizational and Processual levels: lacking UD competence and insights, lacking UD needs specification and priority, unclear UD responsibility, lacking UD/UX integration and lacking quality control.

Study 5, Part 3: Background

Based on the qualitative insights from Part 2, we determined key issues related to clarifying UD responsibilities, improving UD priority and focus, and quality assuring UD/UX aspects – as discussed in Paper 10: *Universell utforming og digital eksamen i UH-sektoren: 5 anbefalte tiltakspunkter*. By solving these challenges, a contribution could be made to better ensure UD in procured digital solutions. From our discussions, we arrived at the following five action points for the HE sector:

1. Move focus from individual facilitation to inclusive/universal standard solutions; aim to create more cost-effective solutions usable for a wider range of students.
2. Requirement specifications should include explicit universal design, technical accessibility and usable accessibility needs.
3. Clarify UD responsibilities; demand solution providers (developers) are responsible for implementing technical accessibility and assistive technology (AT) compatibility.
4. Clarify UD responsibilities; institutions should take on the responsibility for ensuring (universal) usability in real-life contexts of use, with QA prior to hand-off.
5. A more student-centered and user-involved process should be implemented for procurement.

Study 5, Part 3: Research Approach

Figure 30 outlines our Study 5 Part 3 research process and our three Part 3 contributions. Our focus was on solving the above action points. To this end, a generative research approach was applied; drawing on the empirical findings from the case study to develop early concepts and propositions to solve the identified challenges.

Prototyping an UD Quality Expert Assessment Approach

To advance the third action point, we looked at technical accessibility requirements levels that could be demanded of providers. We prototyped a feature-analysis based expert inspection method: UD Quality Expert Assessment (UD-Q). Through UD-Q assessment, we investigated the current accessibility levels of the digital assessment solutions in use (Inspera and WISEflow).

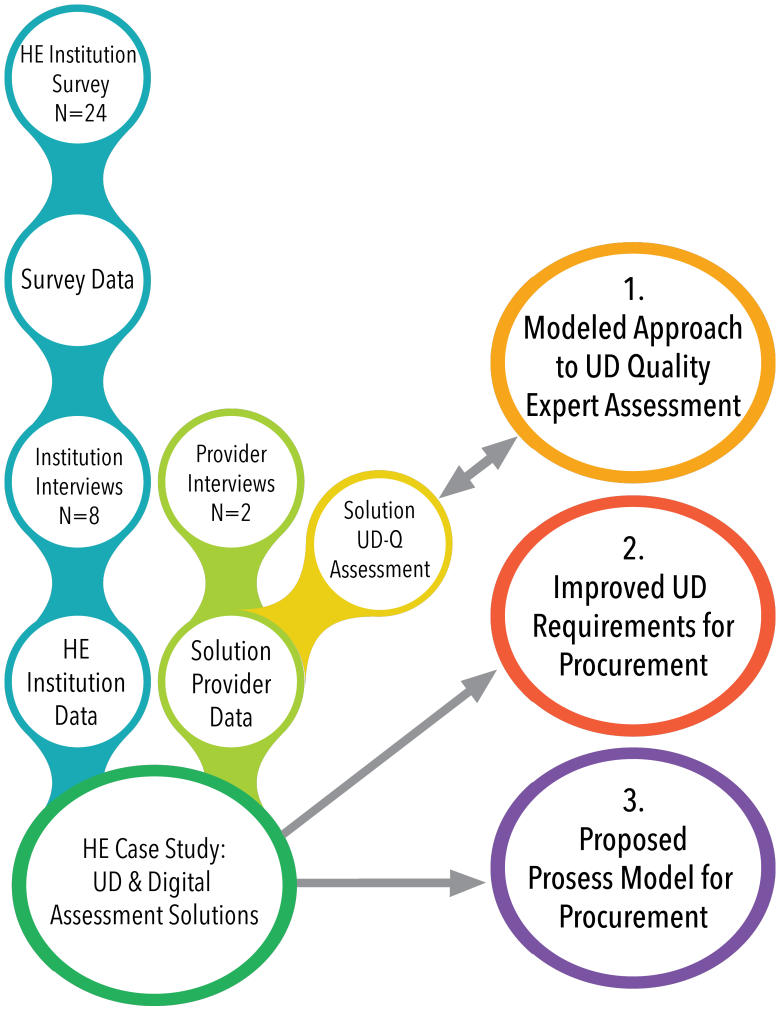


Figure 30: Generative Research Process Overview & Outcome

Improving UD Requirements

We approached action point 2 by looking into the current Uninett requirement specification, and evaluating their UD (and UX) requirements. Based on comparing the current accessibility levels of digital assessment solutions to Uninett's recommended UD requirements, we proposed clarified and more extensive UD requirement, which we could demonstrate as feasible and testable through our modeled UD-Q expert assessment.

Proposing a Process Model

Finally, advice on how to advance action points 1, 3, 4 and 5 were reflected in a procurement process model.

Methodological Background for Part 3

Following is a summary of the methodological background for Study 5 Part 3 work on the UD-Q expert assessment method, and the generation of fitting UD requirements and UD responsibilities. The UD-Q expert assessment contribution was generated iteratively with the improved set of UD requirements, to make sure that the requirements were realistic, and is presented in Paper 11: *Digital assessment in higher education: Promoting universal usability through requirements specification and universal design quality (UD-Q) reviews*. In this work, we drew on feature analysis methodology, as detailed in Paper 11 section 4.3 Universal Design Quality (UD-Q) Expert Assessment Analysis.

Accessibility Evaluations

Paper 11 outlines in section 3.1 Expert Evaluations how expert assessment (also called expert inspections, expert evaluations and expert testing) are effective assessment methods, even if facing validity and reliability challenges.

Expert assessments often draw on guidelines. This is also the case for our UD-Q assessment method. We included the WCAG 2.0 criteria when building our UD quality expert assessment method, as we could not find any specific accessibility guidelines for digital assessment solutions and 2.0 was the latest available WCAG version. Expert assessments based on such technical accessibility guidelines are commonly denoted "accessibility evaluations". Likewise, inspections carrying this label are often focused on assessing technical accessibility.

As briefly mentioned in 2.3 Reflections on Current Norwegian UD of ICT Legislation, the use of guidelines for technical accessibility assessments are not without drawbacks. Using technical guidelines will only provide a limited UD quality evaluation. Corresponding to the weaknesses of expert inspections at large, one might not detect real-life usage issues in such an inspection. Still, both the use of guidelines and the use of expert inspections are recommended as an effective and cost-effective initial evaluation method, with results likely to reveal major flaws and be indicative of potential UD and usability issues.

Heuristic Evaluation

We regarded "accessibility evaluations" as a subset of "heuristic evaluations". Heuristic evaluations are based on a certain set of design guidelines (called "heuristics"). However, most heuristic evaluations are described as holistic, and the inspections are often less technical and checklist-based compared to the "typical" accessibility evaluation.

We viewed the seven principles for UD as a fitting set of holistic design guidelines to further inform our UD quality assessment method. These broader principles were considered helpful for conducting a more immersive and empathic expert inspection into usable accessibility issues, and expanding on the WCAG technical accessibility findings in a more holistic quality assessment.

The strengths and weaknesses of heuristic evaluations overlap with other expert assessment methods. Just as for (technical) accessibility evaluations, there is a risk for false negatives (not detecting real issues). For holistic heuristic evaluations, we also believe there is a heightened risk for false positives (detecting non-issues). With assessments led by broader design guidelines, the expert might identify more issues that real users in actual contexts of use would not be bothered by than in assessment led by very specific and narrow guidelines.

Cognitive Walkthrough

Another weakness with heuristic evaluations is they do not investigate the stepwise order of user tasks. Cognitive walkthroughs are expert inspections simulating user tasks, and conducting such stepwise user task tests, attempting to include user perspectives. The cognitive walkthrough may thus further increase user empathy and needs sensitivity. In our UD-Q assessment, we chose to use cognitive walkthroughs in order to test the compatibility of the assessment solutions with ATs. We chose to include walkthroughs of a screen reader (JAWS) and a 2-switch navigation solution. These were considered fitting edge-cases for representing Norwegian student in danger of exclusion, and our knowledge of preferred ATs.

We specified and tested the following core user tasks for digital assessment solutions in our walkthroughs: 1) logging in, 2) finding/navigating to the examination assignment, 3) reading the assignment, 4) responding to the assignment, 5) delivering the assignment, and 6) receiving assignment delivery confirmation.

Feature Analysis

The dependability on individual experts for which issues are identified is proved by research, e.g. trough imperfect between-subject correlations in experimental studies asking different experts to evaluate the same system using the same procedures and heuristics. Despite these challenges, expert inspections are considered efficient to uncover major usability flaws.

However, in order to overcome validity and reliability issues due to expert finding variations, some researchers recommend approaches that are more systematic. We chose to use Barbara Kitchenham's feature analysis approach to build such a systematic UD quality assessment method. The aim of the feature analysis approach is to support non-biased and objective expert inspection reviews (B. A. Kitchenham, 1996a). In addition to increase assessment consistency, the approach also contributes to transparency. Increased transparency of assessments in turn facilitates repeatability and comparability.

By using a feature analysis-based framework, we merged heuristic evaluations based on the seven principles for UD, cognitive walkthroughs using assistive technologies and WCAG accessibility evaluations, in a structured and transparent manner.

Study 5, Part 3: Results

1. UD-Q Expert Assessment

The UD-Q approach is visualized in Figure 31.

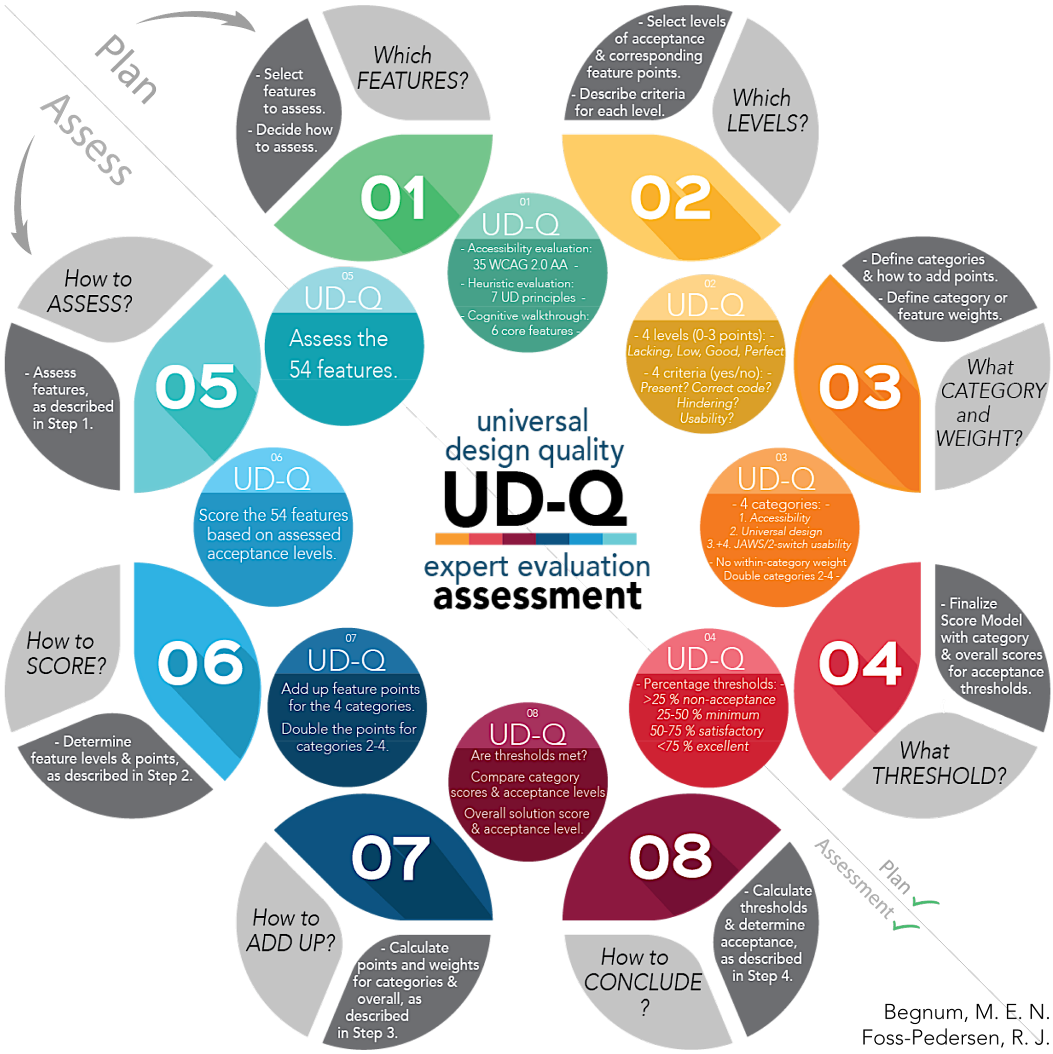


Figure 31: Universal Design Quality (UD-Q) Expert Evaluation Assessment

The **outer circle** of Figure 31 explains the generalized UD-Q assessment process, with 4 planning stages: *Which features? Which levels? What category and weight? What threshold?*, and 4 corresponding assessment stages: *How to assess? How to score? How to add up? How to conclude?*

The **inner circle** presents the specifics of each step for the prototyped UD-Q assessment method applied to the digital assessment solutions:

- In Step 1: *Which features?* we selected 35 WCAG guidelines, 7 UD principles and 6 core walkthrough tasks as features to assess, forming a total of 54 features.
- In Step 2: *Which levels?* we described 4 levels of acceptance, criteria for each level and corresponding feature point. Feature scoring descriptions are found in Paper 11, Table 1.
- In Step 3: *What category and weight?* we defined how features should be categorized into categories: 1) Accessibility, 2) Universal design and 3) Practical usage AT JAWS and 4)

Practical usage AT switch, and how feature points should be added up in each category. The score system we used for assessment solutions is presented in Paper 11, Table 2.

- In Step 4: *What threshold?* we specified 4 acceptance thresholds, based on the assessment solutions achieved percentage of overall possible scores – see Tables 3 and 4 in Paper 11.
- In Step 5: *How to assess?* we used the expert assessment approach outlined in V.B.1 above, mixing accessibility WCAG evaluation, holistic UD-principles evaluation and cognitive AT-compatibility walkthrough in the 6 core user tasks for digital assessment solutions.
- In Step 6: *How to score?* we scored each of the 54 features, assigning them 0, 1, 2 or 3 points based the criteria for each level and our expert evaluations against these criteria.
- In Step 7: *How to add up?* we added the points for each category, which can be found in Paper 11, in Table 8 (for 1. Accessibility), Table 9 (for 2. Universal design) and Tables 10 and 11 (for categories 3 and 4 Practical usage on AT compatibility). We also compared the categories and looked at the effect of practical usage category weights, which is overviewed in Paper 11, Table 7. We found that in both Inspera and WISEflow students using ATs such as screen reader and 2-switch solutions were **excluded** from core user tasks.
- In Step 8: *How to conclude?* we calculated the thresholds and thus determined acceptance levels, according to Step 4 specifications. Results are found in Paper 11, Table 6. We found both Inspera and WISEflow reached an overall satisfactory UD-Q threshold.

2. Revised & Improved UD Requirements Specification

Our second contribution was an improved set of requirements for UD for digital assessment solutions, in order to facilitate procurement. This contribution was focused on the second action point on specifications, on including explicit universal design, technical accessibility and usable accessibility requirements. The specification may also clarify further on the third action points to both HE institutions and digital assessment solution providers, on what UD responsibilities on technical accessibility and assistive technology (AT) compatibility might entail.

The improved specification was based on a review of the existing Uninett requirements and the results from the UD-Q expert reviews on current solutions. This requirement specification is presented in Paper 11: *Digital assessment in higher education: Promoting universal usability through requirements specification and universal design quality (UD-Q) reviews*. The original Uninett requirements on UD are found in Table 13. Here, the only mandatory requirements on UD were on securing English as a second language for international students. The only desired, not mandatory, requirement was on securing New Norwegian for students with that version of Norwegian as their first language. All accessibility requirements were unspecified, asking the solutions providers for descriptions. The only Uninett requirement related to accessibility and disabled users seemed to be descriptions of potential for improved accessibility (Descriptions 7 and 8), and descriptions of the relation to WCAG 2.0 level AA criteria and principles (Descriptions 9, 11, 12, 13). As such, we did not find Uninett-recommended requirements on UD sufficient.

Our revised requirements are found in Table 14. As the requirements span usability for non-disabled and for disabled students, we labeled them “universal usability” requirements. The revised set of UD requirements was considered more appropriate. They held basic needs considered relevant in relation to digital assessment solutions, based on our limited case study, and from which responsibilities of the solution providers could be discussed. Through the UD-Q approach, we showed how our improved UD requirements could be assessed in the UD-Q method framework. Thus, any increased specificity was matched with increased measurability.

The main aim of our revision was to improve flexibility and technical accessibility in the user interface and features. Our only change to mandatory requirements was adding New Norwegian to language specifications. Next, we extended the desired requirements to include the WCAG guidelines on AA-level, and as such envisioning that this would be a clear pass/fail feature test for all serious providers. We also clarified and moved up to desired features two points that were only asked for descriptions on in the Uninett specification, but that were technical possible to implement. However, the majority of the UD requirements proposed were mandating more detailed descriptions on technical accessibility issues, points 7-10 in Table 14. We also mandated a description of the providers UD strategy in point 6, and desired descriptions of methodological approaches to secure user-centeredness, QA and user-involved testing.

3. Procurement Process Model

The final Study 5 Part 3 contribution related to the overall procurement process, and we explored how an adjusted process model could facilitate UD. This work is presented in Paper 10: *Universell utforming og digital eksamen i UH-sektoren: 5 anbefalte tiltakspunkter* (Foss-Pedersen & Begnum, 2016), along with empirical findings and action points. As the article was written in Norwegian, to cater to the Norwegian HE sector, key content will be repeated here.

The advised process model for procurement is displayed in Figure 32. Phase 01 start with defining explicit requirements for the ICT-solution to be acquired (CSC number 5 and action point 2). For the case of digital assessment solutions, we here refer to our contribution on improving the requirements specification.

Figure 32: Process Model for Procuring Digital Solutions

As Figure 32 shows, a phase 02 is added to distinguish between the types of general, non-negotiable UD needs we proposed in the requirements specification, and specific UD/user needs relative to actual contexts of use. To establish needs to be developed, dialogue is needed between procurers and providers of the solution. User representatives could also be included.

Next, we recommended entering into an iterative and flexible process; in line with best practice processual CSC from Study 4 Part 3. These include merging UX and UD needs in in phase 02 and 03, and drawing on cross-disciplinary collaborations in phase 03.

Our advice is to place the responsibility for technical accessibility – and AT compatibility – on the solution providers. We recommend to suppliers that they test these accessibility aspects through UD checkpoints, code validations, UX inspections, accessibility evaluations, cognitive walkthrough and heuristic evaluations. For the latter three, we refer to our prototyped UD-Q assessment model and expert assessment approach.

The supplier QA on technical accessibility is illustrated in phase 04, where the design and implementation is recommended to immediate iterate back to phase 03 if failing to meet the agreed upon accessibility requirements. Only upon "passed" technical accessibility QA do we recommend institutions receive a delivery/version for usability and usable accessibility testing.

The process model further advises HE institutions to conduct the iterative evaluation of usable accessibility and practical usability in a phase 05. We recommend the HE institutions to do this "universal usability" evaluation through student involvement. Based on Study 4 success case characteristics, we advice best practice should be considered as user testing with real students, in actual contexts-of-use, including students with disabilities and students using ATs.

If the delivery fails the phase 05 universal usability evaluations, uncovered usability issues (including UD issues and AT issues) must be improved through re-iterating phase 03 on design and implementation. The improved design and implementation should then pass phase 04 again, and then phase 05, prior to completion.

When the delivery passes the phase 05 universal usability evaluations, it is ready for release (phase 06). At this point, the HE institution can also specify further needs, iterating back to phase 02.

The proposed process model for procurement thus encouraged the division of UD responsibilities as advised in action points 3 and 5, reminding the HE institutions that they are the legally responsible (and liable) for ensuring UD in real-life contexts of use.

Study 5, Part 3: Discussion

In Study 5 Part 2, our findings pointed to a set of action points. Instead of continuing to investigate other cases, and find out how generalizable the identified challenges were, we prioritized creating contributions to solve the already detected challenges. Three contributions were made to facilitate UD in procurement of ICT based on the case at hand. This section will briefly discuss these contributions.

UD-Q Expert Assessment Approach

We both modeled an approach to, and demonstrated the use of, UD-Q (Universal Design Quality) expert assessment. However, we do not consider it sufficiently applied to the problem and evaluated to reach the level of design-based-research. Instead, we describe it as a proof-of-concept application, where the generated research process has resulted in a modeled method.

Through the UD-Q reviews, we were able to **refute** the notion that technical accessibility is too costly or difficult to demand, and provide the HE sector with guidance on division of responsibilities; proposing solution providers (developers) should be responsible for implementing technical accessibility and assistive technology (AT) compatibility.

The **proof-of-concept** term implies we have showed the UD-Q approach is feasible to implement, and have demonstrated its practical potential, but recognize it may not be complete.

We encourage Inspera and WISEflow to utilize our UD-Q results as a benchmark on the accessibility in their system, to iteratively improve their solutions. We encourage the HE sector to ask (and pay) for UD-Q assessments of digital assessment solutions, and other ICT-solutions, in order to compare the accessibility of solutions.

Improved UD Requirements Proposed for Assessment Solutions

Uninett's requirement specification on UD for digital assessment solution procurement was lacking key accessibility aspects. Based on the UD-Q approach, we could prove our proposed set of improved and clearly specified **UD requirements** for digital assessment solutions are feasible.

The new requirements was recommended as a **minimum expectancy** on the UD quality in digital assessment solutions at the time of the study, in order to inspire and promote increased UD quality in these ICT-solutions. They are **not** considered particularly advanced or pioneering.

For example, the UD-Q cognitive walkthrough on practical usability indicate students using screen reader and 2-switch solutions are currently not able to conduct digital assessments, as they are likely excluded from core user tasks in the assessment solutions. Even so, we only included a mandatory description of 0,5 page on this specific issue. Instead, we focused on making sure the improved UD requirements matched current technical possibilities and UD knowledge held by the digital assessment solution providers (as reflected in our UD-Q benchmarks and case study).

As such, public procurers should feel free to ask for a higher UD standard than reflected in our minimum UD requirement proposition for digital assessment solutions.

As the contribution is only proposed, and not applied in procurement processes, we have limited information on how they would impact procurement projects. Our overall hope is that by making WCAG compliance explicitly asked for as a desired aspect, and mandating the provider to describe their UD strategy, the revised requirements specification could boost a UD focus.

Proposed Process Model for Assessment Solution Procurement

The process model is proposed as a contribution to facilitating UD practices in procurement of eLearning tools, help identify accessibility issues early and focus on usage value. It provides advice on how to structure UD focus, UD requirements, UD responsibilities, user focus, and the roles of the involved parties. Overall, the model visualizes a structured procurement process drawing on identified best practices for ensuring UD in ICT-solutions, and specific challenges identified in the case of HE ICT-procurement of digital assessment solutions.

The iterative approach with increased focus on UD, user needs, real-life usage, and user testing is believed help prevent a situation where a finished solution is proven illegal. A solution is illegal if not adhering to UD legislation, that states that from 1.1.2018 all new solutions in the HE sector supporting education, including major updates, must be accessible and usable for all. The process model explicitly proposes how to divide **UD responsibilities** between the different parties.

Assuming the findings on personal engagement, understanding and organizational awareness from Study 4 Part 2 remains present for the Study 5 case; increased user involvement in general, and inclusion of students with disabilities specifically, help communicate a real-life practical usability focus. As such, organizational **UD anchoring** may increase if using the process model.

In addition to UD focus, the process model facilitates a focus on **end-users** and the **end-value** of the procurement in real contextual use, including specifying and delivering (more) inclusive general solutions – potentially decreasing the need for costly individual facilitation processes.

By the explicit "send-backs" in phases 04 and 05, advice is given on how to ensure user needs are not ignored, in order to push features out to the institutions. In other words, the process model points to a hard "no" on in-accessible features. Although one could imagine some bugs and minor issues could be allowed in real-life scenarios, we did not model softer "yes/no" scenarios, e.g. depending on the threshold of acceptance.

A move from current practices to practices more aligned with the proposed model could thus help shift the current feature-heavy focus in the procurement to a focus on **digitalization value**.

Limitations of Study 5, Part 3

In the following are brief descriptions of contribution-specific limitations. Note that published papers also include thoughts on limitations and future research. As mentioned, the identified action point challenges were not proven generalizable to other cases. As the Norwegian HE sector has changed in recent years, there may be a need to explore their validity over time.

Further, we did not utilize participatory or co-creative methods in our generative research approaches, but recognize this could be a viable future step as part of a design-based research approach; applying the contributions in real life settings, to evaluate and adapt them further.

Finally, generative research efforts were not exhaustive with regards to the action points. The contributions can nonetheless be viewed as propositions on how to proceed on the action points –highlighting the potential for improved facilitating of UD.

Key Points on the Limitation of the UD-Q Approach

The UD-Q scoring model could have been stricter when measuring AT compatibility and practical usability to core features (Categories 3 and 4). It can be valuable to extend the number of AT compatibility and practical usability cognitive walkthrough categories for other user groups and ATs. As such, the UD-Q method could be improved upon related to emerging, popular and common ATs in different regions and over time, and updated knowledge on which student groups are in danger of exclusion. We encourage future studies to use fresh WebAIM surveys as a reference point for debating the inclusion of more or different screen readers in the UD-Q evaluation framework.

The approach was only prototyped for the case of digital assessment solutions, and the generalized model (outer circle steps) may or may not fit other specific cases where UD expert reviews are needed. Further studies are also needed to test the assumption of the approach fitting for UD evaluation across international assessment solutions, across contexts of use, and over time. There might also be contextual differences on what should be considered core features. We also propose the method should be tailored based on legislative updates (e.g. to WCAG 2.1).

Key Points on the Limitation of the UD Requirements

Our revised UD requirements are based on the level of UD quality and technical accessibility identified in the Study 5 reviewed digital assessment solutions. As new legislation impact the Norwegian HE sector, we might see an increase in the UD quality of ICT-solutions utilized by the sector. At this point, future revisions are needed to further raise the bar on UD requirements.

The requirements as-is are tailored to the case of digital assessment solution procurements, and should be altered as appropriate when used for other solutions.

Key Points on the Limitation of the Procurement Process Model

Finally, to an increased degree than the two other contributions, the model has not been evaluated; iteratively applied to the problem and adapted. Thus, its potential impact is still unknown, and the model could be considered a generated concept. The process model was designed for digital assessment solution procurement in particular, and we do not know if it suits ICT-procurement for the HER sector in general – or public procurement in other sectors.

We have not looked into how the model relates to more traditional software test procedures. Instead, we assumed unit testing would occur at them same time as code validations and UX inspection, while integration and system testing would occur in parallel with UD checkpoints and more extensive UD expert assessment. Thus, sometime during phase 04, or in preparation for phase 05, we hypothesized a pilot-test environment is set up. We imagined phase 05 as a type of acceptance testing on incremental deliveries. In terms of the type of testing, we envisioned phase 04 would include white box testing, in addition to black box, conducted by designers and developers, while Phase 05 would likely be black box testing only. Both phases were assumed to focus on functional or non-functional needs corresponding to the scope of the delivery.

Towards Study 6, Part 3

The next chapter will present work aimed at advancing UD in the service design discipline.

Study 6, Part 3: "UD in Service Design"

Study 6 Part 2 indicated there is very limited UD awareness in the service design (SD) discipline. In Study 6 Part 3, we thus aimed to contribute to advance UD in SD. Our view on "UD of ICT" was now from a practitioner's stance, highlighting the need for defining UD expertise into disciplines involved in the creation of ICT-solutions. Increasingly frequent, SD is one of the disciplines involved in digitalization projects and processes. The research question formulated was: "What should be regarded as "best practice" UD expertise in the SD discipline?"

Study 6, Part 3: Background

The background for Study 6 Part 3 is described in Paper 12: *Towards Inclusive Service Design in the Digital Society: Current Practices and Future Recommendations* (Bue & Begnum, 2018). Summarizing the results from Study 6 Part 2, the interviewed service designers expressed an interest for UD, but gave voice to a strong, concurrent uncertainty on how to integrate UD into the SD methodology. They affirmed a definition of UD for the SD discipline is lacking and needed, as was indicated by our literature search. Further, that "best practice" examples and specific methods for creating inclusive services were lacking, both from industry experience and educational programs. As such, we make the assumption that established UD competence is lacking in the SD discipline.

Service designers seemed to a) enjoy great methodological freedom, but possess little UD knowledge; b) care deeply about understanding target group needs, but not consider needs of edge-cases; c) take on responsibilities for maintaining holistic service value perspectives, but not feel responsible on ensuring inclusive services. We hypothesized key challenges are related to the lack of UD of SD awareness, knowledge, education, definition, methodology, legislation, and responsibility. This is our starting point for Study 6 Part 3.

We see that there is a need to simply propose a UD "best practice" for the SD discipline. We also see the need for a road map ahead to strengthen UD awareness in the field of SD.

Study 6, Part 3: Research Approach

A generative research approach was applied in Study 6 Part 3; drawing on the hypothesized key challenges from the explorative study in Study 6 Part 2.

In Part 3, we used our empirical insights to provide a basis towards advancing UD in SD. We focused on proposing solutions to that were believed a) have a high value/impact, or b) be easy to generate/implement.

We identified these "low-hanging fruit" through a SD technique called "idea portfolio" (Stickdorn, Hormess, Lawrence, & Schneider, 2018, pp. 139-141). In the "idea portfolio" technique, is to rank ideas or options. Options are ranked on a graph according to two variables.

Commonly used variables are “feasibility” and “impact”. Those options that score high on both axes, are “low hanging fruit”.

Figure 33: Idea portfolio - intervention selection

Value Ranking

From this selection technique, we evaluated all the UD of SD challenges as valuable to solve; awareness, knowledge, education, definition, methodology, legislation, and responsibility. However we did evaluate **defining** UD for SD, integrating UD into SD **methodology**, adding SD to UD **legislation** and spreading UD **knowledge** to service designers as particularly impactful first steps. It seemed less valuable to spread UD of SD knowledge, without first having a definition or methodology. It would be possible to spread UD awareness to service designers, however a more general awareness was regarded as less impactful and useful compared to also providing or proposing terms and methods for UD.

Feasability Ranking

On the feasibility variable, we were in a position to experiment with including UD into our new SD course, and thus including UD knowledge in **education** was feasible. Likewise, we could continue research efforts on **defining** UD for services and including UD into SD **methodology**.

However, it seemed hard to propose legislations at this stage. We believed both knowledge and legislation contributions needed to be based on more research, and that these of edge-case needs.

Combined Ranking

Based on the value and feasibility ranking, the two “lowest-hanging” fruits were, respectively, 1) **defining** UD for SD and 2) working on including UD in SD **methodology**.

Testbed for Generative Design Proposals

Through general UD awareness lectures, speeches and workshops with industry, as well as in the SD year 2 bachelors in IxD course to be run in the spring of 2019 for the first time, we created a testbed. We used this testbed for introducing our views on what UD in SD should entail, testing SD techniques attempting to facilitate UD and the inclusion of edge-case needs, and collecting UD of SD best-practice experiences and examples. As this iterative work is still in its early phase, we do not (yet) label this a design-based research methodology, but rather generative.

Study 6, Part 3: Results

Defining UD for the SD Discipline

Based on our related research on UD of ICT and our knowledge of the SD discipline, we felt it feasible to propose a definition of a Universally Designed service. Our view was such a contribution, if published and otherwise receiving positive industry feedback, would be a good basis for further work on creating UD awareness, UD legislation and UD methodology for SD. In Study 6 Part 3, we thus started by proposing a definition of a Universally Designed service.

A Universally Designed Service

We worked at formulating a definition that could be a foundation for generating a methodology for creating inclusive services. We wanted to create a definition that was measurable, or that we could work to generate methods for in order to make it feasible to measure UD in SD practice.

We proposed the following definition for whether a service is universal designed:

"A service is universally designed when its customer journey is usable to all people, to the greatest extent possible and without the need for adaptation or specialized design, by selecting suitable touchpoints"

This definition does not necessitate all touchpoints must to be available to all users (customers). Instead, all users must find accessible touchpoints and appropriate interactions throughout their service journeys. If all (potential) service users are able to do so, then all users are able to use the service as a whole, across its different phases.

In order to evaluate whether a service is Universally Designed or not against this definition, there was a need to develop a method for assessing the UD of touchpoints and the UD of phases, processes or steps in a customer journey or similar, for users representing the (target) population – and includes any users with edge-case needs in the society.

Feedback is tentatively positive. The proposed UD of service definition was published in it's first version in Paper 12 (Bue & Begnum, 2018), and presented at the NordDesign 2018 conference. It was further presented in its second version at a Girl Geek Dinner Oslo (GGDO) speech, November 14th 2018 (Miriam E. Nes Begnum & Lintho Bue, 2018). Both academics and industry professionals showed an interesting in learning more about our efforts on UD of SD, and proposed minor changes to the phrasing of the definition that we accommodated.

Finally, the definition was published at the 3min industry-blog, as an invited guest blogger (Miriam Eileen Nes Begnum, 2018). 3min is managed by Making Waves, and focused on societal digitalization and technology, design and media innovations. After 3 months, the blog-post had had 375 views, 161 reads (43 %), 16 claps (likes), and 9 fans.

Inclusive Persona Approach

Since the general UD knowledge and awareness in our Study 6 sample was quite low, we wanted to introduce UD perspectives by re-designing existing methods.

The persona is one of the first specific techniques used in a SD process, and is extremely common and widely used across UX and UCD-approaches (Stickdorn, Hormess, et al., 2018, pp. 69-71). We hypothesized that direct contact with edge-cases; marginalized and disabled users, would significantly push the service designer towards creating inclusive services and increase UD awareness. In addition, Study 4 identified an early focus on users with disabilities as a characteristic of UD successful ICT-projects. For these reasons, the persona was the first approach we looked at making more inclusive.

The Persona Method

A persona is meant to present an archetype of a group of people, typically your target users (customers), through an exemplified fictional person. This fictional person is specific, and usually built on insights from a small number of real persons, for example 2 to 4 persons.

A common starting point for personas is based on assumptions. In SD, such assumption-based personas drafts are commonly co-created in workshops including stakeholders. These drafts can both be based on and enriched by marked research data, for example on demographics and economics.

However, assumption-based personas are susceptible to be stereotypical and caricature-like. Thus, empirical insights from real persons are needed to validate you will actually find these types of users in real life. Empirical insights ensure personas are not “idealized users”, and add rich descriptions. Empirical insights are typically gathered through interviews (talking to your users).

If a target user group is varied, one may choose to develop a range of Personas, which together overviews and exemplifies the key users. Stickdorn, Hormess, et al. (2018) call this “core personas”, and advices creating 3-7 such personas to represent a business’ main marked segment.

Personas as used company-wide, and typically updated every 2-3 years (but not changed – unless your marked segment/target users change). Employees familiarize themselves with the personas, and keep them in mind when planning, designing, developing and marketing solutions.

Integrating Edge-Case Needs

We wanted to generate a persona-development approach that integrated UD perspectives. Three service designers from Part 2 pointed out checklist tools or method cards could aid in remembering to include edge-case needs, and know which specific edge cases to focus on.

Our first idea was to develop a range of personas, representing users with edge-case needs. In order to capture common, but also commonly neglected, challenges in the Norwegian population (Slettemeås, 2014), we suggested adding personas for:

1) A user with visual impairments being completely blind and having a guide dog,
2) A user with motor impairments using a wheelchair,
3) A user with visual impairments being partially sighted,
4) An elderly user with somewhat reduced cognition, vision, fine motor skills, strength, balance – using a walking aide, and hearing – using a hearing aide,
5) A non-native Norwegian speaker such as a first-generation non-western immigrant, who not at all uses digital touchpoints.
6) A user suffering from fatigue (e.g. ME/CFS/MS or due to an illness) or ASD,
7) A child with ADHD, or a parent with a child with ADHD also pushing a stroller (with a toddler in need of a diaper change and breast feeding).
8) A young user with dyslexia,
9) A third-semester pregnant woman or a person on crutches.

However, the number of personas needed for a service developer would be too extensive using this approach. Instead, we suggested adding edge-case needs to "core personas". However, a challenge is that archetype users available for empirical insights may not have any edge-case needs. Likewise, available edge-case users may not fall into the target user group.

Inclusive Core-Personas

To solve the above-described issues, we proposed an approach for integrating edge-case needs into a persona. We merged archetypes for target users are with archetypes for edge-case users, by:

1) Creating initial core personas as usual, based on real persons from your target group.
2) Iteratively or in parallel, you add on to your core personas one of the edge-cases above.
   - In this second step, you use the same approach of assumption-based, research-based and empirical-based insights to capture an archetype of a group of edge-case people.
   - The 9-point edge-cases list above is presented in a proposed order of importance – but may be adjusted or added on to based on the service and target group at hand.

The approach was introduced and tested in the new SD course, and seemed useful. All students had previous training with creating and using personas, thus could compare the inclusive core-persona approach with the traditional persona method. Five groups applied the approach, while one group identified two different participants with the desired edge-case and target representativeness and could thus build their personas directly. The other five groups merged archetypes for target and edge-case user representativeness using the above approach. Four of the five groups did this without issues. One group reported increased uncertainty about assumptions made compared to personas derived from non-merged insights. Three of these four issue-free groups had an participant each with the desired edge-case *and* target representativeness; this may have aided their confidence when merging additional insights and added descriptions.

Inclusive Persona Canvas: In the SD class, some of the groups utilized the "Personas Canvas" from DesignABetterBusiness, see Figure 34. We discovered health issues had no natural place in the original canvas map, We thus did minor revisions to original Persona Canvas, mainly re-phrasing text to be more fitting for mapping personas with edge-case needs, see Figure 35.

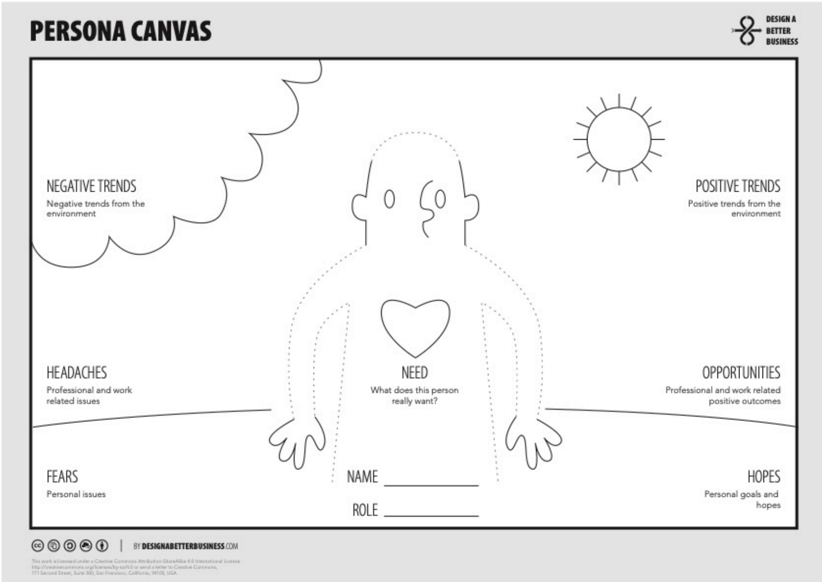


Figure 34: Personas Canvas from DesignABetterBusiness

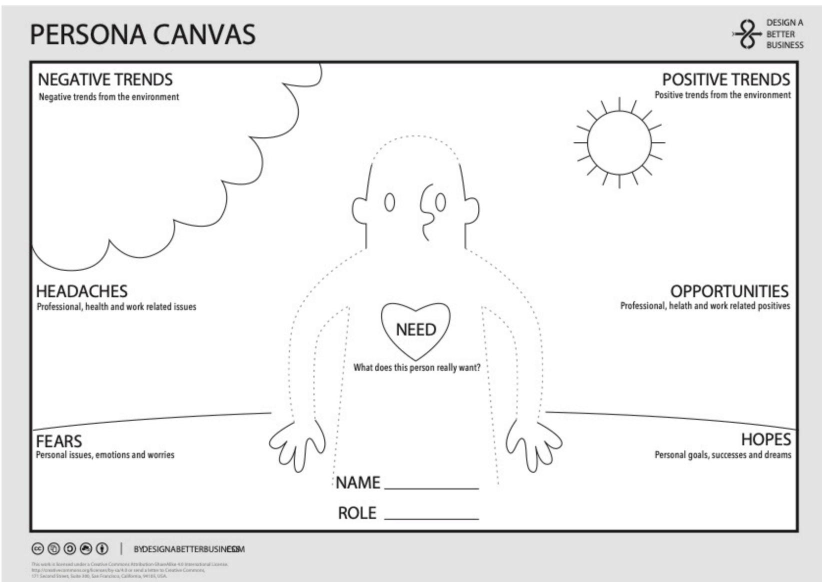


Figure 35: Inclusive Persona Canvas, modified by Begnum, based on DesignABetterBusiness

The DesignABetterBusiness toolbox group has confirmed that under the CC BY-SA 4.0 creative commons license, it is possible to create derived works from the canvases. The derived work would also need to be published under the same license (CC-BY-SA 4.0), and original creators (DesignABetterBusiness) must be credited.

Empathic Service Safari Approach

Self-ethnographic approaches are also widespread in SD; and are typically undertaken in the initial explorative phase. Common self-ethnographic approaches are auto-ethnography and online ethnography. Online ethnography refers to investigations into how people interact online, and is also known as virtual or cyber ethnography (Stickdorn, Hormess, et al., 2018, pp. 24-25). Auto-ethnography encompass methods supporting self-exploration and self-documentation a particular experience (Stickdorn, Hormess, et al., 2018, pp. 20-23). We looked into how to make the auto-ethnographic approach more inclusive.

Auto-Ethnograpic Approaches

There are several common variants of auto-ethnography in SD, such as mystery working (disguised as an employee for a limited time), mystery shopping (acting as customers, often evaluative), traditional service safari (immersing oneself in an experience – often combined with ethnographic methods), explorative service safari (collecting good and bad service experiences – often from competitors) and diary studies (longitudinal studies of self-experiences).

We wanted to facilitate service designers in gathering insights into how edge-case users would experience services and environments through auto-ethnographic SD methods. Among the auto-ethnographic approaches, we selected the service safari approaches for this purpose, as these are aimed at creating insights through contextual bottom-up experiences.

Empathic Modeling

Through empathic modeling, you try to experience services the way another individual would. Empathic modeling is commonly used in inclusive design approaches for user research insights, in design, prototyping and evaluation, and a complement to seeking out and getting to know edge case ("extreme") users (McDonagh & Formosa, 2011). Within inclusive design, you attempt to gather first-hand insights into what edge case users are actually going through.

In order to do this, a range of techniques can be applied. It is common to use empathy-building artifacts ("empathy artifact" – such as vision-reducing or motor-impairing), assistive technologies (AT) or theatrical techniques (such as role-play) (Battarbee, Suri, & Howard, 2015). Such simulations and embodiments of disabilities, injuries, limitation or pains can augment the empathy-building experience, including triggering emotions (fear, isolation, insecurities, shame, gratitude etc.) and responses from the social environment.

Empathic Service Safaris

We wanted to make the service safaris more focused on including the needs of edge-case persons, and increase the sensitivity and ability of the service designers to gather insights on how edge-case users would experience the services. Thus, we added empathic modeling as a technique for self-experiencing edge-case needs to the service safaris. We could not find any documentation on the integration of empathic modeling and self-ethnography as used in SD. We thus propose labeling and presenting this integration as a new method: "Empathic Service Safari".

In our empathic service design method, we simulated and embodied four disabilities: paraplegia, walking impairment, blindness and low vision. We journeyed to two different museums for our auto-ethnography. In the first museum (National Museum – Architecture), we did an open and exploratory visit/safari. In the second museum (Astrup Fearnley Museum), we did a more structured and traditional service safari.

A first group simulated and embodied the disability *paraplegia*, using a wheelchair throughout the service safaris. Their edge case user group was persons needing to use a wheelchair due to paraplegia or other muscular or neurological disabilities. The empathic service safari simulated a disability that could e.g. be caused by a spinal cord injury. Their personas were based on contact with target users 18-25 years with Cerebral Palsy (CP). In the empathic service safari they noted they could experience parts of what a person with CP would, but not e.g. spasticity and speech impairments and related stigmas. This group in particular expressed emotions related to irritation, dissatisfaction and frustrations, and the need for extra time and extensive aid.

A second and third group simulated and embodied visual impairments, using a blind fold/closed eyes and Cambridge simulation glasses respectively. Their edge case user groups were 18-25 year olds with severe visual impairments. Their personas reflected contact with non-target users with very low vision and visual impairments, such as tunnel vision. In the empathic service safaris they did not consistently use the empathic modeling, thus their insights were not as immersive and empathic as they could have been, and more on the practical level. The groups expressed boredom and inaccessibility, but no feelings. Our observation was they "cheated" in both service safaris, testing short-time aspects, but not immersing themselves in the empathic experience.

However, the third group also conducted two other auto-ethnographies utilizing empathic modeling. One was by visiting The Norwegian Association of the Blind and Partially Sighted (NABP), where they were given a range of glasses for empathic modeling, simulating different types of visual impairments (such as cataracts, tunnel vision etc.) They then walked around wearing the impairing glasses (empathic modeling) while being trained in key mobility and navigation issues, experiencing the effect of tactile surface guiding lines and warning studs, banisters, door designs, signs and way-finding design, braille, color contrast and contrasting stripes on walls, the ground, external corners of walls and stairs etc. This empathic-modeled auto-ethnographies training were reported as extremely educational and insightful. The student group further conducted a final more immersive and exploratory auto-ethnography/service safari. Here, they navigated the university campus - walking down stairs and moving between campus buildings while using the Cambridge glasses, simulating a moderate visual impairment (0.74 logMAR; well below the Snellen visus 6/18 (0,33) 0.5 logMAR ICD-10 benchmark). They stated using the empathic modeling was highly effective for increasing their in-depth understanding of the effect of functional facilitation – but not contributing significantly to emotional (non-functional) insights.

A forth group simulated and embodied a temporary or permanent walking impairment requiring the use of crutches as a walking aid. Their edge case user group was persons 18-25 years old with injuries or diseases causing walking impairments. Their personas reflected contact with both persons from a wide age range using crutches periodically and contextually due to Multiple Sclerosis (MS) symptoms, including foot drop and pain. During and after the immersive traditional empathic service safari, the group expressed tiredness, muscle strain, and discomfort, frustrations and as well as difficulties maintaining focus and engaged due to fatigue, and relief when finding somewhere to rest.

The approach was successfully utilized in the new SD course. Overall, three of the four groups that attempted the empathic service design (groups one, three and four) were successful in their insight outcome; clearly empathizing with edge-case users during their self-ethnographic experiences. This was the case not only for the group member that embodied the empathic modeling over time during the immersive, traditional service safari – but also for the team members having to aid, support, and observe their peer during this safari. The groups showed sensitivity to edge-case needs on both a functional and an emotional level, but perhaps more on functional (practical) aspects than on emotional. Their empathic insights were documented and utilized in the following months, as the groups synthesized insights, specified service value propositions, ideated and selected potential solutions, and prototyped service innovations.

Touchpoint Inclusiveness Evaluation

Another SD method is the touchpoint matrix. All the participants interviewed in Study 6 Part 2 used some approach to map out the service, with all the touchpoints.

The Touchpoint Matrix

The touchpoints matrix overviews the interactions between customers and service mediated by channels, such as social media channels, telecom channels, web channels and physical channels. The method is credited to Gianluca Brugnoli. His matrix lists service touchpoints vertically and user intentions horizontally, as shown in Figure 36.

During their service experience journey, the business wants all customers to experience easy-to-use touchpoints, of consistent quality and “feel”. This means designing both digital and physical (analogue) interactions, experienced through time and in different phases, contexts and places, fitting our users needs. Further, to ensure that the UX across touchpoints is consistent and adequately high. As each touchpoint is an added cost for the service provider, any excessive channels (not necessary for a “par” or “above-par” holistic service experience) might be cut. At the same time, UN recommends multiple channels, in order to provide users with the freedom of choice, and in order to facilitate more inclusive services (Brugnoli, 2009).

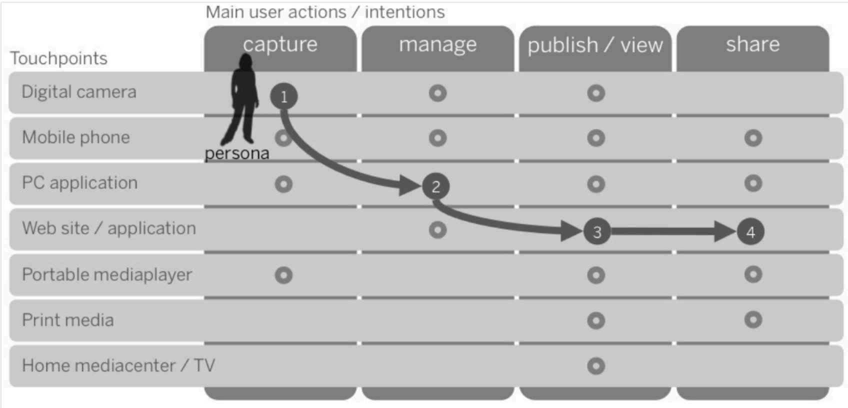


Figure 36: The Touchpoint Matrix as designed by Brugnoli (2009)

Including UD Assessment of Touchpoint

Study 6 Part 2 indicated there is a lack of checkpoints that address different edge case and evaluates the service accordingly. Today, the only touchpoints in which accessibility is ensured is the digital touchpoints (such as mobile apps, web-forms and websites). We thus believed a method was needed to facilitate service designers in assessing UD across all touchpoints. We decided to re-design the Touchpoint Matrix to do so.

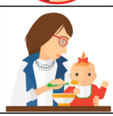
Touchpoint:	Brev	Epost	SMS	Telefon	F2F i Skranke på HS	Nettside	Brosjyrer	Facebook	F2F Konsultasjon på HS	F2F i Hjemmebesøk	
											
											
											
											
											
											

Figure 37: Touchpoint UD Assessment Matrix, designed by Begnum for GGDO Workshop

Touchpoint UD Matrix

In the re-designed touchpoint matrix, we listed the touchpoints along the horizontal axis, and the edge case personas across the vertical axis, as visualized in Figure 37. The methodological approach to UD assessment is very simple: check if the touchpoints are accessible and easy-to use for all users, and identify any pain-points and usability issues.

The approach was successfully piloted in a Girl Geek Dinner workshop. We used expert inspection and empathetic modeling to evaluate the touchpoints across a child healthcare service from Ullensaker municipality. We supplied the workshop participants with actual information pamphlets, letters of appointment notice, child health card, and other service artifacts. We further supplied them with images from the service, such as picture of rooms and spaces, toilets etc.

To support the expert inspection, we provided the workshop participants with the Irish NDA Universal Design Public Service Toolkit guidelines on written, verbal and digital customer communication (CEUD, 2017).

To support the empathic modeling to assess whether existing touchpoints were usable, we also supplied information on wheelchair needs and Cambridge Simulation glasses. We asked them to focus on assessing the touchpoints for parents with low vision and blindness, using a wheelchair, being pregnant with a second child and suffering from pelvis pain and back pain, for a first-generation immigrant parent and for a non-digital parent (see Figure 37 and Figure 38).

Workshop participants used different ways to 'score' the touchpoints. Some used a scale to rate the touchpoints, and others simply ticked ok/not ok. If touchpoints were inaccessible, we encouraged the participants to add textual descriptions explaining why.

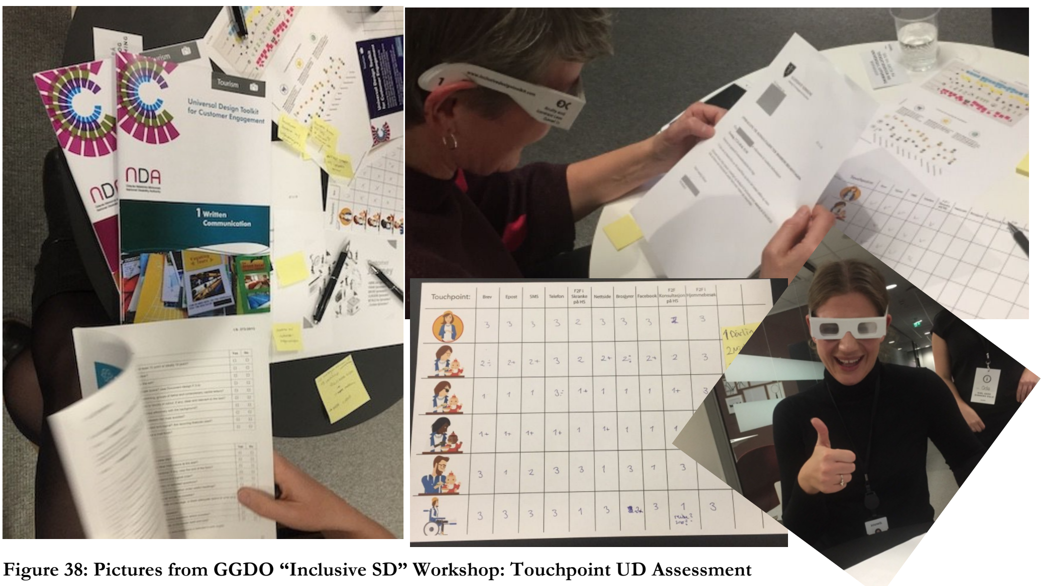


Figure 38: Pictures from GGDO "Inclusive SD" Workshop: Touchpoint UD Assessment

Service UD Evaluation

Finally, we looked into how to enable service designers to evaluate UD of the service as a whole. Here, our proposed definition guided us. Again, we wanted to attach the evaluation of UD to an established service evaluation method.

The Service Blueprint

We considered using service blueprints, as this is a common way of specifying and prototyping new services. Thus, we figured the specification phase would be a good point for UD evaluation, as a quality assurance checkpoint in the design process. However, although the service blueprint maps interactions between customer and service in a comprehensive manner, the touchpoints available to the customer are not so clearly visualized.

The service blueprint is a form of system mapping, where a service is described visually. Figure 39 shows a service blueprint example, from Stickdorn, Lawrence, et al. (2018, p. 55). At the top of the blueprint are the customers' steps, phases or actions taken. Sometimes, a lane of "physical evidences" is also added. Physical evidences (or service evidences) refer to physical or digital evidences of a service. Stickdorn, Lawrence, et al. (2018, pp. 74-75) exemplify the folded end of the toilet papers as evidence of room cleaning services. Common physical evidences are emails, SMSs, brochures, products, websites, letters, tickets, signs, bills, giveaways and receipts.

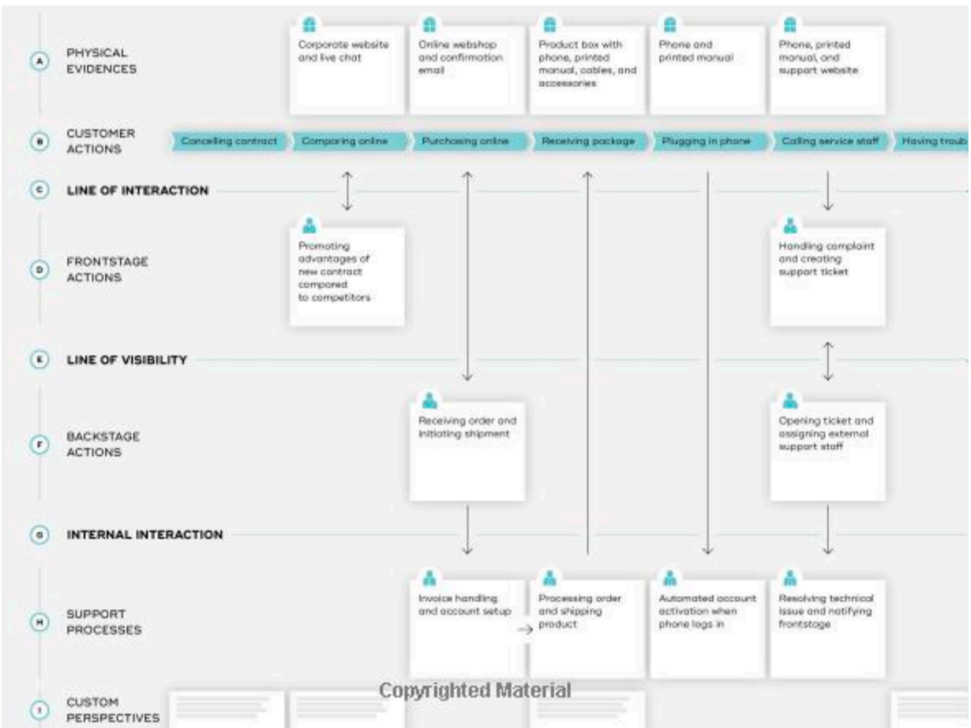


Figure 39: Service Blueprint example, from Stickdorn, Lawrence, et al. (2018, p. 55)

Underneath the customers' actions is the line of interaction, followed by a lane specifying the service frontline customer interactions. Beyond this, the line of visibility is drawn. We are now mapping the parts of the service that is invisible to the customer. Here, you can add backstage employee actions, front-end and back-end activities, technical systems, suppliers and processes.

The Costumer Journey

One of the most common SD methods is mapping the customer journey, also called the user journey. The mapping follows a specific user's 'journey' through a service, in order to reach a valuable service end-goal. We found the journey mapping a fitting tool for UD service evaluation. Journey mapping is more human-centered compared to the business-focus of blueprints.

The journey is typically illustrated as a story of a specific actor using a service as a sequence of steps. This specific actor is usually specified as a persona. The most common is the high-level journey map, which shows the entire end-to-end experience. However, you can also "zoom in" and create detailed journey map showing only minutes (Stickdorn, Hormess, et al., 2018, p. 73).

In addition to its basic structure of steps and stages, journey maps can be enriched with various additional lanes – such as a scenario with specific journey goals, touchpoints available and utilized, a UX lane with customer satisfaction ratings, pictures, key moment snapshots, customer quotes and key insights. The UX lane, also called the "emotional journey", provides specific insights into how the persona experiences a service at key moments, during each phase or in relation to each touchpoint. This lane typically highlight potential "low" and "high" points during the service experience. The "low" UX points are called "pain-points". The "high" UX points are called "gain-points".

The customer journey is focused on mapping the human experience. Still, touchpoints are included. In fact, a variant of journey mapping is the product-centered journey, which only include touchpoints (Stickdorn, Lawrence, et al., 2018, pp. 50-51).

The Service Walkthrough

One of the service designers' goals is to design a service experience to be satisfactory ("par") or positive ("above-par"). The service walkthrough supports the designer in considering this, and is an empathic and evaluating method.

The service walkthrough is in essence an enactment of the service journey. Stickdorn, Hormess, et al. (2018, p. 169) describe the walkthrough as an interactive mini-theater play to simulate end-to-end customer experiences. Props are used whenever necessary to facilitate the enactment, and service roles can be assigned if a team is doing the walkthrough.

A service walkthrough can be conducted in a variety of ways. The simplest is perhaps the desktop walkthrough, were the designers remain at "their desk" (Stickdorn, Hormess, et al., 2018, p. 169).

The service walkthrough can also draw on more theatrical and exploratory full-body techniques, such as investigative rehearsal. Investigative rehearsal is similar to bodystorming in that it is a full-body prototyping technique. When using these techniques the walkthrough move away from the desk in order to enact the service in settings reflecting "scenes" from the user journey.

In addition to the extent of role-play, the service designer can choose whether to rely on a journey mapping (which is the common approach), or a system mapping approach (such as a service blueprint), or any mixed mapping technique (that may or may not yet exist). Both system maps and journey maps can be used both to visualize existing experiences (current-state journey maps) and to specify new experiences that do not yet exist (future-state journey maps).

Regardless of the type of walkthrough, the technique simulate the service in order to formatively evaluate it (Blomkvist & Arvola, 2014, p. 171) The deliverable is not a prototype, but the holistic experience feedback and any identified critical steps and problem areas (Stickdorn, Hormess, et al., 2018).

We found the service walkthrough fitting for UD evaluation for the following reasons:

- A service walkthrough is a holistic and formative approach to service evaluation.
- The walkthrough can support human- and UX-focused evaluations as well as process- and business-focused evaluations.
- In the walkthrough, the service designer can choose whether to be more analytic and do a desktop walkthrough, or be more playful and use theatre-like settings, or do a mixture.
- Props can be generated (such as lego, role-play, cardboard and other prototypes) or be brought from existing services (e.g. touchpoints such as letters, emails, signs, apps, etc.).
- The walkthrough facilitates UD evaluation of both current-state and future-state services.
- In the service walkthrough, it is easy to include empathic design techniques.

Blomkvist and Arvola (2014) describe the method as a blend of pluralistic walkthrough, experience prototyping, and bodystorming. We argue that empathic modeling and empathic design should be part of this blend.

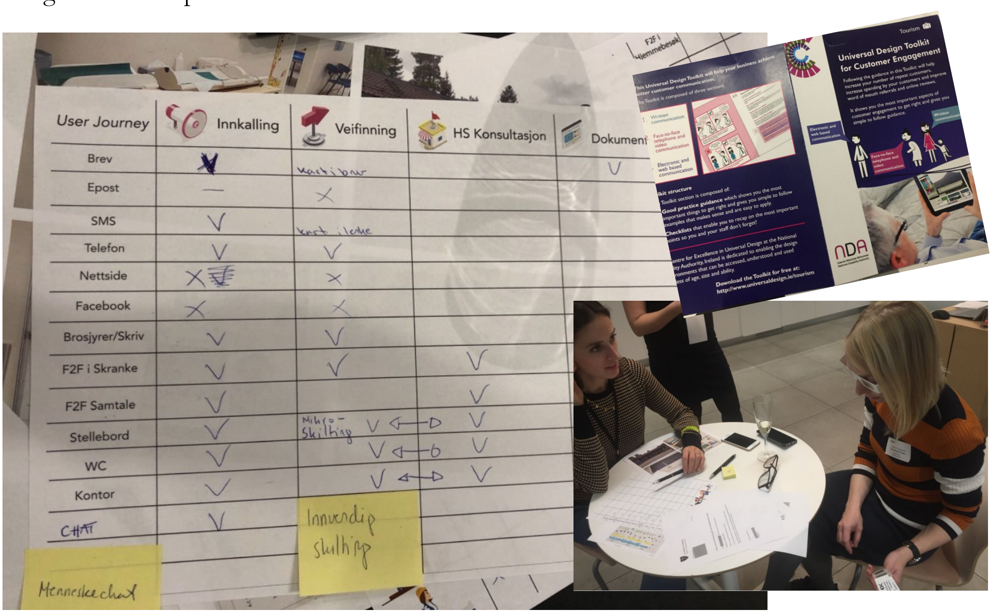


Figure 40: Picture from GGDO Inclusive SD Workshop – Service UD Evaluation

Service UD Evaluation

Both journey maps and system maps can be designed to include touchpoints – in fact this is very common in both service-mapping approaches. Therefore, we could generate a walkthrough version for holistic UD evaluation a service based on matching touchpoint inclusiveness to a customer journey. Our generated service walkthrough approach was piloted in the GGDO workshop, right after the UD Touchpoint Assessment Matrix.

In our GGDO workshop, we chose to conduct a desktop walkthrough. In the desktop walkthrough, we cross-tabulated service phases and touchpoints in a matrix (see Figure 41). We used inclusive core-personas and existing physical evidence suitable for a desk walkthrough as props. All core-personas were edge-case users.

User Journey	Innkalling	Veifinning	HS Konsultasjon	Dokumentasjon
Brev				
Epost				
SMS				
Telefon				
Nettside				
Facebook				
Brosjyrer/Skriv				
F2F i Skranke				
F2F Samtale				
Stellebord				
WC				
Kontor				

Figure 41: Service UD Evaluation, matrix designed by Begnum for GGDO workshop

We conducted the service walkthrough by evaluating a specific personas' journey through the service – thus in line with the customer journey walkthrough approach. We used one matrix for **each** of the core-personas.

For each phase in the service journey, we evaluated whether a persona could find at least one accessible touchpoint, based on the Touchpoint UD Assessment Matrix. If a persona could not, we knew we had to add or re-design a touchpoint in this phase. Alternatively, we could propose new touchpoints – even if this would add service cost.

When all personas had accessible touchpoints in all phases, the service was regarded as Universally Designed. The UD-evaluation walkthrough thus matches the proposed definition – enabling the service designers to actually validate the UD of existing or new service designs.

The GGDO workshop participants gave us very positive feedback on this evaluative SD method.

Figure 42: Sign-language applause from the GGDO Inclusive SD Workshop participants

Study 6, Part 3: Discussion

In our opinion, it does not make much sense to ensure high UD quality in digital service touchpoints if the edge-case users cannot use the service overall. For services, the current focus is on ensuring accessibility and usability to digital touchpoints only, even if the importance of promoting UD on a societal level is clearly stated in current legislation. Our viewpoint was that ensuring everyone can use services (and in particular public services) is becoming a critical socioeconomic, democratic right-based, and ethical quality of life-issue. Still, no one has the responsibility to ensure UD in public cross-channel services, and there is no UD expertise taught to or utilized by service designers.

Our findings from Study 6 Part 2 indicated six key challenges. Based on an impact versus feasibility analysis (called "idea portfolio"), we chose to focus on two of these: Creating a **definition** for UD of SD, and integrate UD into SD **methodology**. According to Study 6 Part 2, the SD discipline has neither a definition of what UD of a service entails, nor any methodological approaches or techniques to support UD perspectives during the SD process.

This generative design work was communicated to industry through presentations and a GGDO workshop, and to the scientific community through writing and presenting research paper(s).

The generative design work was also done within the new bachelor course on SD, where the inclusive methods were utilized in order to develop museum experiences for a wider audience of young visitors. As a bonus, a third key challenges were thus simultaneously researched; how to include UD knowledge in SD **education**.

The Definition

We wanted to embed UD expertise within SD in line with the practitioners' definition of "UD of ICT". The practitioner's perspective view fits with our empirical evidence on the overlap between UD, UCD and UX-work and how these should be integrated, and with our identified CSC.

We thus proposed a definition using SD lingo. We proposed that in order to claim a service is Universally Designed, a service provider must simply make sure that *all* potential users can use at least *one* touchpoint at any stage of the user journey:

"A service is Universally Designed when its customer journey is usable to all people, to the greatest extent possible and without the need for adaptation or specialized design, by selecting suitable touchpoints"

Simply put, we proposed a Universally Designed service as being a service where all potential users can use the service. This definition does not necessitate all touchpoints must to be available to all users (customers). Instead, all users must find accessible touchpoints and appropriate interactions throughout their service journeys.

We propose adding our UD of services definition to accessibility legislation; moving beyond the sole focus on accessibility of digital touchpoints, and towards real-life usability of services. If added to the Norwegian legislation in the same manner as for ICT solutions, it would likely be limited to the key customer journeys offered by a service provider.

The Methodology

If our UD of service proposition is legalized, this means the service providers should have a technique for validating whether existing or new service designs are inclusive and legal according to the definition of a Universally Designed service. We thus moved on to developing methodology to facilitate UD design and evaluation of services.

To make sure we embed UD expertise within the SD profession, we proposed to alter the utilization of established SD methods. Study 6 Part 2 findings indicated service designers have great methodological freedom as well as positive attitudes towards UD. The current SD approach is highly user centered, and therefore we did not view established SD methodology as problematic for integrating UD into SD.

By altering widespread and common SD methods to facilitate UD and include edge-case perspectives, we could build upon existing knowledge on what works within the SD discipline. We thus selected established SD methods worked on merged them with techniques from UD methodology. We considered this a sneaky way of establishing UD as an easily attained add-on competence within SD.

From this work, we generated 4 new SD methods:

Inclusive Core Personas: We have piloted an approach to integrating edge-case needs into core personas. Thus, the SD project can use core personas as usual and at the same time increase their direct user contact with and understanding of edge-case users.

UD Touchpoint Matrix: Using a matrix cross-tabulating x-axis touchpoints and service-interactions to y-axis inclusive core personas, the SD project is able to evaluate the accessibility of touchpoints for each persona. They may also use the method to iteratively improve touchpoints, through added or re-designed service interaction alternatives during the assessment.

Empathic Service Safari: Through merging service safari with empathic modeling, service designers are encouraged to bodily and emotionally experience edge-case needs in an immersive and contextual manner.

Service UD Evaluation: This walkthrough enables the service designer to assess whether all users are available to use at least one touchpoint in each service phase. Through empathic modeling, inclusive core personas and the UD Touchpoint Assessment Matrix, the evaluation approach is flexible and relatively easy to use. The walkthrough cater to a wide spectrum of SD projects, both those focused on marketing (the business process of creating relationships with and satisfying customers) and on UX (the design process of enhancing user satisfaction by improving the usability, accessibility, and pleasure).

The Effect

Through our Study 6 contributions, service designers now have a relatively easy approach to conducting holistic UD valuation of a service, and a concrete definition of what a Universally Designed service entails. We have also generated UD of SD evaluation techniques corresponding to the definition.

Further, we have merged empathic modeling from inclusive design approaches into some of the commonly used SD techniques for research, design and evaluation.

These contributions enable service designers to complete (and take on the responsibility for) overall UD service evaluations. Further, the new and inclusive SD methodology includes UD perspectives from the start of a SD project, thus avoiding risk for late and expensive re-design in order to fulfill an envisioned legislation of UD in public services.

Freedom to Choose Inclusiveness

Current methodological SD practice is flexible; with a freedom to choose techniques, the designer believes the most fitting. Our impression is the service designers themselves choose which methods to use, and so that creating and promoting more methods that are inclusive could have bottom-up impacts. We thus believe the generated UD of SD methods have the potential to impact the service designers' degree of contact and empathy with edge-case users, which we considered likely to significantly push service designers towards wanting to create inclusive services – and contribute to creating grass-root movements for UD promotion within SD.

Ability to Take on Responsibility

Using the inclusive methodology, we believe that the service designer could have the overall responsibility for UD of services, as the service designers would have the insight and methods to understand all touchpoints and their relations to service-user interaction. Service designers do not necessarily need to have the direct responsibility for all touchpoints regarding UD, but could hold an overall UD responsibility when creating new service development or re-designing services.

UN discusses the need to align, mix and integrate service channels (Mebuke, 2015), including offline service channels. Usability is viewed as critical for usage uptake; services must be relevant, inclusive, easy to use, easy to find and available through multi-channels with mobile becoming increasingly important. Through inclusive service design techniques, service designers can gain the insight needed to determine which channels are necessary, unnecessary, wonderful, or in need of improvement—both for edge-case as well as mainstream users.

We hypothesize that the service designer, with her/his holistic and cross-sector service viewpoint, would be a good candidate for taking on the responsibility of evaluating the overall UD of a service. When applied by service designers in industry, the methodology could be an important first step towards empowering service designers to design and consider the level of UD needed to offer inclusive services.

Limitations of Study 6 Part 3

So far, no surveyed service design (SD) methodology mentions UD or accessibility aspects, nor reflects on the integration, mixing or aligning of services in service chains with the aim of UD. In particular, we see a need to further investigate how UD is handled in service chains spanning several touch-points and sectors, as this is currently not specified in ICT of UD regulations.

In real-life, more direct feedback and insights from actual users is also likely to be incorporated in the methodology; such as contacting edge-case users and user organizations to better understand pain-points for personas creation, identify edge-case user groups to involve in design workshops, and involve edge-case end-users in testing services to quality assure the UD service evaluation walkthrough results. Though the Service UD Evaluation Walkthrough was successful as an expert inspection desktop walkthrough with empathic modeling, we envision the Service UD Evaluation Walkthrough could also be very well suited for co-creative and pluralistic workshop evaluations conducted with real edge-case users.

It should be noted that the level of SD expertise in the GGDO workshop varied. Both the workshop and the class methodology piloting were thus done by samples in which the SD expertise was quite low. Piloting has also been limited, and the Study 6 contributions need a more robust industry testing in the future to ensure their usefulness. Future work will likely push the research methodology towards design-based research approach.

Towards Study 7, Part 3

The next chapter turns to another UX discipline, interaction design, and our work to advance UD in this discipline.

Study 7, Part 3: “UD in IxD Education”

In Part 3, UD is seen as a professional add-on expertise, which should be embedded into professional activities. Promoting “UD of ICT” thus entails promoting UD in disciplines involved in the creation of ICT-solutions. By exploring current educational content in IxD HE programs, Study 7 Part 2 highlighted the very limited UD focus in Norwegian HE IxD educational programs. Thus, in Study 7 Part 3 we aimed to promote UD considerations for IxD. The research question formulated was: “What should be regarded as “best practice” UD expertise in the IxD discipline?”

Study 7, Part 3: Background

Disciplines involved in ICT creation varies based on the solution being developed, but typically span development, visual design, content design, management, (more and more frequently) service design, and interaction design (IxD). IxD is a discipline focused on how to design users’ experiences when interacting with various products, over time and in their context of use.

As such, UD in the context of IxD is viewed as focused on how to make sure user interactions with various products offer positive experiences to as many users as possible, over time and in their context of use. Depending on the professional role of the interaction designer, he or she must be prepared to know relevant standards and guidelines for technological as well as physical design aspects, and know fitting methodological design approaches.

The interaction designer thus needs end-user knowledge on relevant user groups (including disabilities), as well as when and how to include marginalized users in user-centered processes, design to fit these user needs, foster user empathy, and triangulate knowledge of situated user needs with established guidelines. The shift from “traditional” to “universal” design typically lies in broadening the view of the user, considering extreme users and edge-case contexts-of-use.

Study 7, Part 3: Research Approach

In order to contribute to the articulation of UD expertise for IxD professionals, we decided to approach the research question “What should be regarded as “best practice” UD expertise in the IxD discipline?” through investigating the types of interaction designers being educated, and then proposing fitting UD skills for these. We asked: *What are the abstract archetypes representing IxD professionals? What is the UD expertise needed by these interaction design professionals?*

In this approach, archetypes are utilized similarly to the way “personas” are used in the design field: as a construct that holds key characteristics typical of a given stereotype (Stickdorn, Hormess, et al., 2018, p. 73). “Personas” typically aim to evoke empathy in a design process through describing a fictitious person (including, for example, name, age, and social background) who represents a user type. A story is then narrated around a usage situation, which also serves as a communication aid (Cooper, 2004).

"Archetypes" are not necessarily focused on representing users or evoking empathy, but rather on articulating and describing a high-level "type" or "model" for an understanding of traits and functions, or as in Platonism, embodying "the fundamental characteristics of a thing" (e.g. Grudin & Pruitt, 2002 in Nielsen). In this article, we use the construct "archetype" to indicate the key characteristics or patterns of a phenomenon (study programs), focusing on the high-level skillsets and strengths of interaction designers.

Study 7, Part 3: Results

Table 23 summarizes the findings from the Study 7 Part 2 program analysis and sorting. The following sections then briefly present each of the ten HE IxD programs. These presentations synthesize comparative findings per program; based on the categorization process, online presentation, as well as content descriptions (which as noted did not always coincide).

Table 23: Summary of study program sorting (• = present, ◦ = partly present)

	Key Content Categorization				Orientation		Industry		Didactics	
	Industry	Values	Technology	Design	User	Society	IT	Media	Theory	Realism
HE Institution 1	•		•		•		•			•
HE Institution 2		•	•			•	•		•	
HE Institution 3		•	•			•	•		•	
HE Institution 4		•		•		•	•	•	◦	•
HE Institution 5	•			•	•			•	•	◦
HE Institution 6	•			•	•			•		•
HE Institution 7	•			•		•		•	◦	•
HE Institution 8	•		•	•	•	•		•	•	◦
HE Institution 9	•	•	•	•	•	•	•	•	◦	•
HE Institution 10	•	•		•	•		•		◦	•

HE Institution 1

"You become a technical designer who will master web development and interaction design."

This program results in an IT BA degree, and lacks a clear design focus. However, it does include some IxD topics and has a User orientation. The study is front-end focused and covers web and mobile development and user testing. A medium-level UD focus is provided through the web design and web development courses; focused on skills in applying web accessibility. The program incorporates practical casework and portfolio-based evaluation, with many cases provided by external clients. It has an applied focus, and industry collaboration is emphasized, specifically with the IT-industry.

HE Institution 2

"You understand how IT influences individuals, organizations, and society and vice versa."

This track is also Technological, but with a strong IxD component. Descriptions focus on informatics competences, such as the ability to "explain how computers are built and function", and refer to apps, websites, and programming. User research and design processes are also mentioned. The study targets the IT-industry. Both MA and BA offer opportunities for an increased focus on IxD, and related fields such as information design, software engineering, mobile and web technologies. Ideals are related to increasing Societal Value, illustrated by an emphasis on awareness of legal obligations, technology as an influencer of organizations and social systems, and the ability "to reflect on key ethical, societal and academic issues related to own and others' work." Still, only a low, theoretical focus on UD is provided. Overall, the emphasis is on analytical reflection and theoretical insights. No industry collaboration is mentioned. Courses teaching practical skills and case-based reflection are more prominent in the BA, while theoretical reflection is emphasized at the master's level.

HE Institution 3

"…suited for you who want to be a specialist in universal design of ICT-systems."

This program is quite Technological and builds on IT BA or similar degrees. There is a strong focus on UD and accessibility, with social gap and equal rights-based disability model perspectives. It is Value focused around the topic of UD, with a Societal orientation. Environments can create disability barriers, thus a societal responsibility is to reduce these. The program draws on UCD principles, but is otherwise not focused on design. Emphasis is on analytical reflection and evaluation of existing ICT-solutions, mainly using expert evaluations and technical accessibility checks. Assessments are done through traditional written and oral exams and written hand-ins. There is no apparent industry collaboration. The study program educates candidates for the IT-industry.

HE Institution 4

"…educate specialized students with a common grounding in design thinking."

The first three years of this five-year MA degree in design, may be replaced by another design BA. The online profile emphasizes design-driven processes and design thinking, highlights the creative aspects and is Design oriented. The online profile does not clearly match the learning outcome descriptions, however. The industrial design background of the program is evident through courses related to physical production, production technology, and methods. Although the profile states that external enterprises and industry work environments are utilizes in the teaching practices, it is unclear to what extent industry collaboration is included in the education. A Societal orientation with a Value focus seems far more prevalent. The students are taught design reflection, design theory, and design methodology; however, UD perspectives are missing. Portfolio-based evaluations are utilized, but multiple-choice school exams and design reflection hand-in assignments are also included. Students are mainly educated to work in the IT-industry.

HE Institution 5

"…provides you digital competence closely related to creative disciplines."

The online profile describes a study that is closely associated with the Media industry. It is however difficult to determine how much practical collaboration with the industry the program offers. No internships, real-life casework, or external project assignments are highlighted. Instead, the program seems to value academic writing skills. Thus, our assumption is that the program has more fictional casework and project evaluation. The program has a well-balanced mix of individual portfolio assessments, written and oral school exams, and project reports. The program seems User oriented. The online profile emphasizes creative processes, thus appears Design focused. When considering the content of the study program, learning goals are however more focused on Technological skills. The study program description is somewhat vague, with quite general learning outcomes, making it hard to pinpoint the true focus. The UD focus is low, and limited to web development.

HE Institution 6

"Teaching takes place in close cooperation with media businesses …"

This online study program mentions topics such as front-end development, web programming, games, and mobile solutions. It thus seems quite Technological. However, the study content does not clearly fit the online presentation. Based on the specified learning outcomes, it appears that Design receives more focus than technology. Both design practice and design theory (ethical and analytical) is covered. Technological competencies seem aimed toward utilizing existing digital tools within the media context. Production of media content is included, and the program targets the Media industry and stresses a close Industry collaboration. The program is User oriented, but without a strong ideological or value-loaded focus on user-centeredness. UD is however completely lacking from the program. The study program has an overall assessment style based on fictional casework, with hand-ins of textual reports for grading based on practical assignments, in addition to portfolio-based assessments.

HE Institution 7

"…you design and create content for today's and tomorrow's platforms."

The program is presented as focusing on technology as a mediating platform in society, and has a Societal orientation. The program does not have a clear IxD component, but Design perspectives are highlighted in designing interactive digital solutions and concepts. The presentation emphasizes web and multimedia, the producing of media content, and visual communication. There is not a strong technology focus, instead humanistic perspectives seem to be the influencing factors in the study program. UD is given very little focus. Students are mainly educated to work within the Media industry. The study mentions collaboration with Industry, but though teaching and assessment methods are similar to HE Institution 6, a close connection to industry seems lacking. An applied focus is present in the program content description, although academic reflections are also expected. Exams are a mix of individual and project work, and include written assignments, case reports, produced work, portfolios, oral exams, and home exams.

HE Institution 8

"…foundation in technology so you can develop complete multimedia products."

This study profile is clearly targeting the Media industry. Content wise, it includes graphic design, and 3D visualization, in addition to animation, video- and audio-production. The IxD component appears weaker than its focus on digital media production. The study is viewed as somewhat Society and User oriented, and theoretical reflections as well as design and development skills related to user-friendly solutions are expected. However, no ethical or methodological stances or values are highlighted. UD perspectives are lacking. Extensive self-study is combined with problem-based learning and workshops. The students are evaluated partly through written hand-ins and partly through practical design and development projects. Portfolio assessment is emphasized. No industry collaboration is mentioned.

HE Institution 9

"… making the world better through designing and building great user interfaces..."

A strong Value focus is conveyed in the BA+MA track, together with Societal engagement, idealizing contributions to a better world through design, as well as a strong User orientation. User-centered methodology is emphasized. Online profiles fit contents with respect to the emphasis on design skills, including UX, human factors, service design, information architecture, visual design, and a strong UD focus. However, in-depth content information reveals that the track also includes Technological and Industry focuses - offering some web-technology and front-end skills. As such, the education merges Design, Technological, Industry and Value focuses. The track focuses on cross-disciplinary teamwork, methodology and uses case-based learning. Some industry-related practice and collaboration is included, especially at the BA level. Reflection and analytical skills are stressed, both as related to practical case experiences and theoretical knowledge. Students are mainly educated for the IT-industry, but also serve the Media industry.

HE Institution 10

"The job of an interaction designer is to make technology functional and user friendly."

This program is profiled as technology and value focused: understanding human needs and designing and developing websites and apps to bring value to users. When the learning outcomes and program contents are considered, this picture changes slightly. Here, the technological focus is downplayed, whereas the User orientation and Value focus remain present. Like HE Institution 9, the study provides a cross-disciplinary introduction to IxD spanning from front-end to service design, but it has a low focus on universal design. The program expects their students to be able to make ethical and methodological reflections. The study appears hands-on and practice-oriented, emphasizing processes in industry and IxD-related teamwork. The study program mainly aims to educate students for the IT-industry.

Identifying Archetypes

Based on a comparison of all the categories (A, B, C, D, and E) for all 10 study programs, we identified key patterns that emerged from the data. We used these to describe five archetypes of interaction designers. These five archetypes reflect identified characteristics of the competences and skills that a student is expected to possess when graduating from the Norwegian IxD educational programs included in our sample. The next sections present these five archetypes.

The Front-ender

The first theorized type of interaction designer is the Front-ender. The main characteristic of this archetype is defined as proficiency in web development and web design, hence the name Front-ender.

The Front-ender is considered likely to have limited full-stack abilities as well as limited user research and design skills, especially as a newly educated professional. In addition to basic knowledge and skillsets within human-computer interaction, user-interface (UI) design, user-centered design (UCD), mobile development, responsive design, and web accessibility competences are highly relevant and to be expected. A candidate fresh out of school is likely to have up-to-date industry relevant skills in web and mobile programming as well as in other industry-relevant topics.

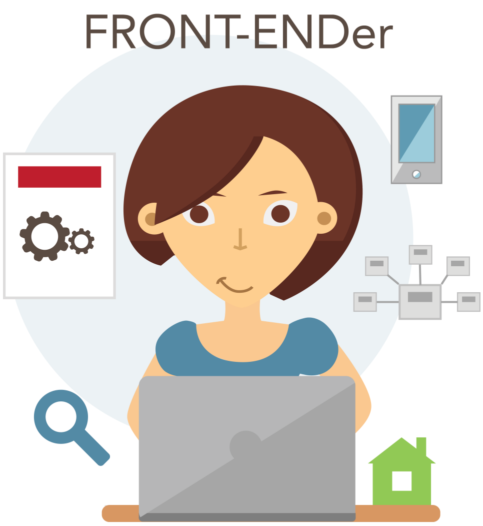


Figure 43: The Front-ender IxD archetype

Expected skillsets were illustrated in Figure 43 by:

- Gears on a paper document, indicating an applied technology focus;
- A cell-phone, referring to mobile development and responsive design skills;
- A house, pointing to online website home-icons;
- A magnifier, referring to online search-functions and user navigation; and

- A site diagram referring to planning the information architecture for websites.

The study program from HE institution 1 was hypothesized as educating Front-enders, as this program is more technology focused than design focused. Further, the program seems to utilize a realism didactic approach, tailoring the content to the skillsets needed by the IT-industry.

The Full-stacker

The second type of interaction designer is one coming from a classic informatics (or computer science) background. This designer will have received basic knowledge of typical back-end skills, such as programming, databases, networks and operation systems, and computer hardware knowledge. This archetype is therefore likely to have full-stack development capabilities, be well versed in software engineering, and have the potential to aid in bridging the gap between designers and developers.

In addition to proficiencies in mobile and web technologies, a candidate fresh out of school is assumed knowledgeable regarding cutting-edge technology, but not jet mainstream in industry—such as Internet of Things (IoT) and health technology innovations.

This archetype may lack extensive training in design methodology, user research and user empathy. The IxD training of the Full-stacker has probably been mostly HCI and UI focused, such as considering input/output modalities and information design.

Figure 44: The Full-stacker IxD archetype

Our Full-stacker illustration included a classic coffee cup and haircut, stereotypical for the "IT-guy", pointing to:

- A traditional desktop monitor, signifying a traditional informatics background;
- A ruler in his pencil cup, referring to an engineering influence;

- A server cabinet, referring to back-end skills and full-stack capabilities;
- Two binders, to signify theoretical and analytical skills;
- A light bulb on one of the binders, to signify reflection and innovation training;
- A keyboard input device, hinting to programming abilities and HCI-based skills.

Apart from the level of back-end and classic informatics training, a major difference between the Full-stacker and the Front-ender was extrapolated to be the degree to which the education is value versus industry focused, and realism versus theory focused. Full-stackers are perceived trained in a more traditional academic manner (theory-heavy didactics), focusing on analytic and evaluator abilities and exercising reflection on theoretical insights. Two programs from our sample were viewed as likely to produce Full-stack'ers; programs from HE institution 2 and 3.

The Design Tinker

The third archetype denotes an interaction designer with a design degree. In contrast with the informatics degrees from which the Full-stacker and Front-ender are educated, Design Tinkers have their core from design disciplines, including product design and industrial design. He or she may thus be regarded as belonging to a discipline that overlaps with IxD, such as information design, graphic design, industrial design, or product design.

The Design Tinker holds broad design skills, and know design thinking, design theory and design reflection. The Design Tinker should be well versed in problem solving through design thinking using creativity triggers. The name "Design Tinker" refers to the creative process of "tinkering" – experimenting with ideas and materials to explore, improve, or create something. This bottom-up and hands-on experimentation of moving between theory, experimentation, and reflection is viewed as a different approach to innovation than the traditional top-down analytics of computer scientists and engineers.

Figure 45: The Design Tinker IxD archetype

Design Tinkers are assumed to have limited development and programming capabilities. However, the Design Tinker is expected to be familiar with physical prototyping and may have developed technology knowledge through problem solving by tinkering and prototyping with technological artifacts—such as utilizing sensors, IoT, etc.

Overall, this type of interaction designer is probably suited for tasks where a broader design skillset is needed – including service design positions, as they are probably capable of designing much more than technological contact points and interfaces.

Main characteristics of the Design Tinker were illustrated by:

- A dart arrow, to visualize problem solving abilities;
- A note book, indicating bottom-up idea generation and design reflection;
- A pencil holder with pencils, referring to traditional design skills;
- Puzzle pieces, referring to iterative tinkering and prototyping; and
- A pencil indicating a watch design by paper sketching, referring to product design skills of combining tangible artifacts and digital technologies.

One program was assumed educated this archetype – the one from HE Institution 4.

The Communicator

The Communicator represents an interaction designer schooled in how to use technology to develop media services and to communicate with users, trained in content production and visual communication. The Communicator holds at least some basic skills in visual design, UI and creative processes, but is less skilled in reflecting on ethical and societal implications related to applying solutions, including UD perspectives.

Communicators are expected trained in media design and in media production (such as animation, video- and audio production). Some skills may also be expected relating to front-end development, games, and web and mobile solutions.

The archetype is caricaturized as a "journalist" type with a classic coffee cup and a messy hair bun. The main skills expected were illustrated by:

- A camera, pointing to visual communication and media technology usage;
- A textual document, indicating skills in content production and communication;
- A news globe, referring to the utilization of digital tools in media services.

Students graduating from HE Institution 5, 6 7 and 8 are likely to educate Communicator archetype professionals. Although design aspects are given some emphasis, IxD is not a primary focus in these programs. Further, their levels of technological focus vary, but the focus is overall on technology as a mediating platform. All four programs primarily educating candidates for the media industry, and teach their students how to utilize interactive digital solutions within the media context. The focus is thus more on applying rather than developing technology.

Figure 46: The Communicator IxD archetype

The User Empath

Finally, we found a user-sensitive archetype, the User Empath. This type of interaction designer has received an interdisciplinary training, and draws on both design and IT topics – including UI and visual design, web and app development.

Further, this type of interaction designer is well versed in design methodology, including reflection on ethical aspects. We hypothesize a focus on UCD and cross-disciplinary teamwork, but it could also include e.g. creativity and innovation training.

This archetype would be trained in user research and user testing, and is the most likely IxD archetype to be skilled at user-involved, participatory, user-sensitive and empathic design techniques, such as co-creative workshops, ethnography, empathic modeling, auto-ethnography and contextual interviews, and participatory observation strategies.

In addition to strong user-centered design competences, we envision the User Empath holds some visual design skills.

Due to the interdisciplinary programs inspiring this analytical construct, we believe this archetype skillsets covers basic front-end design and development skills, mainly as related to websites and apps A User Empath is also likely to hold basic competence in IxD-related disciplines, such as service design, information architecture (IA), HCI, and human factors.

Expected expertise is:

- A note book, pointing to user-research field-guides or interview notes taking;
- A tea cup is added, signaling a focus on taking the time to meet and talk to end-users;
- RGB color palette, reflecting visual design as well as front-end abilities;
- A picture of users, emphasizing user-centered design and user testing skills;

- A pencil holder with pencils, referring to traditional design skills; and
- A computer mouse input device, referring to HCI and IA UI design skills.

The HE Institutions 9 and 10 provide in-depth IxD training, with the common core emphasis: on training students in user-centered IxD skills. These programs were considered likely to deliver User Empaths. UD perspectives are included in the programs, and although the level of in-depth reflection skills varies, all communicate value-based design choices.

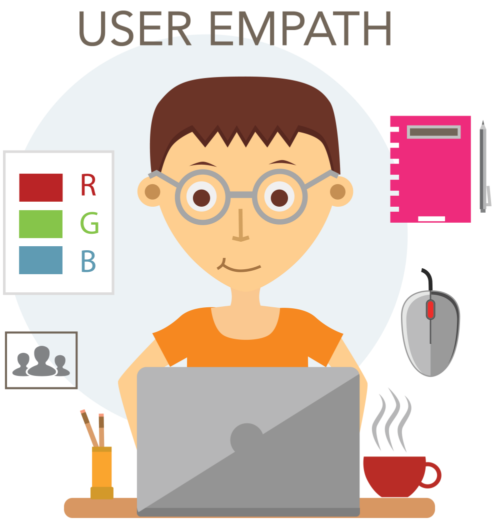


Figure 47: The User Empath IxD archetype

Study 7, Part 3: Discussion

We have identified five different archetypes of interaction design being educated in Norway. Each of the archetypes emphasizes various characteristics and personal skills, ranging from the highly technical to the more user-oriented with softer skills. Although there is common agreement as to the importance of user inclusion and user-oriented development, e.g. through activities such as usability testing (as consistent with Nørgaard & Hornbæk, 2006), we find a scattered IxD content focus across the various study programs.

This large variation in the IxD field raises some challenges, both for the design industry as well as for the individuals. Currently in Norway, this seems especially critical in four instances: 1) when failing to recruit enough students into IxD programs – thereby maintaining an industry shortage of interaction designers, 2) when failing to educate professionals with the necessary expertise, 3) when failing to recruit the correct type of interaction designer to adequately match competence needs, both in organizations as in-house designers and on projects as design consultants; and 4) when failing to recognize and utilize the competence available, e.g. for project team collaboration.

Our view is that the IxD field is not static or definite, but is constantly changing in relation to technological and societal developments. Thus, to attempt to specify one "correct" interaction designer archetype would not be a relevant aim. Rather, we argue that articulating IxD archetypes could combat the four challenges identified above without limiting the field in time or content. As the field changes, new archetypes may be added and existing archetypes may be updated whilst still remaining strong IxD communication tools for a wide range of audiences.

Previous studies have indicated that IxD skills and topics as taught in various educational programs are often inadequate to match the competence needs of the design industry (Sørum & Pettersen, 2016). Consequently, we can speculate that there is a mismatch between the topics considered significant in an educational context versus the knowledge that is needed in the industry. Such a mismatch between theory and practice has also been highlighted by Goodman, Stolterman, and Wakkary (2011), who also emphasize the importance of minimizing this gap.

The archetypes may aid educational institutions in improving their IxD programs, and in communicating their program to potential students as well as to industry. They can help quality assure the IxD educations, by increasing the match between what is asked for in job positions (the industry needs), what is taught (the study program focuses), and what is available (designer skillsets and types.

In addition to within-programs improvements, improved articulation not only of the IxD field but also regarding specific educational programs has the potential to ensure that political and managerial strategies in the HE sector understand the overlap between, or the uniqueness of, IxD programs, and whether institutions are competing with or complementing each other. This might aid strategic adjustments, future mergers, student exchange opportunities, and collaboration between study programs.

Further, the archetypes may aid business and organizations in matching designers to the competences required, improve cross-disciplinary team collaboration and increase awareness and utilization of IxD and UX skillsets in user-centered agile integration, and service and software development.

Our assumption, based on the data, is that current professionals working as interaction designers in the IT-industry have a cross-disciplinary background in informatics and front-end and UI design. In the media industry, our findings indicate that professionals holding IxD responsibilities are likely to have a cross-disciplinary background in media technologies, media design and media production. Further, that the current professionals working as interaction designers are likely to lack necessary UD expertise to adhere to UD legislation, and promote an inclusive digital society.

Proposing UD Expertise for IxD Archetypes

The extent to which relevant UD competences are missing from Norwegian IxD educations should be of interest to industry, students, and educators. Table 24 summarizes the UD focus of the HE institutions against the typical archetype we hypothesize they would mainly educate. From this, it is evident that UD expertise is not established in relation to any of the archetype competencies. For example, the User Empath type of IxD professional can either have been educated with a high degree of UD skillsets, or with a low degree of UD expertise.

Since Part 3 of Study 7 sought to promote UD within IxD, and identify best practices, we decided to propose UD competence relevant for the identified archetypes. From our understanding of UD in ICT and the background literature on UD as described in sections 2.3 Reflections on Current Norwegian UD of ICT Legislation and Study 1: Background, p. 73, we held the following views:

Table 24: Summary of UD focus and archetype representations

	Universal Design Focus	Archetype Representation
HE Institution 1	Medium	Front-ender
HE Institution 2	Low	Full-stacker
HE Institution 3	High	Full-stacker
HE Institution 4	Lacking	Design Tinker
HE Institution 5	Low	Communicator
HE Institution 6	Lacking	Communicator
HE Institution 7	Low	Communicator
HE Institution 8	Lacking	Communicator
HE Institution 9	High	User Empath
HE Institution 10	Low	User Empath

First, all professionals contributing to the digitalization of services (including media services) are considered likely to be covered by accessibility regulations, and therefore they need to know at least the current national and international legislation, and when UD regulations become relevant.

Second, those who enter IxD positions in the IT-industry are considered extremely likely to do either front-end coding or user-interface design. For both these tasks, they need technical accessibility competence related to web, mobile and other digital surfaces and web-based solutions, in to achieve the minimum UD standards as determined by current legislation.

Third, we hypothesize it highly beneficial for securing UD in ICT-solution that interaction designers utilizing user-centered approaches understand key needs of major user groups in danger of exclusion. In particular, we believe users with severe visual impairments should be prioritized. Other highly relevant user groups for digital product design are in our view persons with dyslexia (or reading- and writing difficulties), first-generation non-western speakers (and tourist), persons with severe motor disabilities, and persons with cognitive challenges (such as dementia, fatigue, context-, or emotion-related challenges).

Forth, for physical product design, we hypothesize persons with dexterity challenges, persons with impaired hearing, and persons with non-typical sensory experiences (including many with autism-spectrum disorders, ADHD) should be considered.

Fifth, for service design, we believe non-digital users (such as many elderly over 80 years of age) needs to be emphasized, in line with UN recommendations on non-digital customer journeys.

Sixth, IxD professionals producing multimedia content should know how to make this inclusive and multi-modal; e.g. using captions, tagged pdf-reading order, alt-texts, subtitles, or audio description. Both content design and information design touches upon visual, cognitive, and audile aspects, including readability and understandability. In other words, content accessibility expertise is needed.

Seventh, IxD professionals responsible for visual design, such as in the design of wayfinding systems, signs, UIs, posters or other visual products or touchpoints, must be aware of color and contrast issues. This includes knowledge about persons with reduced vision, color blindness or different types of visually impairments.

Finally, we hypothesize it highly beneficial for securing UD in ICT-solution that those interacting directly with users in user research and design phases know how to apply inclusive design methodology into user-centered approaches. This includes empathic modeling and inclusive design techniques, direct user contact with disabled and marginalized user groups, end-user involvement, and contextual disability awareness (such as in the "gap" model).

Based on this understanding, we propose the following UD expertise for the five archetypes.

The Front-ender

UD expertise suggested for the Front-ender mainly involves ensuring technical accessibility, but also covers basic user-interface design, accessible navigational structures, colors and contrasts:

- Knowledge of WAI accessibility guidelines and expertise in adhering to the WCAG criteria;
- Ability to code according to best-practice standards, including mobile (app) accessibility;
- Ability to do automatic accessibility assessments using online or downloaded tools;
- Understanding of the needs of disabled user groups that can be accommodated through accessible coding, especially visual impairments, including color blindness. Awareness of users with dyslexia, reduced cognition and motor control is beneficial, but not expected;
- Ability to do formative user testing with disabled users;
- Knowledge of assistive technologies, including switch-systems, screen readers and magnifiers, and the need to ensure compatibility with these;
- Ability to do expert accessibility evaluations of user interface and front-end code according to accessibility best practices and guidelines and simulated assistive technologies (e.g. keyboard to simulate switches). Ability to do expert testing with assistive technologies is beneficial, but not expected;
- Awareness of current international and national legislations and responsibilities.

The Full-stacker

We propose IxD professionals reflecting this archetype include UD expertise focused on technical accessibility:

- Ability to code according to best-practice standards, including mobile (app) accessibility and WAI accessibility guidelines;
- Ability to do automatic accessibility assessments using online or downloaded tools;

- Knowledge of assistive technologies such as switch-systems, screen readers and magnifiers and how these assistive technologies function in relation to complex and server-based systems. Ability to consider assistive technology in relation to IoT, health technology and other technological innovations is beneficial, although not expected;
- Ability to do expert accessibility evaluation of systems to ensure accessibility and assistive technology compatibility, including basic user-interface accessibility evaluations. Ability to do a more thorough expert evaluation of user interfaces and front-end code and the ability to do basic expert testing with assistive technologies are beneficial, although not expected;
- Awareness of the needs of disabled users groups;
- Ability to do formative user testing with disabled users;
- Awareness of current international and national legislations and responsibilities.

The Design Tinker

Proposed UD expertise for the Design Tinker are mostly viewed as relating to user-involved and empathic design techniques to increase the inclusiveness of ergonomics and interactions. For example, related to service design, this would include inclusive personas, edge-case need assessments in relation to the contexts of use (for example Empathic Service Safaris), and capability for UD evaluations of digital and physical touchpoints (for example through applying Touchpoint UD Assessments and UD Service Walkthroughs). The following universal design expertise is proposed as fitting for the Design Tinker:

- Understanding the needs of user groups with specific needs, such as the effects of reduced motor control, dexterity, fine motor skills, and cognitive abilities, through illness, age, low vision, and blindness as related to the use and ergonomics of digital and non-digital solutions;
- Understanding the effects of dyslexia and visual impairment on information design;
- Awareness of users in danger of exclusion, including the elderly over 80 years and first-generation non-western immigrants;
- Ability to do user involvement with marginalized user groups, including user testing, interviews and observation;
- Knowledge of the social "gap model" on disability as related to different contexts of use;
- Knowledge on how to simulate the needs of marginalized users for empathic design strategies as well as for expert testing, e.g., by using assistive technologies such as wheelchairs and crutches, or by applying limitations to their vision, dexterity etc.;
- Awareness of current international and national legislations and responsibilities.

The Communicator

For the Communicator, we thus suggest UD expertise centered on ensuring accessible and inclusive content (text, video and images) in user interfaces and media services:

- Understanding the needs of disabled user groups related to user-interface design and content design, especially hearing impaired and visually impaired users;

- Knowledge of audio description for the visually impaired and closed captions for deaf and hard of hearing audiences of video content, in addition to subtitles for non-native speakers;
- Understanding the implications of dyslexia and visual impairment for textual and visual information design;
- Ability to do user-centered design involving disabled users, including user testing;
- Knowledge of WAI accessibility guidelines and expertise in adhering to WCAG criteria;
- Ability to do automatic accessibility assessments using online or downloaded tools;
- Awareness of current international and national legislation and consequent responsibilities.

The User Empath

For the User Empath, we suggest a stronger UD expertise on inclusive and edge-case UCD approaches compared to the other IxD archetypes:

- Understanding the needs of marginalized users and the effects of reduced motor control, dexterity, fine motor skills, and cognitive abilities, together with illness, age, low vision and blindness as they relate to the use and ergonomics of digital solutions. Awareness of users in danger of exclusion, including the elderly over 80 years and first-generation non-western immigrants is beneficial, although not expected;
- Ability to do user involvement with marginalized and disabled users, including user testing, interviews and observations;
- Ability to simulate the needs of marginalized users for empathic design strategies as well as for expert testing and evaluation;
- Understanding the social "gap model" on disability as related to different contexts of use;
- Understanding the needs of disabled user groups as related to user-interface and visual design, navigational structure, and digital ergonomics—especially the effects of dyslexia and visual impairment on textual and visual information design, and the effects of reduced cognition, fine motor skills, and vision on interactions. Knowledge of audio description and closed captions is beneficial, but not expected;
- Knowledge of assistive technologies, including switch-systems, screen readers, and magnifiers, and how these influence human-computer interaction. Understanding the needs of disabled user groups that can be accommodated through accessible coding is beneficial, although not expected;
- Ability to do automatic WCAG accessibility assessments using online or downloaded tools;
- Awareness of current international and national legislation and consequent responsibilities

As such, in addition to discussing the implications of a shortage in UD skills in the study programs, Study 7 made an explicit contribution to ensuring that the necessary additional expertise in UD is promoted, by articulating archetypes and proposing UD expertise for each of them. To this end, we demonstrate that an increased awareness and articulation of current educational content, here through the construction of archetypes, may contribute to addressing possible competence gaps.

Further, from the different archetypes, we can extrapolate common UD skillsets. Table 25 summarizes the proposed UD expertise across the five IxD archetypes. Based on this, we can extrapolate that all professionals need UD expertise in legislative responsibilities, user need knowledge on persons with dyslexia and visual impairments, as well as the ability to do expert inspection accessibility assessments of code or UI/visual design and user test with disabled users. This expertise is indicated in Table 25 as black dots.

Further, most IxD professionals need UD expertise in WAI/WCAG/ mobile (app) accessibility/code standards (with the exception of the Design Tinker). Further, most need assistive technologies (with the exception of the Communicator), inclusive information design, inclusive UCD involving edge-case users, and user need knowledge on persons with reduced motor skills, dexterity or cognition, elderly users, younger users, and persons suffering from illnesses and injuries (with the exceptions of Front-enders and Full-stackers). The expertise most need is indicated in Table 25 as grey dots.

Table 25: Summary of proposed UD expertise for IxD professionals

Expertise:	Front-ender	Full-stacker	Design Tinker	Communicator	User Empath
Legislative responsibilities.	•	•	•	•	•
WAI/WCAG/ mobile (app) accessibility/code standards	•	•		•	•
Assistive technologies	•	•	•		•
Accessible code impact for visual & motor impairments	•	•			◦
Accessibility assessment, Expert inspection code/UI	•	•	◦	•	•
User testing with disabled	•	•	•	•	•
Inclusive user involvement			•	•	•
Empathic design techniques			•		•
User need knowledge; dyslexia, vision	◦	◦	•	•	•
User need knowledge; motor skills, cognition, age			•	•	•
User need knowledge; illness, dexterity, other			•	◦	•
Contextual "gap" awareness			•		•
Inclusive information design			•	•	•
Inclusive multimedia/content				•	◦

We hope to open up a debate on the necessity of UD skills in IxD, and the responsibility of HE educators to assess what level of UD competence is relevant for their IxD education.

Limitations of Study 7, Part 3

Although the empirical data for this study were drawn from a Norwegian sample, we believe the contribution will be relevant to an audience beyond the Scandinavian countries, as we extrapolate abstract archetypes of interaction designers from our data, and discuss necessary UD expertise in relation to these constructs.

We also encourage future research to follow up on the consequences of a lack of UD awareness, both for marginalized citizens in danger of exclusion and in relation to the legal implications for interaction designers as the European Accessibility Act (EAA) moves toward completion. Opportunities for raising awareness of UD within the IxD profession could also be investigated, for example, how our archetypes could be utilized and developed to aid organizations, students, and educators in the skillsets necessary.

Towards Part 4 & Study 8

From the work so far, we had in-depth insights into specific areas related to UD of ICT. Key insights included the realization that UD expertise must be developed within all disciplines involved in the creation of ICT-solutions, and the complexity of factors influencing the UD quality of applied settings. We had developed facilitating advice and tools for UD in the researched ICT-procurement and development cases, including how critical success criteria can be utilized in ICT-projects for planning, predicting and managing UD success. In the following Part 4, part, we wanted to utilize case specific insights in order to plan future interventions to advance UD of ICT – including investigating possible interventions on a societal level. Study 8 initiates this work by applying grounded theory to the empirical data.

Part 4

Advancing UD of ICT

Executive Summary of
Part 4 Advancing Universal Design of ICT

This section introduces the final Part 4 of the thesis, followed by a presentation of its final study.

Part 4: Moving Towards Assuring UD of ICT

Studies & Deliverables

S8: Triggering UD Efforts

Begnum, ***Ensuring Universal Design of ICT: Triggering the Triggers!*** UDHEIT 2018

Begnum, ***Triggering Universal Design in HE Digitalization***, NordiCHI Workshop paper 2018

Model of ICT-industry factors impacting UD quality, based on applying Herzberg & Fogg's theories.

Model of aspects impacting UD of ICT in HE.

Part 4 Outcome

- Insight on relations between Societal, Organizational, Processual and Personal factors.
- Theorized factor types & triggers for UD Quality of ICT.
- Hypothesized effect of future interventions from model.

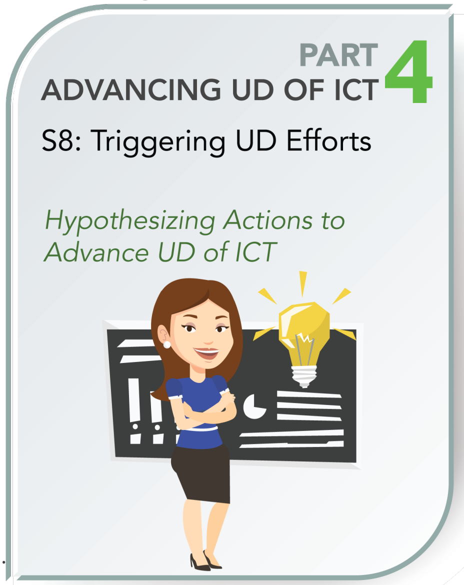


Figure 48: Overviewing the research in Part 4 - studies, papers, and outcomes

In Part 4, we return to our initial thesis aim; advancing UD in digital societies. We investigated how we should move forward towards assuring UD of ICT. It built on the previous studies to explore the possibilities of how the likelihood of UD in the design, development or procurement of ICT-solutions can be improved in the future. The research question asked in this part was: "How should we move towards assuring UD of ICT, and why?"

Study 8 summarizes and models empirical insights from previous parts to discuss future interventions. From the Study 8 findings, we are able to answer the three sub-questions of Part 4:

4.1 Why are procurement requirements important UD-triggers?

4.2 Why is legislation an important UD-trigger?

4.3 Why are passionate individuals important UD-triggers?

In Study 8, we proposed moving forward to assure UD of ICT, by focusing on increasing the likelihood of identified best practice being present in future ICT-projects. Therefore, Study 8 applied grounded theory, to extrapolate from Study 4 and Study 5 findings how to ensure CSC are present in future ICT procurement and development projects.

First, we re-iterated back to the characterizing factors and analyzed how the different CSC worked together to positively influence the projects in our Study 4 sample. Based on this deeper understanding of factor relationships, we modeled the data.

Next, we applied Herzberg and Fogg's theories to classify the 15 CSC as either triggers, facilitators, motivators or hygiene factors. We theorized trigger factors for UD of ICT, in the IT-industry as well as in the HE-sector. We also theorize Herzberg dual-factor theory and Fogg's human behavior theory can be used on a project-based level, to understand the nature of each factors and the dynamics of how trigger factors work in relation to other influential CSC.

Using our theorized model from Study 8, we discuss in Part 4 why we should take certain actions moving forward to assure UD of ICT.

The answers to our research questions were as follows:

4.1 Why are procurement requirements important UD-triggers?

Specifying UD requirements, were described as effectively trigger priority and resource allocation, as the stakeholders specifying the project requirements were also the stakeholders holding the power to determine the level of UD prioritization and allocate the necessary resources. Thus, anchoring UD values among project owners seemed a powerful approach to inspire a maximum of UD quality within the available limitations of a project.

4.2 Why is legislation an important UD-trigger?

Legislation seems effective to trigger a minimum of UD quality. When stakeholders in ICT-projects are aware of the legal obligations to follow UD requirements, and the threat of negative reactions on a societal level is believed to be sufficiently likely and severe, the external pressure triggered by the legislation necessitates they are followed.

Alongside technological and mass media influence, legislation reflects the critical influencing cultural boundaries under which ICT-projects. For many companies, this in itself is enough to necessitate the regulations are followed. Further, under these circumstances, stakeholders may be inspired by the law to ensure UD, and may use legislation to influence other stakeholders.

4.3 Why are passionate individuals important UD-triggers?

Individuals on a project team passionate about UD typically created positive chain-reactions related to raising awareness among other stakeholders, acquiring resources needed, boosting interest among peers, and spreading UD competence to persons without a DfA mindset and accessibility skills.

Contributions from Part 4:

Part 4 discussed how to move forward to increasingly promote CSC presence in future ICT procurement and development projects. Applying Herzberg and Fogg's theories to empirical data derived a theoretical model. This model was viewed as grounded in the qualitative insights, and as such, we framed the research approach as grounded theory:

- We theorize that factors can be separated into ability influencers and motivation influencers.
- We theorize that three triggers factors for unleashing a UD focus can be identified.
- Finally, we theorize that these can be modeled according to Fogg's theory on human behavior – moving from single human to theorizing project-level behavior patterns.

Our hope was that by understanding and modeling factor types and their relationships, we could understand triggering mechanisms for success or failure, and utilize these insights to guide future UD efforts in the ICT-industry and HE sector respectively. We end Part 4 with proposing 11 interventions and actions towards promoting and assuring UD of ICT from this model:

1. **Legal interventions to enforce a minimum level of UD**

- Intervention 1: HE Vice Chancellorship training in Institutional UD Responsibilities
- Intervention 2: Increasing UD Responsibilities to cover Contractors
- Intervention 3: High Fines for Companies Breaking UD Legislation
- Intervention 4: Increased Fining of Small and Medium-sized Companies
- Intervention 5: Adding Process Documentation Demands to UD Regulations

2. **Awareness interventions to inspire maximized UD priority**

- Intervention 6: Public Procurement training in UD Requirement Specification
- Intervention 7: Creating Project Tools for UD Planning and Management
- Intervention 8: Promoting Design Thinking for All prior to specification

3. **Training interventions to advance UD grass-root movements**

- Intervention 9: Embed UD aspects into all study programs targeting the IT-industry
- Intervention 10: In-situ Industry Training for ICT-creators, designers and developers
- Intervention 11: Increasing the Readability of Guidelines & Regulations

1 paper were published from Part 4:

Paper 14. Begnum, Miriam E. Nes. (2018) *Ensuring Universal Design of ICT: Triggering the Triggers!* Studies in Health Technology and Informatics Vol. 256, Transforming our World Through Design, Diversity and Education, Proceedings of UDHEIT 2018. IOS Press.

In addition, 1 unpublished paper were written for a conference workshop:

Paper 15. Begnum, Miriam E. Nes. *Triggering Universal Design in HE Digitalization*. Workshop Paper, NordiCHI 2018 [available at: https://www.mn.uio.no/ifi/english/research/projects/udfeed/events/Workshops/contributions-documents/ paper11_nordichiworkshop_triggering-universal-design-in-he-digitalization-processes.pdf].

Study 8: Triggering UD Efforts

In Study 8, the qualitative insights from Study 4 were explored in order to achieve a deeper theoretical insight into influencing factors for UD of ICT. From and improved understanding, we may better plan future interventions, and predict their impact effect.

We re-explored empirical insights from previous parts, in particular from Part 2 Study 4. The goal was to overview the findings on factors promoting or obstructing UD of ICT, in order to build meta-level insights. Fogg (2009) and Herzberg (1964) both had theories that seemed relevant for describing and modeling the data. We aimed at identifying the dynamics in play in the sample – how factors appeared to affect each other.

Study 8 investigated:

(1) What are the relationships between the 15 Critical Success Criteria (CSC)?

(2) Using Herzberg's dual-factor theory, are the CSC motivators or hygiene factors?

(3) Using Fogg's B=MAT model for persuasive design, are the CSC motivators, facilitators or triggers?

(4) Based on our findings, can we model Project-level behavior?

(5) Based on our findings, what are the likely high-impact interventions for UD of ICT?

Study 8: Background

Our focus was on the ICT-industry, as we had more complete and structured data set from the Part 2 Study 4 success sample. Some ICT projects manage to create award winning, inclusive solutions, while others fail. In Study 4, we had investigated 23 projects that had successfully delivered Universally Designed ICT-solutions, and gathered data from 34 participant interviews, which had subsequently been imported and coded in NVivo. The success sample projects' reasons for success were complex, spanning a broad range of Societal, Organizational, Processual and Personal factors. Study 8 now attempted to model these empirical data for societal utilization; advancing future efforts to promote UD. As Figure 18 overviews, 84 characterizing factors were identified, of which 15 were deemed Critical Success Criteria (CSC).

Herzberg's Dual-Factor Theory

Herzberg's (1964) dual-factor theory, also known as the motivation-hygiene theory, revolves around employee motivation. Herzberg identified how someone being satisfied or dissatisfied at work might arise from different factors, and that what motivates people may be different from, and not simply the opposite of, factors causing dissatisfaction (hygiene factors). While hygiene factors must be **sufficiently** present to **avoid** dissatisfaction, motivational factors increase satisfaction when increased.

Fogg's Model for Human Behaviour

Fogg's theoretical model for human behavior focuses on how factors influence human behavior (2009). According to Fogg, behavior (B) can be triggered (T) if adequate motivations (M) and abilities (A) are present (B=MAT) (Fogg, 2009) A trigger factor is thus only successful if there is a sufficient combination of motivations and abilities in place. High motivation can overcome constraints, and high abilities can overcame low motivation. In other words, the formula of "B=MAT" can be applied to model the relationship of factors influencing human behavior. The theory has been successfully applied to persuasive design. Its strength and weakness is the simplified and static view on behavior and motivation (e.g. not considering sustaining motivation and behavior over time), and the lack of individual (project) difference.

Study 8: Research Approach

The overall research approach in Study 8 was categorized as within a grounded theory research approach, fitting definition of grounded theory as inductive, qualitative research aimed at developing a well-grounded theory from empirical data by multiple stages of in-depth qualitative analysis, saturation and interpretation (Jonathan Lazar et al., 2010, p. 283).

The study also had hermeneutic traits, as we were incrementally deepening our (post-) understanding. First, we re-investigated and described characterizing factors and factor levels from Study 4 Part 2. Next, we explored the relationships between them, using narrative evidence and focusing on the CSC. Third, we applied Herzberg dual-factor theory to investigate whether CSC were motivators or hygiene factors. Forth, we modeled, theorized and discussed future actions for triggering UD initiatives in the IT-industry and the HE-sector.

Early findings were presented at the Norwegian national "Universal ICT" expert network (UNIKT, 2018), on the characterizing factors for UD successful ICT-projects, CSC and narrated factor relationships (Figure 49), and hypothesized trigger aspects for UD promotion in the IT-industry (Figure 50). The results received a warm reception and exceedingly positive feedback, providing some tentative external validity.

Analysis of Factors and Interview Narratives from Study 4

The qualitative interview data from the interview study was re-analyzed through thematic content analysis. Narrative evidence was used to describe relationships and apply theoretical perspectives.

The Study 4 characterizing factors from were gathered from an exploratory interview study; appropriate for eliciting tacit knowledge and subjective views on informal and complex practices in organizations (Marshall & Rossman, 2011, p. 91; Merriam, 2009, p. 5). We mapped empirical factors for UD success through emergent (and later directed) coding of textual transcribed in-depth interviews in NVivo, and supported by audio recordings.

In Study 8, we re-examined the qualitative interview data in NVivo to identify the dynamics in play in the sample – how factors affect each other. Study 8 gained knowledge of project members' experiences and perceptions of a situation or phenomenon, and was as such interpretive with phenomenological traits (Leedy & Ormrod, 2014).

Analysis of Study 4 Factors based on Herzberg Theory

Now, we apply theoretical models as a-priori coding schemes to the data to investigate the type and nature of the factors. We used Herzberg to classify the 84 factors based on participants' interpreted descriptions, and specifically looked at the CSC distribution.

Analysis of Study 4 Factors based on Fogg's Theory

We then applied Fogg's theoretical model for human behavior to the 15 CSC in order to identify abilitators, motivators and, most importantly, the trigger factors.

Modeling Project-level Behavior for the ICT-industry

Through the lenses of Herzberg and Fogg, we interpret and model the empirical data, and present findings for research community feedback. We model CSC relationships and use this to discuss actions to promote UD in the field of ICT. This theorizing was first done based only on the Study 4 empirical data, focused on triggering UD promotion in the IT-industry.

Analysis of Interview Narratives from Study 5

Based on insights into empirical data from Study 5 on the HE sector, we identified several challenges related to UD in HE. These challenges were classified as factors using a directed coding approach – combining an open, emergent analysis of the data to the characterizing factors identified from the Study 4 data.

Analysis of Study 5 Factors based on Herzberg and Fogg

We then applied the theoretical models from Herzberg and Fogg in a directed coding manner, by comparing factors identified from Study 5 to factors identified as abilitators, motivators and triggers from Study 4.

Modeling Project-level Behavior for the HE-Sector

Subsequently, the model based on Fogg and Study 4 data was adjusted in line with qualitative insights from Study 5, and high impact interventions hypothesized for the HE-sector.

Study 8: Results

The results section starts with re-iterating the key factor categorization from Study 4. Following this, the first four sub-sections describe the factors identified on the different factor levels; Societal, Organizational, Processual and Personal, from the thematic content analysis in Study 8.

Next, a sub-section describes the key factor relationships we find in the Study 4 data. Then, we present the findings from Herzberg on separating between motivators and hygiene factors. Following this, we present our findings from applying Fogg's theory. We then theorized a model based on Fogg's from Study 4 data. After this, we present factors identified from Study 5 data, by applying an interpretive approach. We then apply Herzberg and Fogg's to the Study 5 data from the HE sector, and theorize a model from the HE sector.

Finally, we discuss potential high-impact interventions drawn from the empirical insights.

As described in Study 4, 22 of the 84 characterizing factors from the ICT-project success sample were considered main-factors, holding 45 sub-factors, and 9 sub-sub-factors. Based on how frequency factors were mentioned in the interviews, 15 factors were considered Critical Success Criteria (CSC):

(1) Legislative Support (Societal)

(2) UD Awareness, (Organizational)

(3) UD Priority (Organizational)

(4) Strategic UD Competence Building (Organizational)

(5) Requirement Specification of UD (Processual)

(6) UD/UX Needs Integration (Processual)

(7) Continuous Focus (preferably iterative, Processual)

(8) Cross-disciplinary Team Collaboration (Processual)

(9) User Testing (preferably with real and disabled users, Processual)

(10) Internal quality control (code validation, inspections etc.) (Processual)

(11) Enough Time & Budget (Processual)

(12) Enough Equipment & Human Resources

(13) Design for All (DfA) Mindset (Personal)

(14) Interest in UD (Personal)

(15) Enthusiasm about UD (Personal)

Societal Factors

The Societal level reflects the culture and boundaries under which organizations and individuals operate. Policy, Technological and Mass media influence are the three main categories of characterizing Societal factors, both promoting and obstructing. Policy is the most influential.

Policy Influence

The main-category "Legislative Support" is the only Societal level CSC. Focus is on the influence of the Anti-Discrimination and Accessibility Act (BLD, 2017). In addition to being a supervisory authority on the regulations on UD of ICT solutions (KMD, 2013, 2017), the Norwegian Agency for Public Management and E-Government (Difi) holds a position as an advisor. Some participants therefore cooperate with Difi, and receive training and guidance. Participant 18 is among those commending Difi for providing supporting online "how to"-guidelines, information and tools.

However, there are also "Legislative Issues". Though a few mention real-life lack of consequence for breaking the law, most are related to the complexity of regulations. Several worry that detailed focus on technical accessibility derails from the mindset of designing quality products for all. Participant 24 describes the WCAG guidelines as a *"wall of text"*, making it hard to create enthusiasm among peers who do not (yet) have UD interest.

Technological Influence

Technologies may either be UD-promoting as “Technical Drivers”, or obstruct UD as "Technical Challenges". For example, on the aspect of new technology, Participant 20 states his iPhone is *"the best that has happened for universal design in the last 10 years"*. The reason, he explains, is due to the diverse range of smartphones pushing simplified UIs, responsive and adaptive designs. Participant 27 wants to use new technologies for tech-insights into disabled user perspectives, such as VR and AR (virtual and augmented reality).

On the other hand, both old and new technology can cause trouble. Participants 11, 12 and 13 describe how online trends may disrupt web accessibility, such as *"Flash, when that was hot"*. Some “Frameworks” obstruct UD. Participant 10 mentions JavaScript libraries, Twitter, Bootstrap, Angular, React and Content Management Systems. Participant 19 explains sometimes being *"stuck with existing conventions on how implement functionality"* in legacy systems that are not UD compliant.

Other frameworks support accessibility; five participants commend Apple; two commend Google; Participant 18 applauds Microsoft and Participant 19 Android. Participant 16 details how Apple and Google incorporate UD in their design principles[11]. When developing applications on these platforms, both ready-to-use library components (e.g. automatically adjustable font sizes, accessible menu selections, voice-over, and appropriately sized tap surfaces) and design guidelines assist UD. For iOS, following their guidelines enables built-in iOS device accessibility preferences can be used for further individual adaptation.

Mass Media Influence

Mass media is less mentioned than policies and technologies, but our data shows positive media attention on the importance of UD is promoting (especially when speaking to our emotions and values), while negative media on the futileness or cost of UD hinder initiatives. Please note that codes related to efforts taken in order to avoid media bashing are categorized in the promoting Organizational factor "Reputation".

Organizational Factors

The term "Organizational" covers all management levels from product owner to HR-department, including codes referring to clients for consultant participants. On Organizational level, a strategy for and cultural understanding of UD are promoting factors, while "UD Resistance" is obstructing.

11 Please refer to Apple’s "human guidelines", Google’s "material design"

Organizational Culture

The first promoting main-category "UD Anchoring" holds sub-categories "Awareness" and "Priority", which are both CSC. Both visual designers and developers are mentioned as sometimes showing "Resistance" to UD – unwilling to make the necessary changes to their work.

Organizational Strategy

The second promoting main-strategy on organization level, "UD Strategy", holds the third and final Organizational CSC: "Competence Building".

Within "UD Strategy" we find six sub-categories; "Reputation", "Visibility" "Competence Building", "Expert Group", "Disabled Employees" and "Best-Practice Library".

"Competence Building" is focused on in-house activities such as workshops, training and seminars and is as such linked to "Visibility", but includes making sure teams have the UD competence needed.

"Reputation" largely points to external recognition (an ethical and inclusive company, awards, nominations). "Visibility" is focused on spreading knowledge inside the organization, and seems a strategic step linked to promoting a cultural anchoring through a bottom-up movement. There is an overlap between codes in the categories "Reputation" and "Visibility", especially with regards to presence at conferences, which can be visible both internally and externally, and external activities shared internally in the organizations.

Quite a few of the success projects in our sample have established "Expert Groups" as part of the organizational competence development. Some have dedicated UD sections, while others have one or more persons with a special responsibility for UD within other sections. The common denominator is that someone within the organization has been assigned a mandate to ensure or promote UD. These persons are often described as "UD beacons", and are as such persons with a high degree of enthusiasm. They typically try to promote UD awareness and knowledge among colleagues, management and clients.

Competence building is also related to strategic hiring, and represents a top-down strategy to securing in-house UD competence derived from an anchored understanding on management levels. A not so common but seemingly powerful and interesting strategy is hiring people with disabilities, such as developers with severely reduced vision or designers with severely reduced motor skills. "Disabled employees" provide organizations with in-depth competence on assistive technologies (AT), easy access to real-life marginalized users for testing and experts for AT quality reviews and design guidance. Having disabled colleagues also seems to make the issue of inclusion more real, and promote organizational awareness.

Several participants recommend establish a "Best-Practice Library" of re-usable and validated code/solutions in order to spread best-practice and good examples.

Processual Factors

Processual factors point to all activities and actions taken within a project; including the team composition and collaboration, the process model and phases, methodological approaches, priorities and allocated resources. The majority of factors influencing UD success in our sample are such Processual factors, with 8 CSC.

Resources

First, all participants mention needing resources to achieve UD; lacking resources obstructs and adequate resources promotes. "Time and Budget" are the primary resources mentioned, with "Equipment and Human resources" close behind – and both are CSC. Participant 17 explains: *"the thing is, we had a client – Project 16 – who was willing to pay for this, for them this was important. And that's what made it possible. And that's the problem today. It isn't that we can't do universal design well enough. One can surely never be good enough, but we can do it quite well. The reason why we don't do it in many apps today is because the customer isn't interested in buying it."*

User & Expert Quality Assurance

Spending time on UD, takes up resources that could have been used to implement or quality assure other aspects. Finding the time to do thorough "Quality Assurance" (QA), particularly user testing, thus seems difficult without adequate resources. Participant 10 says on the subjects of resources and quality assurance; "*how much time do we have to do the job? (…) Professional resources - do we have interaction designers, do we have interface programmers, do we have UD specialists, usability specialists, available? Test-lab, is it unavailable? Do we have, like for the X solution, do we have a <users> to test with?*"

Wide ranges of QA methods are used, with two CSC: early, direct, informal and frequent "User Testing" (preferably with real and disabled users), and frequent "Internal quality control" (code validation, peer review inspections etc.). "Team collaboration" is the fifth CSC on Processual level, and points to cross-disciplinary efforts during design, implementation, evaluation and improvement of the solution.

UD from the Start

An early UD focus is critical*: "So, I think it's very important to have it from the very beginning. It applies to the almost everything like that (...) it will be abandoned if you wait to implement it"* says Participant 1. This factor is expressed in the CSC: UD "Requirement specification". Participant 2 describes how requirements lead to focus and resources: *"But we got it in already in the requirements, and created non-functional requirements, sort of from the WCAG guidelines but with more focus on the users, so you got more like, "Ok, as a blind user, I should be able to..."*

UD embedded into UX-Work

Lastly, our data strongly suggest there are huge overlaps between UX and UD work, and the final two CSC on Processual level refer to this finding.

A "Continuous Focus" on user needs is a CSC – not separating between UX and UD work. This is a common trait in the successful projects.

The other CSC is on UD/UX "Needs Integration" between marginalized user needs and mainstream users needs, across devices and contexts of use. In fact, based on our data, UD could be interpreted as "UX for all". Participant 10 says: "*As I see it, it's part of the quality of use, user experience like the big umbrella, then it's usability, and then you have accessibility, universal design for everyone*".

The process issues faced and the UD obstructing factors on Processual level seems to fit well with general challenges for integrating UX work into ICT-development processes.

Personal Factors

Personal factors refer to the mindsets, attitudes, competences and experiences of individual team members. On the promoting side, two main-factors are identified: "Competence" and "Personal Qualities".

Competence

Competence is divided into the sub-factors "Experience" and "DfA Mindset", of which the latter is a CSC.

Technical accessibility "Experience" amongst the team developers seems a particularly important competence to secure on the team. Participant 1 explains: *"…a lot of developers don't know enough about (UD), so you still have to school them a little, or point out things... And when you don't have the technical competence yourself, this is not always easy."* Even so, the knowledge and experience aspect of competence is not a CSC. Understanding the DfA mindset aspect of competence however, is.

The DfA mindset points to a generally strong end-user focus, and an overlap between UX and UD: *"When we say 'design for all' - then we think basically 'good for everyone'"* (Participant 26). Several participants suggests including developers and other team members not normally involved in UX work into user tests, in order to promote both user focus, user empathy and a DfA mindset. Participant 27 tells us *"..anyway when sitting together with them (users), and review, the one who was blind sits and explains and shows how he uses a website and how he would find things, then you learn an extreme amount from it, and you keep this knowledge with you for the rest of the project."*

Personal Qualities

The category "Personal Qualities" hold five sub-factors; "Interest" and "Enthusiasm" are CSC, while "Innovating", "Empathic", and "Teachable" are not.

That team members are interested in UD relates to being positive about UD. This is in many ways opposite to the content of the obstructing Personal main-category "Lack of Personal Qualities". Being uninterested and negative is connected, and likewise being interested and positive.

The presence of "Interest" and "DfA" insights seems to positively affect the level of practical competence, at least if team members are "Teachable". Together, they are viewed as forming an approach to developing competence as a team effort over time: *"Because if you understand* *why* *you do something, then you have the motivation to do it. But if you only see it as a checklist that you have to read through and comply to, it'll be, like, substantially harder."* (Participant 29).

"Enthusiasm" refers to someone on the team being passionate about UD, and typically boosts interests and focus in a project. If team members understand the purpose – e.g. the "DfA Mindset", this may help create "Enthusiasm". Alternatively, if the team is negative, the "UD beacons" seemed to feel they were "nagging" and critizising others for doing things wrongly. Participant 2 says it well in this quote: *"And you will sort of constantly meet resistance in some way, and if someone realy emphasize it (resistance) - then its really tough to do the work"*.

CSC Relationships

On the Societal CSC "Legislative Support", participants expressed how the Anti-Discrimination and Accessibility Act (BLD, 2017) boosted mandates to create inclusive solutions, while the threat of fines ensured a minimum priority from stakeholders. Participant 23 states: *"It's a shame to say it, but it's the law and regulation that promotes it here (state agency)"*.

Personal Factor Influence

A "pointing fingers" approach of critizising others for doing things wrongly was however not always motivating. An alternative approach was influencing Personal CSC: "Enthusiasm", "Interest" and "DfA Mindset" and develop competence over time, as a team effort. Personal qualities were affecting each other in the stories told; as each team members influenced the next; either i) derailing UD efforts by being uncooperative and negative, ii) being generally obstructing by not being interested, iii) being generally supporting by being somewhat interested, willing to learn and share knowledge, or iv) spreading UD enthusiasm and actively advocating for higher priority.

Personal attitudes were of course not formed in a vacuum. Indifference to UD on management levels, as well as lacking colleague encouragement, was described as detrimental to the enthusiasm and focus on UD in a project. This coincides well with Khang and Moe (2008).

Getting disabled co-workers, on the other hand, made UD something tangible and self-explanatory. Of course, your colleague should be able to use the solutions you create! As such, Personal factors were influenced by both external factors such as legislation that set a benchmark for professional conduct, and internal Organizational factors that promoted UD values.

If at least one team member was enthusiastic about UD, and the rest of the team was positive to doing UD and understand the mindset of "usability for all", then the three Personal CSC factors were sufficiently fulfilled. Participant 6 summarizes the link between these Personal factors in the statement: *"It's hard to pintpoint the perfect way to do things (in order to secure UD), but summarized it's the knowledge among those who are involved; interest, enthusiasm - spreading it. Someone have to 'pull the loot', someone must 'be the beacon' (showing the way) and push on. And also to seeing the users. That's the most important thing, I think, the most effective thing. It also increases interest"*.

Some may wonder why competence is not a CSC, and not highlighted more in this article. Though UD competence is viewed as important, competence in itself did not seem to matter too much if the will to reach for UD qualities was not there. Participant 2 says it well in this quote: *"But if they don't care if the contrasts are good enough or not, it (designers or developers skillsets) doesn't matter. Then it (the solution) won't be (universally designed)."* As such, you need team members that are teachable and positive to learning and sharing UD insights, and time to learn – but not necessary highly skilled in UD at the start of the project.

Processual Factor Influence

In addition to adhering to technical accessibility standards and ensuring assistive technology compliance, the successful projects aimed for UD as an extension of UX. Participant 10 explains; "*As I see it, it's part of the quality of use, user experience like the big umbrella, then it's usability, and then you have accessibility, universal design for everyone*". A lack of DfA mindset may lead to indifference: *"I generally feel that people are ready to receive input (about UD) - at different levels. (…) But I have also received feedback like 'Ok, why should we spend time on this? It's only 1% of users who...is it so important?.'"* (Participant 4).*"*.

UX and UD aspects were typically quality assuring simultaneously. A wide range of quality control methods were used for this, such as external assessments by third parties, frequent internal expert evaluation, code validations and peer reviews and testing with real and disabled users early, directly, informally and frequently. Cross-disciplinary team collaboration seemed necessary for optimal results, and was interpreted as related to how features are designed, implemented and iteratively improved through collaborative, early and continuous QA work, such as low-cost internal evaluations and user tests.

Organizational Factor Influence

Lack of management and client focus on UD was a problem for the resource allocation (the amount of time and efforts allocated to ensure UD). All participants described how adequate resources are necessary in order to do UX and UD work. "Time and Money" were the primary concerns, with "Equipment and Human resources" a close second. Participant 21 stated: *"I think if I'm to be completely honest, I think the customer had decided to do it. And they ordered it from us – they wanted to be good at it. I think that was absolutely crucial. That means we could, and in some way had to, spend a lot of time on it, on universal design. But if it hadn't been part of their order, we would probably not have done it, so .. that the customer was a good procurer, I think was absolutely crucial."*

We thus identified key factor connections between 1) a project owner that asks for UD: affecting 2) the resources given a team, and 3) organizational aspects such as culture and competence building strategies over time. Alternatively, between A) the enthusiastic team member who takes on the role of "a UD beacon", B) spread UD interest in the team, and thus C) avoid scenarios such as Participant 14 described; "*I use a lot of my free time to get more information about things. Since you have little time for it at work, there are many evenings where I sit and read, but then perhaps universal design is not what I choose first.*"

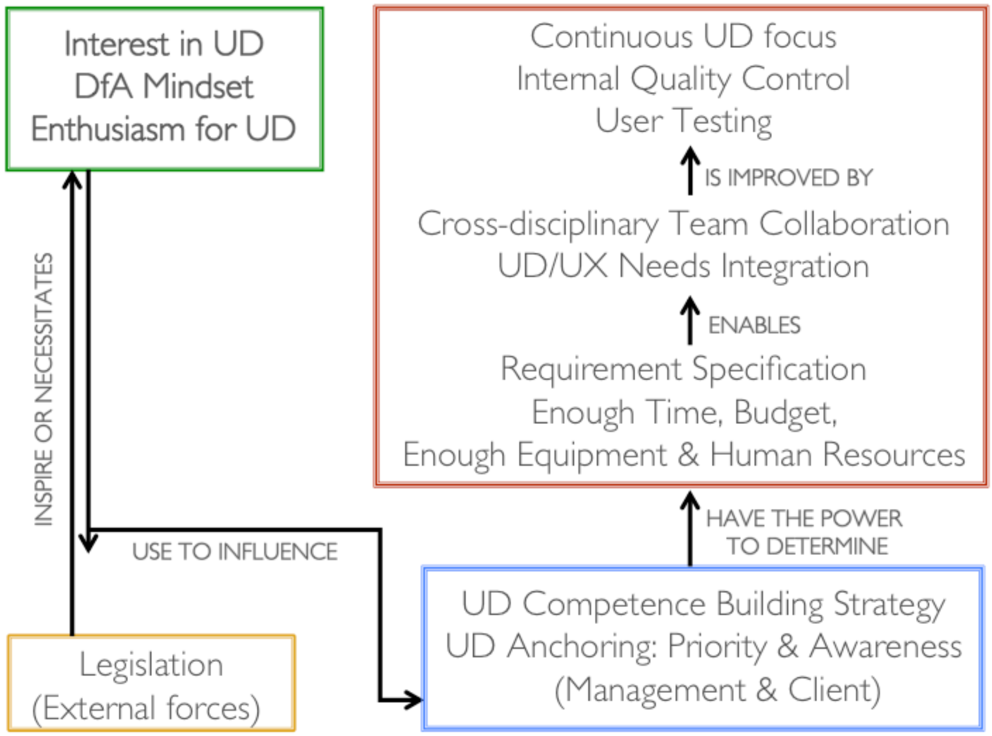


Figure 49: Critical Success Criteria relationship illustration

Figure 49 summarizes how we view the relationships between the levels of characterizing factors based on the stories told in the interviews. Through the thematic analysis, we identified three main narratives:

1. Grassroot Enthusiasm

We see that many enthusiastic or ethically focused professionals utilize the legislation to influence the client or organization they work for to prioritize UD more. Positive team dynamics, positive attitudes to UD on all levels and enough allocated resources are thus examples of critical aspects in order to succeed – and not the competence of the team at the start of the project.

If the Personal CSC are in place, and the team was given the "go ahead" on how to prioritize UD over other aspects and the resources allocated to UD work, then the team was likely to put efforts into achieving the stated UD goal. Usually this worked well. The successful projects saw UD as an extension of UX, with a DfA mindset pointing to user focus.

2. Legislative Force

The stories that told us of the greatest collaboration problems and UD resistance is usually the ones where there is little management or client interest in UD. In these cases, the legislation became more important, in order to force a minimum level of accessibility.

3. The Client is Right:

Apart from grass root enthusiasm, the management levels, and the client in particular, had the most direct power to determine the Processual CSC, such as resource factors and weight given to UD aspects over other aspects.

Applying Herzberg's Dual-Factor Theory

Corresponding Factor on a Gliding Scale:

As Figure 18 illustrated, many obstructing and promoting factors corresponded to each other.

For example, the sub-category "Framework" within the category "Technical Drivers" was found on the promoting side, but the same "Framework" sub-category was also found on the obstructing side within the category "Technical Challenges". Thus, findings indicated frameworks could both aid or hinder UD, depending on their levels of inherent (in)accessibility.

Likewise, media attention could be either "Positive Media" or "Negative Media" (assuming not all media is good media).

Similarly, Organizational "Resistance" opposed "Anchoring", while sub-categories "Ignorance" and "Indifference" was narrated as corresponding to a lack of "Awareness" and "Priority". While "Awareness" referred to management and project stakeholders (on all levels) holding a positive understanding of UD, "Ignorance" pointed to management and project stakeholders viewing UD as something irrelevant, often paired with a lacking focus on user needs in general. "Priority" was narrated as taking UD seriously, investing in real-life practice, while "Indifference" codes pointed to a weak or missing focus in the organization or from the client.

Another example is found on a Personal level, where "Lack of Personal Qualities" was divided into the two sub-factors "Uninterested" and "Negative". The former was viewed as in opposition to the personal quality "Interest", and the latter was narrated as the opposite of "Enthusiasm".

These examples illustrate that corresponding factors were identified on all factor levels. Further they indicate that many factors could be viewed as on a gliding **scale** from negative to positive.

One could envision Tech frameworks, Media attention, Organizational cultures and Personal attitudes that were "neutral" – neither facilitating nor hindering UD – though these were neither asked for nor emphasized in the participants narratives. The question then asked, was whether there was a **sufficient presence** cut-off to avoid hindering UD for these factors. In other words, should the factors that could be both viewed as on a gliding scale be considered **hygiene** factors.

Hygiene Factors must be Sufficient on this Scale:

Hygiene factors do not necessarily promote UD if increased beyond sufficient presence. For some factors, this fit very well. Resource was an obvious candidate, as lacking resources to do UD work were clearly detrimental. However, unlimited access to users, time, equipment and staff was not necessary either. What you need is **sufficient** resources. In the case of Resource, a minimum of resources must be present in order for experts to choose appropriate approaches, but resources were not narrated as key influencers in themselves.

Other hygiene factors were less apparent, but were equally interesting to investigate. If legislation is a hygiene factors, as Participant 22 indicated when talking about using legislation to push UD priority: *"Then you have no choice, but that's not to say that it is the main driver to do the job well"*, then legislation will on its own only advance minimum requirements. Further, if it is possible to avoid negative consequences of breaking the law, then the UD focus may simply be disregarded.

We hypothesized it is beneficial to distinguish between **hygiene** factors that are obstructive when (too) absent, and **motivators** assumed to always increase the likelihood of UD when increased.

Motivator Factors:

Investigating the data, we found that all factors categorized in "UD Strategy" were likely motivators, as were the UD/UX Integration sub-factors "Needs Integration" and "Simplicity/Mobile First", all factors under "Quality Control" and the Personal Qualities sub-factors "Teachable", "Innovative" and "Empathic".

Factor Categorization based on Applying Herzberg:

Using Herzberg to classify the 84 characterizing factors, we identified as hygiene factors:

- All Societal factors
- Cultural Organizational factors
- Resources provided (Processual)
- How early and strong the UD focus is (Processual)
- Process qualities, such as flexibility and collaboration (Processual)

The following were classified as motivators:

- Strategic Organizational factors
- UX and UD integration (Processual)
- All the UD QA activities (Processual)
- Personal abilities to empathize, learn and innovate

Applying Herzberg to the 15 CSC, the following 10 were classified as hygiene factors:

(1) Legislative Support (Societal)
(2) UD Awareness, (Organizational)
(3) UD Priority (Organizational)
(4) Continuous Focus (preferably iterative, Processual)
(5) Cross-disciplinary Team Collaboration (Processual)
(6) Enough Time & Budget (Processual)
(7) Enough Equipment & Human Resources

(8) Design for All (DfA) Mindset (Personal)
(9) Interest in UD (Personal)
(10) Enthusiasm about UD (Personal)

and the following 5 as motivators:

(1) Strategic UD Competence Building (Organizational)
(2) Requirement Specification of UD (Processual)
(3) UD/UX Needs Integration (Processual)
(4) User Testing (preferably with real and disabled users, Processual)
(5) Internal quality control (code validation, inspections etc.) (Processual)

Applying Fogg's B=MAT Theory

For Fogg's B=MAT model, we had already identified motivators by applying Herzberg. Next, we translated Herzberg classified hygiene factors into Fogg **abilitators** (e.g. the projects abilities or limitations).

What we did not know in relation to Fogg's theory on human behavior was which, if any, CSC was **trigger** factors?

Legislation

Based on the narratives, we knew that the **legislation** was sometimes the only thing forcing UD in ICT projects. Participant 12, a consultant, said: *"We try not to use the law more than necessary, but we can resort to it if nothing else works"*. The current legislation seemed vital to enforce resources and protect against budget cuts in projects were UD was not a priority. Thus, we hypothesized legislation was a trigger factor.

However, it was generally narrated as a negative to have to resort to the legislation as an enforcing mechanism, instead of as a mechanism for promoting awareness. Instead, participants wanted to spread a positive attitude.

Enthusiasm

This brought us to **enthusiasm** about UD as a narrated second trigger factor.

Projects seemed to benefit greatly if someone inspirational took responsibility for UD. Someone enthusiastic about UD often used the law as leverage, to secure a mandate for taking on UD responsibilities. Sometimes, this "leverage approach" empowered individuals to call for increased prioritization and competence building, either within a project or within the company organization. This narrative also strengthened our assumption of legislation as a trigger factor.

In parallel with this "leverage approach", several funneled their professional enthusiasm and knowledge of UD to colleagues, clients and management. In some cases, UD awareness seemed to slowly be internalized in the organizations or clients originally *not* interested.

The participants stories also indicated grass-root movements used external factors apart from legislation to influence their workplace, in order to become more aware and strategic; for example if media attention and awards created a positive external UD image, enthusiast would inspire the management to keep up their good UD reputation by increasing UD priorities.

UD Requirements:

The narrations indicated an organizational UD culture would provide UD focus and priorities beyond what the legislation was able to ensure on it's own. In particular, we discovered that when a project owner (either from internal management or from an external client) specified an order for UD requirements (requirements specification), this triggered that the necessary resources for meeting these requirements were allocated – including e.g. training and external evaluations. Participant 7 summarized: *"Cause if they have the awareness, they will probably find money."*

Thus, specifying clear **UD requirements** was the third trigger identified.

III.I.I Factor Categorization based on Applying Foggs:

Applying Fogg's theory to the CSC, we found

8 abilitators:

(1) UD Awareness, (Organizational)
(2) UD Priority (Organizational)
(3) Continuous Focus (preferably iterative, Processual)
(4) Cross-disciplinary Team Collaboration (Processual)
(5) Enough Time & Budget (Processual)
(6) Enough Equipment & Human Resources
(7) Design for All (DfA) Mindset (Personal)
(8) Interest in UD (Personal)

4 motivators:

(1) Strategic UD Competence Building (Organizational)
(2) UD/UX Needs Integration (Processual)
(3) User Testing (preferably with real and disabled users, Processual)
(4) Internal quality control (code validation, inspections etc.) (Processual)

3 triggers:

(1) Legislative Support (Societal)
(2) Enthusiasm about UD (Personal)
(3) Requirement Specification of UD (Processual)

Modeling the Project-level ICT-Industry Project Behavior using Fogg's

As abilitators, motivators and triggers were identified, we could now map these factors into Fogg's B=MAT model for human behavior. Figure 50 shows the results of this mapping.

The green area in Figure 50 illustrates where UD triggers will be successful. As Figure 50 shows, increasing **abilities** to do UD decreases the needed motivation in order for a **trigger** to be successful. Likewise, when the **motivators** to do UD increases, a trigger factor may work even with quite limited abilities.

Our triggers are mapped into the green area of success. Any triggers are successful only as long as the combined ability and motivation in the B=MAT is above the "Success" line. If the motivation and ability relationship falls beneath the "Success" line and out of the green area, then a trigger will fail to take effect according to Fogg model.

Note also, that if the motivation and ability relationship is within the green area, but there is no trigger, then the behavior of ensuring UD will likely not take place.

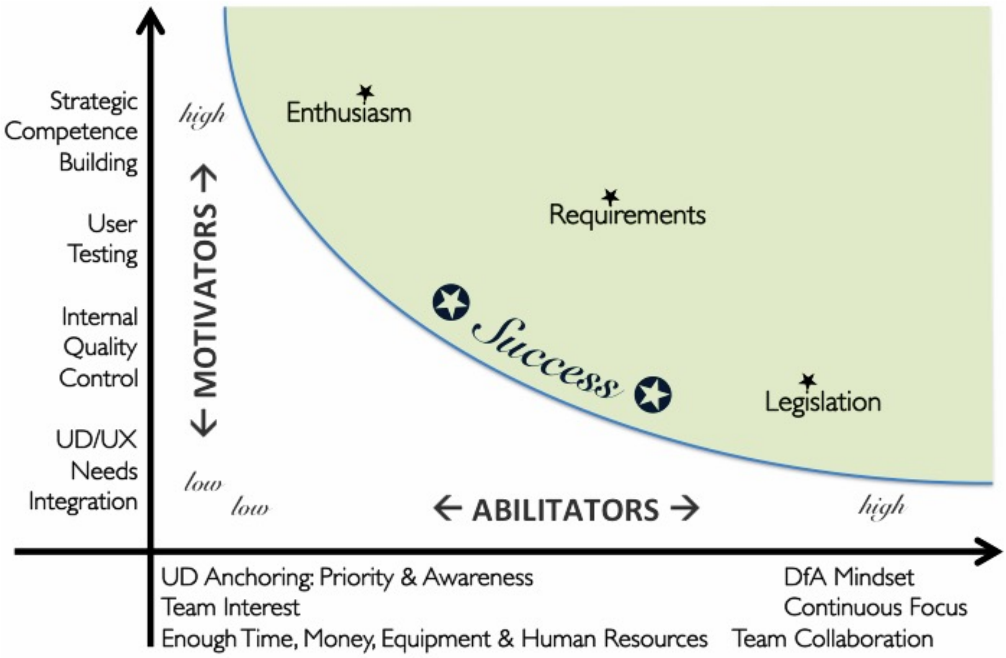


Figure 50: Project-level behavior - CSC triggers, motivators and abilitators for ICT-projects

Trigger Factor Successfulness Mapping for the ICT-Industry:

Based on the qualitative narratives and our interpretation of the factors, we hypothesized that the **legislation** triggers UD even when the motivation is quite low, while **enthusiasm** triggers UD even when the abilities are quite low (see placement of trigger factors in Figure 50).

As specified UD **requirements** may come as either an external or internal request, we view this trigger as taking effect in contexts with both some motivation (either due to in-house culture or as result of wanting to satisfy a client) and some resources (as requirements are described as triggering UD focus, priority and resource allocation).

Including HE-Sector Data into Fogg's Model

From the Study 5 case study on digital assessment procurement, we interviewed 21 participants; two solution providers and 19 from HE administrations. We detected several challenges, which seemed fairly consistent with other research findings. Overall, while the success project sample from Study 4 map both positive and negative factors, while Study 5 mainly detected negative mechanism obstructing UD.

Our interpretation was the identified negative mechanisms could be classified into the factors:

- Lacking UD Awareness
- Lacking Knowledge of Technical Possibilities
- Lacking Knowledge of Legal Responsibilities
- Lacking UD Capacity Building
- Lacking End-User Participation
- Lacking UD Quality Assurance
- Lacking Real User Testing
- Lacking Discussion of Digital Transformation and Value Effect
- Underutilized Technical Accessibility Competence
- Underutilized Contextual Usability Competence
- Weak UD Responsibility Assignment
- Weak UD Requirements
- Staff and Change Fatigue

On the positive side, budget constraints were not emphasized.

Analysis of Study 5 Factors based on Herzberg and Fogg

We viewed the HE-sector procurement of ICT-solution as a specific case within the larger IT-industry. By comparing the CSC to the above-identified factors, we classified abilitators as:

- UD Awareness
- Knowledge of Technical Possibilities
- Technical Accessibility Competence
- Contextual Usability Competence
- Low Staff and Change Fatigue
- Enough Resources

and motivators as:

- UD Capacity Building
- UD Aims - Value Effects in Digital Transformation
- Real User Testing
- UD Quality Assurance
- End-User Participation

- Clear UD Responsibility Assignment

No data from Study 5 related to narratives on trigger factors was inconsistent with the triggers identified for the ICT-industry success projects. Our hypothesis was therefore that clear UD **requirements**, legal **responsibilities** and bottom-up UD **enthusiasm** are triggers. However, from the Study 5 data set, we only clearly identified the following two (which are today negative) triggers:

- (Lacking) Knowledge of Legal Responsibilities
- (Weak) UD Requirements

There were no documented trigger effects from professionals enthusiastic to UD from the HE case study. What we saw was a lack of hands-on UD competence on the HE institutional side; wich was further coumpounded by a lack of real-life testing with disabled students prior to delivery. In addition, there was little to no student and staff participation, user testing and in-context quality control and our interpretation of the interviews were the pedagogical values or cost-effectiveness from the new digital assessment solutions were unclear.

As a result from these process issues, current issues were unsolved and in addition new issues were introduced. We learned that non-digital individual exam adaptation was costly and strenuous for the student, as well as HE staff. Still, the new mainstream digital assessment solutions were not suitable to solve these very real and apparent issues. Instead, they posed new issues, by demanding the use of digital assessment solutions with low accessibility. Further, the digital assessment solutions replicated closed-book exams on campus computers (digitizing rather than transforming) and thus hindered access to assistive technology needed by disabled students.

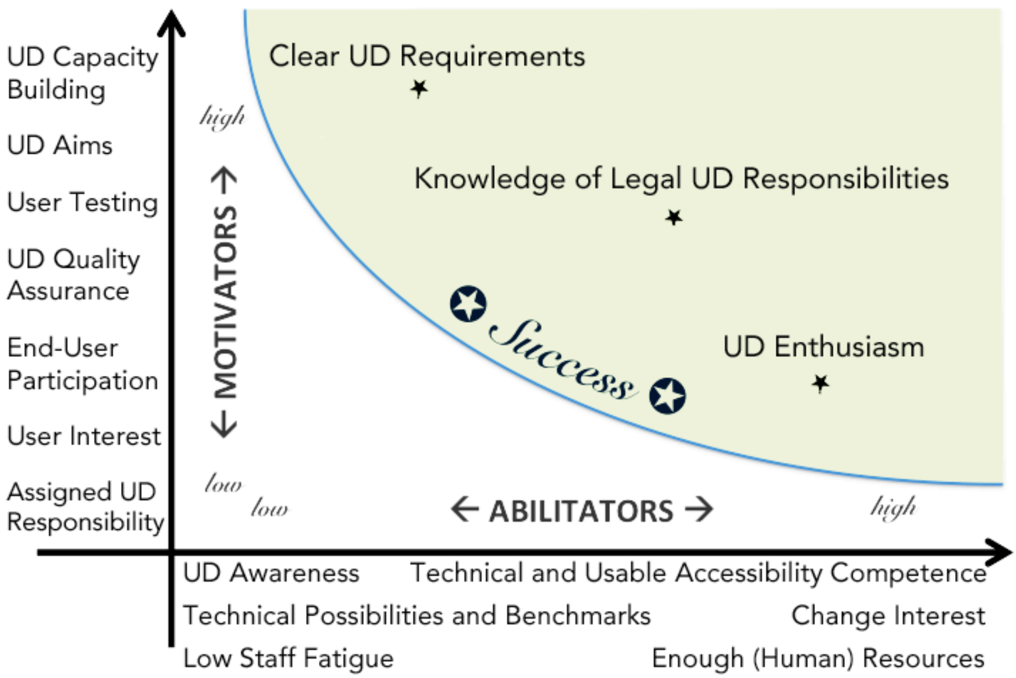


Figure 51: Project-level behavior: triggers, motivators and abilitators in the HE-sector

Including HE-Sector Data into the Project-level Behavior Model

The ICT-project findings were our starting point for understanding the dynamics of what is (not) working in our HE sector sample. Figure 50 proposed triggers, motivators and abilitators necessary to fail or succeed with triggering UD for ICT-industry projects, based on our insights.

Drawing on more HE cases and experiences, we updated the model to reflect factors and mechanisms identified in the HE sector.

Study 8: Discussion

Our Study 8 Project-level behavior model, largely based on Fogg's theory on Human behavior, provided a starting point for understanding the dynamics of what is (not) working in our Study 4 and 5 samples. Based on a theoretical evaluation of the type and nature of identified factors and key insights, we theorized "triggers" for UD actions in ICT-projects.

We hypothesized "abilitators" and "motivators" by applying Herzberg's dual-factor theory to our data set. These are more tentatively hypothesized than the triggers, and we do not feel we have the insights to be fully confident in determining whether all factors are correctly categorized.

The main contribution on this issue is not whether specific factors are correctly classified. Rather, our contribution is the theory that a dual-factor classification of influencing factors is a valuable way of understanding their nature, and as such their influence importance.

This section discusses what interventions we consider likely to have the largest effect on promoting that best practice for UD of ICT is followed, based on the new theoretical insights. We now have the basis for discussing which actions we may take moving forward, and that could potentially "trigger the triggers".

First, we analyze the interpreted narratives related to the three identified triggers in order to propose possible interventions, both for the HE sector and for the IT-industry at large; Legislative Interventions, Requirement Interventions and Enthusiasm Interventions. In total, 11 possible interventions are proposed.

Next, we discuss the status of these 11 possible interventions in the local context of Norway, and share our views on what future actions could be taken.

Legislative Interventions

Legislation seemed effective for triggering a minimum of UD quality.

However, the legislation is only a trigger when it is known. For the success project Study 4 sample, this was the case. However, the HE sector was not aware of their legal responsibilities – even if staff had followed the UD of ICT regulations since 2014, and should have in-depth knowledge of technical accessibility. Though legal demands are clarified in the updated law, there has been little work done yet to "spread the word" and inform the HE sector of their institutional responsibilities related to UD. The following intervention was thus formulated:

- **Intervention 1: HE Vice Chancellorship training in Institutional UD Responsibilities**

Any UD efforts in projects with a high degree of UD resistance are likely to depend on legislative enforcement. Some Study 4 participants narrated how a lack of real-life consequences for breaking the law could be detrimental to its trigger effects. A UD focus relying on legislation could end if possible negative consequences can be avoided. Larger organizations seem to view the threat of fines as more real than small businesses. However, current legislation may not work that well for "less serious" industry actors. EUs proposal of placing responsibilities for ensuring UD across all links in the development process is interesting in this regard (EU, 2016b). As such, the following possible interventions were suggested:

- **Intervention 2: Increasing UD Responsibilities to cover Contractors**
- **Intervention 3: High Fines for Companies Breaking UD Legislation**
- **Intervention 4: Increased Fining of Small and Medium-sized Companies**

Finally, several participants worried that the focus on technical accessibility (the minimum legislated in Norway) derails from the desired DfA mindset. One could therefore consider adding to the UD regulations to better promote DfA perspectives. Usable accessibility must be specified related to the context and aim of the digitalization, e.g. demanding process documentation could be valuable. This approach is in line with our previous arguments on strengthening the focus on usable accessibility aspects, and is supported by several professionals working with UD of ICT:

- **Intervention 5: Adding Process Documentation Demands to UD Regulations**

Requirement Interventions

Specifying UD requirements were described as efficient in triggering UD priority and resource allocation. In order to encourage more projects to specify UD requirements, one needs to trigger top-down strategies derived from management levels. Anchoring UD values among project owners is a powerful approach to inspire a maximum of UD quality within the available limitations of a project. We therefore propose increased attention on raising awareness among procurers of ICT-solutions, especially in public sector, and propose best practice example versions of UD requirements specifications are made available both to industry and public sector:

- **Intervention 6: Public Procurement training in UD Requirement Specification**

Creating tools to facilitate UD discussions among project stakeholders at the start of a project is also considered a potential tool to anchor UD values. Creating checklist-based integrations to project management tools is also an interesting approach to highlight UD best practice at a management level – e.g. propose QA and DfA activities at certain intervals or in certain phases:

- **Intervention 7: Creating Project Tools for UD Planning and Management**

Further, real-life utilization received too little attention in the Study 5 case, with a resulting feature-density over real-life usefulness for students and staff. Rather than focusing on digitizing existing solutions, public sector should explore opportunities for digital transformation. We recommend a shift towards design thinking approaches focusing on universal solutions – "Design Thinking for All" – prior to requirements specification and procurement:

- **Intervention 8: Promoting Design Thinking for All prior to specification**

Enthusiasm Interventions

Having at least one person enthusiastic about UD on the project, or as your colleague, was mentioned very frequently as an important success factor. As discussed in the Results section on CSC Relationships (and visualized in **Feil! Finner ikke referansekilden.** 50), the enthusiasm of single individuals can spur powerful grass-root movements, using legislation as leverage for a minimum UD.

We reflected on the narratives in order to understand what seemed needed to inspire and empower persons to become such enthusiastic UD-promoters. Our assumption is that learning about UD, and understanding the DfA solidarity mindset, was important. This learning process could even be because your customer (or boss) told participants that they had to know this – and it would still seem to have a motivating effect. Further, personal experiences with colleagues, family, friends or end-users could lead to a deepened and value-based motivation.

Some participants complained that developers were not skilled in UD requirements from their educations. Others told us the designers were the issue, as they felt UD hindered their artistic freedom. We hypothesize that is engineering and design students are not being adequately trained in accessibility responsibilities; they might be resistant to regulations in their professional work. However, if best practice and quality control are ingrained as part of their education, they are considered likely to apply and share this competence in their workplaces. We thus argue for:

- **Intervention 9: Embed UD aspects into all study programs targeting the IT-industry**

For industry practitioners, UD in-situ training interventions could be created:

- **Intervention 10: In-situ Industry Training for ICT-creators, designers and developers**

Participant 24 described the WCAG guidelines as a *"wall of text"*. Participants told us *"hundreds of thousand of requirements"* was both personally demotivating and made it hard to create enthusiasm among peers who did not (yet) have a UD interest. Thus, an appropriate strategy could be to simplify regulations:

- **Intervention 11: Increasing the Readability of Guidelines & Regulations**

Local Intervention Status

We know had a set of 11 possible interventions, informed by our theoretical model:

- Intervention 1: HE Vice Chancellorship training in Institutional UD Responsibilities
- Intervention 2: Increasing UD Responsibilities to cover Contractors
- Intervention 3: High Fines for Companies Breaking UD Legislation
- Intervention 4: Increased Fining of Small and Medium-sized Companies
- Intervention 5: Adding Process Documentation Demands to UD Regulations
- Intervention 6: Public Procurement training in UD Requirement Specification
- Intervention 7: Creating Project Tools for UD Planning and Management
- Intervention 8: Promoting Design Thinking for All prior to specification
- Intervention 9: Embed UD aspects into all study programs targeting the IT-industry

- Intervention 10: In-situ Industry Training for ICT-creators, designers and developers
- Intervention 11: Increasing the Readability of Guidelines & Regulations

The next sections briefly discuss their assumed status in the local context of Norway. Upon research, we found some of the intervention had already been initiated (at least partly) in Norway:

Intervention 1: HE Vice Chancellorship training in Institutional UD Responsibilities

This intervention has not been started yet, however, rumors are the Difi is going to review the HE sector in 2019-2020, as the deadline for adhering to the updated UD legislation that went into force January 1st 2018 was January 1st 2019. As such, we expect inspections, warnings, and possible fines will start be issued to Norwegian HE institutions in the coming years. We further expect the large universities and university colleges will be prioritized.

Difi has a dual UD focus, taking on the responsibility to both advisor and reviewer. We encourage Difi to create awareness training directed at Vice Chancellorships in the HE-sector in parallel with, or prior to, conducting reviews. Based on our interpretations of empirical findings from Study 5, the Vice Chancellorships are likely to not have the Processual knowledge and tools to explore inclusive digital transformation possibilities and shoulder responsibilities for ensuring not only legal technical accessibility, but also contextual real-life value and usable accessibility for their students, academic staff and administrations.

Intervention 2: Increasing UD Responsibilities to cover Contractors

The hypothesized effect of this intervention is to force small and medium businesses that do not care about the current legislation today, to ensure the minimum legal requirements for accessibility as according to the UD regulations. Today, many can disregard the UD legislation, as they have a very low risk of being fined (since the service provider top management, not the service developer or contractor, is the sole responsible today).

As previously mentioned, Intervention 2 was proposed in a new EU directive, which we support. Even if not legislated by the EU, lawmakers still have the opportunity to legislate such a shared responsibility across a production chain in their individual countries. We encourage them to consider doing so, even if this means UD legislation will not be fully harmonized internationally.

Intervention 3: High Fines for Companies Breaking UD Legislation

Some countries seem to have increased fines already. The case of the airline SAS[12] is one example. SAS was reviewed by Difi in January 2018, found to break 20 accessibility regulations on their websites, and given until June to correct them. SAS had only corrected 2/3 of the errors by the June deadline. Difi set a new deadline in August. SAS still did not correct all errors, and Difi started finding them daily from August 8th. By August 16th, errors were still not fixed. Difi then decided to demand daily fines at 15.000 euro (150 000 NOK) from August 30th an onwards. SAS immediately fixed all issues.

[12]Please refer to http://www.cw.no/artikkel/siste-nyheter/sas-slipper-dagboter

The SAS case is still perceived by the Norwegian IT-industry as warnings to service providers. Both the high cost of the fine, and the regularity of fines being given, seems highly efficient in preventing and fixing offenses. We therefore encourage national authorities to continue regular inspections and issuing heavy fines.

Intervention 4: Increased Fining of Small and Medium-sized Companies

Inspections and fines seems mainly targeted to large organizations and businesses so far, and we encourage national authorities to randomly inspect (and in the case of offenses; heavily fine) smaller businesses too – in order to expand the preventive offense effect.

Intervention 5: Adding Process Documentation Demands to UD Regulations

Process criteria and documentation has been advised e.g. in the UK (ACCESS8878, 2010), but not regulated – until recently. The updated EU Web Accessibility Directive (EU, 2016a) now have established a process methodology for quality assuring UD of apps and websites. Note that this process methodology is to be carried out by national authorities (not the providers). Authorities are responsible for monitoring legislative accessibility compliance of websites and mobile applications of the public sector. The methodology combines qualitative and quantitative UD QA, and includes input from a variety of stakeholders, including end user organizations. Some criticize the continued heavy focus on technical accessibility QA to the detriment of usable accessibility, usability and UX – e.g. in promoting automated testing and expert inspections.

WAD (EU, 2016a) also legislated public app and website providers to issue accessibility statement, based on internal, external or government UD assessment. This accessibility statement must: note content that is not Universally Designed, and justify why; provide information on alternative Universally Designed content, if available; and provide a link for complaints.

WAD was enforced in the EU from September 23rd 2018. Norwegian legislation is expected legislated in 2019 and enforced from 2020, and might cover both public and private sector.

We applaud ACCESS 8878, WAD and coming legislations focusing on process methodology and mandatory UD evaluations.

Intervention 6: Public Procurement training in UD Requirement Specification

The role of procurement processes and the requirements set forth in bidding processes seems to receive increased focus, in relation to UD. There have been some full-day seminars on this issue in Norway. We are unsure as to the status of e.g. Difi training on the issue directly to enterprises or public and private sectors, however we encourage Difi to conduct these efforts.

Procurement receives some attention in the Difi guidelines to project managers[13]. We further encourage Difi to write a web-article focusing solely on bidding processes and UD requirement

[13] Please refer to https://uu.difi.no/krav-og-regelverk/kom-i-gang/universell-utforming-i-utviklingsprosessen

specification – similar to articles such as “UD in the development process” from their “get-started[14]” section. We advice them to include in this web-article:

A) Case-based “best practice” examples on how WCAG guidelines can be transferred to UD requirement for specific solutions (similar to the “solution examples” they have for web[15])
B) Advice on how to assess responses and rebuttals from the bidders – e.g. re-framing the WAD-based process methodology for UD assessment to aid them in their UD QA of bids.

We further argue our Study 5 Part 3 contribution presented in Paper 11 could be useful input as an exemplification of “low” versus “high” quality in UD requirements.

Intervention 7: Creating Project Tools for UD Planning and Management

Our Study 4 Part 3 and Study 5 Part 3 efforts were both targeted at such interventions.

As mentioned, Difi has written a web article targeting project managers[16], updated in August 2017. The Difi article is not in-depth, but overviews the following Processual topics:

- User-centeredness, including edge-case aspects;
- UD focus – the aims and ambitions of the projects;
- Roles and responsibilities related to UD and QA;
- Cross-disciplinary cooperation between IxD, visual design, content creation and development;
- Advice on test procedures, including early testing and user involvement;
- UD in requirement specification for external procurement and internal projects;
- Iterative, continuous UD QA post initial release (life-time perspectives)

Difi was among those commenting on our UNIKT early finding presentation. DIFI representatives stated they now felt more confident of their recent update on this “get started with UD” guide to project managers. The advice from Difi in this article and the conclusions drawn on Processual CSC “best practice” from our Study 4 success sample aligned extreme well.

The Difi web article may be regarded as a tool in itself, as it offers an overview of critical project process aspect in order to achieve UD. However, in addition to general advice on Processual topics, more in-depth advice is likely in needed, for each critical project process aspect and Processual level CSC.

We encourage Difi to offer this – or for it to be part of future research efforts. We encourage D Difi to exemplify best practices with validated narrative evidence from industry cases.

At the time of our Study 4 Part 3 and Study 5 Part 3 tool generative research, we were not conscious of the hypothesized role of the tools in relation to the CSC relationship model. Going forward, our contributions can be reassessed and improved from this knowledge.

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14 Please refer to https://uu.difi.no/krav-og-regelverk/kom-i-gang
15 Please refer to https://uu.difi.no/krav-og-regelverk/losningsforslag-web
16 Please refer to https://uu.difi.no/krav-og-regelverk/kom-i-gang/universell-utforming-i-utviklingsprosessen

For example, our proposed overall process model for ICT procurement (presented in Paper 10) appears consistent with Difi views. We thus propose it would be valuable to test the approach in a case study, in order to validate and exemplify its successfulness in use.

The Study 4 Part 3 UD3C project assessment and success prediction tool has the potential to facilitate UD discussions in early project planning, by expressing what is needed for the level of UD quality aimed for in a project to be implemented, and predict if this level can be reached based on current resources and practices.

Further, our Study 5 Part 3 contribution Universal Design Quality (UD-Q) Expert Evaluation, presented in Figure 31 and in Paper 11, could further be a support for managers and teams in moving from UD requirements in the requirement specification, to testable accessibly QA goals.

The feature analysis based Universal Design Quality (UD-Q) Expert Evaluation process can also be used for benchmarking of accessibility on a detailed level, e.g. in projects adding on to existing solutions. This could be valuable as documentation for WAD accessibility statements.

The UD3C tool is also designed for iterative management of critical project process aspects. We envision natural workshop experiments in the ICT-industry to assess how the tool works for planning, communication, evaluation and discussion.

We hypothesize based on UDC3 feedback (Study 4 Part 3), that a checklist-based online tool could be useful for project manager, and that future research on the Study 4 Part 3 tool development should add more detail on criteria assessment.

The hope is such research efforts would also aid Difi in developing specific in-depth advice on the different critical project process aspects. Perhaps Difi or similar authorities should consider the tool, in order to advice on how to utilize the tool or a re-design an improved version.

We believe increased collaboration between industry, researchers and authorities would be beneficial for the promotion of UD tools.

Intervention 8: Promoting Design Thinking for All prior to specification

Prior to initiating large investments in digitalization processes, design-thinking (DT) approaches (including service design) can explore the actual, organization and contextual user needs. Instead of moving directly to lean or agile development, smaller DT projects can facilitate in the identification of solutions that will create the most value. In order to avoid costly specialized solutions – or, in worst cases, digital exclusion – UD perspectives is needed in these DT processes. Apart from our own work on embedding UD in SD, we do not know of such efforts.

Intervention 9: Embed UD aspects into all study programs targeting the IT-industry

This thesis has argued for this intervention in Studies 6 and 7, and made contributions to embed UD aspects into study programs within IxD and SD. HE educators are encouraged to reflect on these proposals, and on what UD expertise is relevant in relation to their courses and programs.

Several research groups and research projects focus on UD and HE today, however most are focused on UDL – the pedagogical practices for ensuring universal learning environments – and not on adding UD content into their discipline specific curriculums.

We encourage more research and discussions on what UD expertise are fitting for, and what UD content should be included in, different HE study programs targeting the IT-industry.

Intervention 10: In-situ Industry Training for ICT-creators, designers and developers

Again, DIFI has done important work on digitalizing guides educating content developers (including social media strategies), and web developers. We commend these initiatives, and based on Study 4 interviews, the work is highly useful for industry.

The DIFI guides are primarily focused on regulated standards for technical accessibility, and not on e.g. visual and service design. Thus, it may be extra important to focus on in-situ training for designers moving forward.

There are several courses and seminars on UD of ICT, but our impression is again that these are focused on the legislated regulations – e.g. on technical accessibility issues and content production. Please note that we theorize a change in legislation, to e.g. include process demands related to UD aspects merged into UX, UCD and SD work, would also trigger seminars, courses and online content covering training on these issues.

Intervention 11: Increasing the Readability of Guidelines & Regulations

Difi have started to take action in simplifying accessibility guidelines, by offering online guidelines advise through seminars and online guidelines [19]. We advice the work should be continued by Difi, especially "how-to" guides minimizing complexity.

Limitations of Study 8

The contribution as of today is merely theoretical – though empirically based. Thus, our assessments and suggestions based on these assessments need further validation. As previously mentioned, early findings were presented at the UNIKT network (UNIKT, 2018). At the point of presentation, the focus was only on the IT-industry, and we had applied Fogg and Herzberg and modeled trigger factors as shown in Figure 50 and Figure 51. The results received a warm reception and exceedingly positive feedback, providing some tentative external validity.

In addition, the fit of our Study 4 and Study 8 findings on the CSC and "best practice" Processual factors for ensuring UD in ICT-projects align very well with the Difi project management recommendations; increase the validation of both sources.

Future research should further investigate "low effort, but effective" interventions. As a first step, notes on future actions proposed by UNIKT workshop experts could be analyzed and compared to our findings. In a workshop following our UNIKT presentation on preliminary findings, the around 50 experts participating at this UNIKT meeting, proposed future actions for promoting UD in the Norwegian ICT-industry. The notes from these workshops were received from the UNIKT participants, for future reference and as inspiration for identifying interventions.

In addition, the nature and narratives of the 71 non-CSC characterizing factors could be analyzed to see if any of these are other potential triggers that should be utilized for further strategizing.

For the HE-sector, the model could also be expanded to better ensure e.g. user participation, social cost-reduction and transformational value – which is assumed sector-relevant aspects.

Towards Concluding on Thesis Contributions

Study 8 applied grounded theory to theorize project behavior from the empirical data. In Part 4, we aimed to advance UD of ICT, and have used Study 8 theory to propose, evaluate and discuss future interventions in this respect. The next chapter will apply this theory to the thesis contribution, and as such highlight the main outcome of the thesis work and conclude the thesis.

Conclusion & Future Work

4 Thesis Conclusion

This thesis set out to investigate what contributes to successfully achieve UD, when legislation is implemented in complex real-life settings, in order to advance the continued integration of UD in digitalized societies. Based on the extensive thesis investigations, this section summarizes and discusses five contributions of particular interest.

4.1 "How-To" Guides

When investigating the interpretation and definition of UD of ICT in legislation as well as among UD "expert" professionals, we found that these were not very concrete or measurable, aside from adhering to specific standards. Although the term UD was quite well established as a mindset, knowledge was lacking on how to operationalize this "legislated ideal" into process decisions in an informed manner. Thus, both industry and HE struggled to identify a "how to" ensure UD of ICT.

We hypothesized methodological industry best practice insights could be useful, in order to extend "UD of ICT" beyond the current (and limited) "what" focus of the UD regulations. Using a mixed-methods approach, the thesis identified methodological practices, and aspects critical to the integration of UD in real world settings. Several applied issues were identified, including:

- No unified understanding of the term "UD of ICT" among professionals.
- Lack of UD focus in the service designer discipline, both in literature and professional practice, and no methodologies for creating inclusive or Universally Designed services.
- No definition for UD of services (nor any budding discussions of what it could entail).
- A lack of UD focus in (Norwegian) HE IxD programs, including failing to train future interaction designers on the current UD legislation and technical accessibility standards.
- A broad range of at least 84 different characteristics common for UD successful projects, spanning at least Social, Organizational, Processual and Personal influences.
- UD in agile settings is under-researched, and face at least five common challenges for UCD integration in agile settings, and at least one additional challenge when adding UD into the mix.
- A lack of UD awareness and responsibilities in public procurements.

In order to advance knowledge on methodological and processual project practices for achieving UD, the thesis analyzed applied issues and identified practices beneficial for securing UD. Knowledge of which factors are influential on the resulting UD quality provides policy makers, project owners and procurers, as well as designers and developers, with a "how to" for ensuring UD of ICT. We found:

- A compatibility of and correlation between UD and end-user (UX) focus in ICT projects, with experts reporting cross-method user-centered approaches with direct end-user contact.
- 15 Critical Success Criteria for project-based development.

Overall best practice recommendation findings can be described as iterative or flexible and user-centered processes, where practitioners move between different doxastic styles depending on the tasks at hand – sometimes focused on gathering information and giving advice, other times on gathering in-depth UX research insights or co-creating collaborative efforts, and finally sometimes on questioning the aims set and exploring alternatives.

To aid projects in assessing their ability to deliver UD of ICT, and how UD may be assured in procurement processes, best practice "how to" analyses were completed. The examples warn of fall-pits, especially in the case of procurement of public services for the HE sector. From this, different tool designs were explored, to better communicate recommended approaches and appropriate prioritizations:

- UD requirements specification example, illustrating the necessary level of early focus.
- Procurement process model, recommending technical and usable accessibility responsibility division and emphasizing user-centered and contextual value outcomes.
- The UD-Q assessment model, exemplifying UD quality expert assurance processes.
- The UD3C tool, articulating and assessing Critical Success Criteria compliance.

These tools can be useful for increasing the awareness of UD, including aspects such as the latitudes, costs and competencies needed. The UD3C tool is believed of especial relevance for facilitating discussions on UD between project owner (or procurer) and project team (or supplier), making clear the expectations and resources allocated to UD and UCD tasks. Further, the UD3C tool can be used to facilitate discussions within development teams – potentially improving the anchoring of a DfA mindset and interdisciplinary collaboration.

In summary, the thesis presents a best practice "how to" guides for UD in development projects and procurement processes. The "how to" contribution is believed to be particularly relevant for practitioners involved in creating, managing and implementing digital solutions, to aid in the planning, quality control and prioritization of UD.

4.2 Predictive Abilities

In addition to the "how to" examples, the thesis also contributes to increased ability to predict and influence resulting UD quality of ICT. Based on the scored compliance to the Critical Success Criteria, the UD3C tool predicts the level of UD. The findings of this thesis are considered to improve the ability of ICT managers to:

- Understand the effect of factors influencing UD.
- Enable early prediction and planning of UD.

Knowing more about how to track and assure quality aspects advances the possibilities for influencing the likelihood of UD in the design, development and procurement of ICT solutions, prior to project start-up or in early phases. This is believed to save costs, and as such can be very useful for project owners and developing organizations.

In addition, the predictive compliance aspects extend the focus from resulting technical accessibility aspects, and measure UD quality based on processual, personal and organizational aspects such as approach, latitudes and expertise. This spurs a discussion on whether critical quality criteria should be legislated, for example in a further researched, improved and validated version. Alternatively, we believe a more viable and positive path forward, could be for national authorizes enforcing UD legislation, such as Difi, to use our findings to further improve their recommendations to the industry on the aspect of "how to" criteria and best practice examples.

In summary, thesis contributions increase the abilities of projects to predict, and subsequently influence, the resulting UD quality in their solutions – enabling UD quality evaluations at the beginnings of development processes, instead of at the end. This is believed particularly relevant for project owners, as well as national authorizes.

4.3 Legislative Proposal

As systems and services based on ICT are prevalent in increasingly diverse and digitalized modern societies, regulations for UD of ICT are continuously updated, both nationally and internationally, in order to ensure all citizens can utilize digital services and solutions. Inaccessible services may increasingly block key aspects of life, and as such educational opportunities and independent living. The Norwegian anti discrimination legislation emphasizes the right to service access, for example on §5e on economic, social and cultural rights and §5f on transportation, parks and hotels (BLD, 2017). The law mandates the right to individually adapted (alternative) services when needed. There is no explicit mention of the services being Universally Designed.

Nevertheless, the UD of ICT regulations cover digital service touchpoints, such as web-forms and apps (KMD, 2013, 2017). As such, the current legislation mandates a) that digital service touchpoints are technically accessible, and b) the right of citizens to being serviced, through individually adaptation if needed. In the case of services, we therefore have legislations on UD for digital touchpoints as well as for architecture and buildings, while other aspects of the service can be excluding (such as signs, queue systems, letters, etc.).

This is problematic as the service in its entirety is inaccessible if not all service journey phases have at least one accessible option, and the user interaction with the service is broken. Thus, resources may be spent both on accessible digital touchpoints and on alternative services, instead of on ensuring Universally Designed services. As previously discussed, we believe service providers should instead assess their services in a holistic manner, and not only the digital touchpoints.

In the case of developing even core public services, such as healthcare services, focus is on ensuring technical accessibility, including compatibility with assistive technologies that disabled user groups need. This forms an important basis for inclusiveness, but disregards usable accessibility aspects and contextual use. In relation to digitalized solutions, marginalized users include persons with physical as well as cognitive limitations, but also people with low socio-economic status or low digital literacy, especially elderly, unemployed, non-native speakers, non-western immigrants and children (Abascal et al., 2015; Cremers, Jansen, Neerincx, Schouten, & Kayal, 2014; Fuglerud & Sloan, 2013; Scott et al., 2015; Slettemeås, 2014).

As such, the current legislation must be updated with regards to the design of services, across service journeys, and for a wide audience (including, but not limited to, persons with permanent or temporary physical disabilities).

This thesis proposes such a definition for ensuring UD of cross-channel services, formulated as: "A service is Universally Designed when its customer journey is usable to all people, to the greatest extent possible and without the need for adaptation or specialized design, by selecting suitable touchpoints".

This UD of services definition, and the related piloted service design approach (from Study 6), are believed to cover all the necessary considerations to ensure services are usable by all.

Moreover, the definition is believed to be measureable and documentable through the piloted service design methodology assessment methods. The assessment approach is flexible:

1. Assessors or service providers have the option to divide and delegate different assessments (e.g. for different touchpoints or for different user groups), and later combined to a holistic whole.
2. Thus, solution providers have the option to involve different teams or sectors in assessing "their" touchpoints or phases.
3. Further, the assessment can be done over time, or all at once.
4. Assessments can be conducted by one person alone (as an expert inspection), or be done jointly by several persons.
5. If jointly, it can either be done by different experts together, or collaborative between designers, owners and end-users (as a pluralistic evaluation).
6. As such, there is ample option to involve end-users to provide input, e.g. ask for proxy users or user representatives from different organizations.
7. Finally, it is possible to ask for third-party assistance whenever this is needed, e.g. in the form of external experts, to do either part of the assessment, or the complete assessment.

As such, we believe the definition could thus be viable to implement into UD legislation.

Further, the definition inspires an empathic and user-centered assurance approach to ensure user groups in danger of exclusion can utilize services, across all touchpoint and journey phases.

In summary, we propose a definition for the universal design of services. The definition is tentatively believed to be regulatable and implementable, as it is measurable and documentable. This contribution can be particularly interesting for politicians, policy makers and national authorizes, in addition to public service providers.

4.4 Re-framing UD of ICT

Since informed operationalization of UD is lacking for the design and development of ICT, researchers and practitioners approach methodological decisions through different strategies. For educators, there is therefore not a united understanding of what we should teach future and current practitioners about UD. Especially for ICT-involved disciplines that deal with UD aspects related to UX, beyond the regulated standards for technical accessibility, the notion of what UD expertise is necessary remains vague.

Some argue that strategies for including UD should come from within the professions in order to become successfully integrated, and not pushed through legislation. One way to promote UD is thus to develop or promote positive doxastic styles (strategies and methodological approaches) from within the disciplines.

Our initial view was of UD of ICT as a united field, where general methodological recommendations could be identified if recognized experts and literature agreed on these specific stances and approaches. The best practice examples previously discussed proposes process criteria to promote UD of ICT, in line with our initial aim.

However, this thesis does not conclude with a specific recommended approach or style on a general basis. The reason for this is our view of what UD of ICT entails has changed. An important insight from the re-framed view is the need for each discipline to evolve and articulate UD best practices. This approach to UD fits the practitioners' viewpoints.

This re-framed view also explains how expert professionals on UD of ICT move between different stances and methodological approaches in a flexible and pragmatic manner, as they hold inter-disciplinary backgrounds and responsibilities (assuming that different disciplinary tasks inspire different approaches).

Based on our in-depth applied insights, we now view UD as an add-on expertise within each discipline involved in the creation of solutions – spanning both current and future disciplines, and both digital and non-digital service aspects. "UD of ICT" thus necessitates UD expertise in ICT-related disciplines.

However, we do not at all view the need for disciplinary specific UD expertise as contradicting the need for clear and demanding UD legislations. Rather, our findings indicate that in addition to legislation, UD needs to be embedded into each of the disciplines involved in the creation of ICT-based services and solutions, to facilitate high UD quality in the resulting solutions. Through the in-depth transcription analysis on factor-relationship, we identified that legislation as a social level influencer could trigger interest for UD knowledge among practitioners. Further, practitioners with personal expertise, attitudes and mindsets are often utilizing legislation to increase the UD focus and priority of colleagues and management.

Further, we still hold initial assumptions that more attention should be given to ensuring usable accessibility aspects of UD. Though the definition of UD of ICT is not clearly operationalized, the legislation specifies technical accessibility quite well. As such, for front-end developers, UD competence is likely more clarified than for UX designers.

Findings from two key UX disciplines related to creating UD of ICT – service design (SD) and interaction design (IxD) – corroborates this assumption, as Studies 6 and 7 show discipline-specific focus on UD is lacking for these disciplines. This thesis contributes in this respect:

- For SD, we define UD of services, as well as:

- The **Inclusive Core-Personas** approach integrating edge-case needs into a personas,
- **Empathic Service Safari** merging empathic design and auto-ethnography,
- The **UD Touchpoint Assessment** method for evaluating touchpoint inclusiveness,
- Holistic **Service UD Evaluation** of a service based on matching touchpoint assessments to inclusive core-personas in an empathic service walkthrough.

- For IxD, we identified 5 archetypes of interaction design professionals, and proposed specific UD expertise for each of them, as well as shared UD expertise:
  - Current **UD legislation**, regulations and responsibilities
  - Knowledge of **key user needs**, such as for users with dyslexia or visual impairments.
  - Ability to do expert inspection **accessibility assessments** of code or visual design.
  - Ability to do formative-iterative **user testing** with disabled users

  Further, common UD expertise for most IxD professionals was proposed:
  - On WAI/WCAG/ mobile (app) accessibility/code **standards**
  - Knowledge of **assistive technologies**
  - Ability to do **inclusive design** and involve edge-case users in UCD.
  - Extended knowledge of user needs, such as for persons with reduced motor skills, dexterity or cognition, suffering from illness or injuries, and elderly or younger users.

As such, we consider UD of ICT a trans-disciplinary field based on our matured insights, where the joint UD perspectives extend the interdisciplinarity of traditional ICT-based systems development. In this setting, UD expertise should be viewed additional competence within the involved disciplines, instead of viewing "UD of ICT" as a separate field in itself.

This re-framing of UD of ICT better facilitates how professionals and educators should view and treat UD expertise and UD training. We hypothesize establishing field-specific UD responsibilities, ideals, tasks and methods, could improve the overall enthusiasm for and understanding of UD, and strengthen future grass-root movements and professional standards.

In summary, the thesis re-framed how professionals should view UD of ICT and UD expertise in applied settings, and subsequently how they should be trained. Our findings can be useful for educators, and of particular interest to those teaching UX-disciplines.

4.5 Roadmap for Future Interventions

The thesis work was initiated from the perspective of applied research being needed to articulate what contributes to successfully achieve UD, and we further investigated how these aspects could be measured and triggered to accelerate UD in society. Towards the end of the thesis, we returned to our initial aim, and theorized how our findings could inform future actions. From our empirical basis, a theoretical framework was modeled, reflecting the relationships of identified key factors that influence, foster and trigger UD. We theorized that Critical Success Criteria are present on at least four levels:

1. Personal level (including individual mindset, stances, knowledge, and enthusiasm)
2. Processual level (collaborative and methodological approaches, latitudes and resources),
3. Organizational level (external culture and resource-allocating management values)

4. Societal level (external incentives; including normative legal obligations).

Looking at how Personal, Processual, Organizational and Social factors was narrated as working together in positive or negative ways relative to UD on project, the participant narratives pointed to three triggers: 1) Legislation (threat of fines or societal responsibility), 2) Practitioners' enthusiasm (grass-root movements), and 3) Requirements (owner priorities).

As such, although several thesis contributions carry the potential to promote best practices, aid project planning and communicate the necessary resource allocations, based on the project behavior theory trigger factors and the overall thesis aim, the must impactful thesis contributions are assumed to be targeted to changing organizational, educational and legislative practices.

Legal interventions: Our data suggests that external reactions (positive and negative) are important in order to trigger and enforce UD. Few positive external incentives advance a cultural change towards UD, and such positive external incentives could be explored. The data indicates strong external control trigger UD. It seems current legislation is effective for parts of the IT-industry. However, based on informal conversations the impression is not all freelancers and smaller companies change their organizational culture to prioritize UD – even if they know the regulations demands it – so long as other competing and comparable actors do not. Increased severity as well as likelihood of fines could thus trigger new parts of the industry to take the UD regulations seriously, as could new regulations responding to challenges of the current legislation.

Training interventions: Our analysis indicates developers are the most enthusiastic about ensuring UD – and not designers, though the designers are the ones conducting UCD and UX tasks. This was a surprising find. We hypothesize that the way UD is made explicit for front-end developers through current regulations on technical accessibility standards, communicates what UD entails. The concreteness of UD, as well as seeing the direct effect on end-users in accessibility tests, seemed to motivate practitioners to take on responsibilities for UD. Thus, the hope is as more disciplines articulate what UD expertise entails in practice; more practitioners involved in ICT-based design and development will hold an interest for UD.

Awareness interventions: A strong UD focus among procurers of ICT solutions and project owners of ICT projects is indicated as highly effective for securing UD. Best practice examples prototyped in this thesis articulates increased UD insights, and can improve recommendations and advice, however the ability of the tools to increase organizational awareness has not yet been proven.

4.5.1 Applying the Theory to Thesis Contributions

Our theory-based discussions on the priority of future interventions, suggested the following three strategies as having high impact effects for triggering UD: 1) Legal interventions, 2) Training interventions, and 3) Awareness interventions. Therefore, if trusting the model, the road map towards advancing UD of ICT should align itself with these strategies. Based on the modeled theory, the most influential thesis contributions for advancing UD of ICT seems to be:

(1) Our legislative proposal on introducing and regulating a definition of UD for services.

(2) The way our re-framing of UD of ICT can change the education and training of practitioners.

It can be argued that the specific disciplinary contributions are also highly impactful, as they are being embedded in industry and HE training of SD and IxD professionals. In this concluding argument, they have nonetheless been viewed as the results of (2) above, thus not explicitly listed.

Further, during the empirical thesis work, and the design of the different tools articulating our findings, the empirical base for theorizing and planning future interventions was created. It can be argued that the modeled theory on project behavior itself is an important contribution, as it opens up discussions on the road ahead.

We end the thesis by recognizing that our assumption that "what we do" affects the UD quality outcome remained throughout the thesis, however the richness of factors influencing "project behaviors" was much more complex than initially assumed. Key findings are in particular reflected in the project behavior model, and in the UD3C tool. Both encourages policy makers and lobbyists, as well as researchers and others aiming to trigger UD, to plan future efforts, to better ensure Critical Success Criteria are present in future ICT projects.

In summary, a theoretical framework was modeled from the empirical data, based on which 11 future interventions for advancing UD were generated and their potential effects of discussed. The theory as well as our views as expressed in the intervention discussions can be interesting for anyone wanting to promote UD of ICT, including UD researchers.

5 Future Work

There are many opportunities for future research based on this thesis, for example related to continuing the work on AUD. We encourage researchers to utilize the theoretical model on project behavior in Figure 49, Figure 50 and Figure 51 to reflect on the impact of future research.

In line with our theoretical assessment of the most influential thesis contributions, we aim to focus on the SD and IxD disciplines, including legislative proposals on UD in SD. The proposed legislation on UD of services should be communicated to national authorities and policy makers for discussions on its usefulness, as well as with industry professionals.

Our proposed expertise and methodology must increasingly be made available, both to industry as well as to HE institutions and educators. Now that a SD definition and inclusive service design methodology has been developed, the time may be right for UD awareness interventions targeting service designers based on our findings.

The main aim of future work and continued research will thus be to facilitate fruitful discussion around proposed contributions and related aspects, in order to create contextual value. In particular, we will continue to apply the new ABCs of research model from (Shneiderman, 2016).

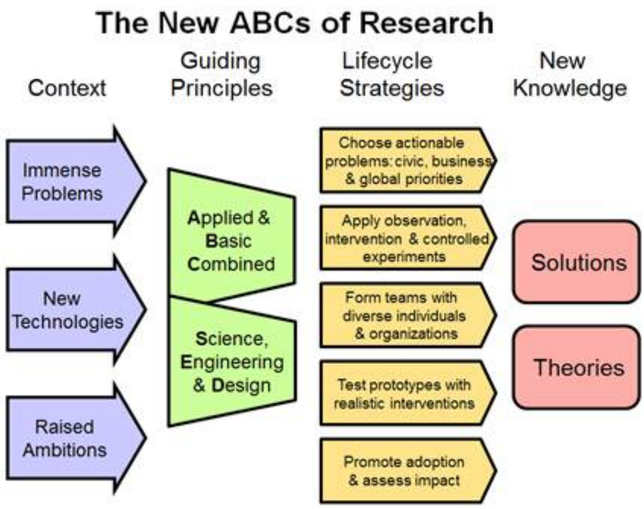

Figure 53: The New ABS of Research, Shneiderman (2016)

Relative to Shneiderman (2016), we are now in the context of "Raised Ambitions", and ready to utilize the strategy "Promote adoption & assess impact" as well as validating preliminary findings on "Test ideas & prototypes with realistic interventions" to improve our solutions and theories. As a next step in our research, exploring and experimenting with fitting manner to do so thus be our focus, in order to ensure the interaction between academia and industry produces useful advice, tools and educational content.

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Thesis Articles

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VIEWS ON UNIVERSAL DESIGN AND DISABILITIES AMONG NORWEGIAN EXPERTS ON UNIVERSAL DESIGN OF ICT

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ABSTRACT

Achieving inclusive eSocieties has prompted a focus on universally designed ICT-solutions. In order to ensure aims and legislations are interpreted in a similar manner, there should be a general consensus on universal design and disability definitions in the professional field. This paper investigates views on disability and universal design in Norwegian expert communities on universal design of ICT through survey research, including which users receive attention. Domain experts are asked on their models (interpretations) of disability, which marginalized user groups they focus on in their work and how they understand "universal design" and related terms. The findings indicate that terminology related to universal design is used differently in the sample. The field "universal design of ICT" is also interpreted in various ways. Further, there seems to be an acquiesce response to most disability views, with right-based disability views being dominant. Unexpectedly, the charity model is also common, as is the social adapted model. The survey measure opposing views related to who should be in charge of assessing a person's need for treatment and assistance: a divergence is indicated between those agreeing with the expert model (professional intervention assessment) versus the empowering model (individual intervention control) with a moderate highly significant negative correlation. Another interesting finding is that three out of the four user groups reported as the most excluded from the Norwegian eSociety receive quite infrequent attention from experts, with median values for receiving focus in "sometimes" or "seldom" categories. The paper contributes with insights into the existing varying interpretations of disability and universal design definitions among Norwegian domain experts, and discusses how different interpretations may affect how inclusion work is implemented. The paper also points out possibly neglected user groups in current practices. Future studies will continue investigations nationally and internationally; particularly on exploring disability focuses.

1 INTRODUCTION

Norway is among the countries having legislated public ICT-solutions must be universally designed, arguing this is necessary to combat democratic, economical and ethical issues in the eSociety. As the Norwegian anti-discrimination and accessibility act came into effect in 2014, the focus on accessbility and assistive technologies has increased in the Norwegian ICT sector. However, existing and dominant views and interpretations on disabilities as well as on universal design for the sector are unknown.

Different models exist for interpreting and understanding the notion of *disability* in different parts of the Norwegian society, from medical views emphasizing professional care to social views highlighting societal barriers. Though investigations have been made into the disability views and definitions existing in health and care sectors as well as the educational sector, few, if any, studies have previously attempted to map out the models of disabilities and disability definitions used in the ICT sector concerned with developing universally designed ICT-solutions.

In order to lessen democratic, economical and ethical gaps in the expansive self-service eSociety, white papers report on marginalization and exclusion issues. In an official report on ICT-use and barriers to digital inclusion, statistics on access, use and competence show visually impaired, elderly above 80 years, first-generation immigrants from non-western countries and people not participating in the job marked (social security/homemakers) are the most excluded in the Norwegian eSociety (Slettemeås 2014). There

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is however little empirically based mapping of what marginalized and disabled user groups are receiving attention in universal design of ICT processes.

Different overlapping terms for *universal design* are being used nationally and internationally in non-academic as well as academic sectors. In Norway, translation issues contribute of possible terms perceived used somewhat interchangeably. It may be argued that universal design is not an academic field in itself, but tied to the specific sectors of *what* is to be universally designed; universal design in the construction sector is different from universal design of voting opportunities etc. Although the term *universal design* is quite well established, it may be operationalized differently in relation to ICT (Mustaquim 2015). In addition, specific national or local regulations may further dilute or specify exceptions for universal design in practice in particular sectors or cases, as is the case for the Norwegian ICT-sector. It is thus unclear what terms are considered to be synonyms and/or highly overlapping among Norwegian universal design of ICT experts. It is also unknown how working within "universal design of ICT" is interpreted, and if the experts share similar or diverging views.

The aim of this study is to contribute to identifying generalizable insights into views on disability and universal design among Norwegian universal design of ICT domain experts, and what focuses are being applied in their work; What do we mean when we say we are doing "universal design", which user groups are we focused on when doing "universal design" and how do we understand and view "disability"? The article attempts to shed some light on which mental models of disability are prominent among Norwegian universal design of ICT experts, and what user groups are receiving the most focus in the experts' everyday work. Is there a shared mental model of what "disability" is? Are there opposing views? Are user groups reported at high-risk for exclusion receiving the attention? The paper also investigates how domain experts interpret the term universal design related to their work within ICT, and if distinctions are being made between accessibility, universal design and related terms.

2 BACKGROUND

2.1 Definitions of Disability

Though perhaps not often reflected upon, different models for defining "disability" co-exit in our societies. The **social** model view disabilities as mainly socially created, where physical and/or social barriers, including attitudes, are viewed as what is excluding impaired persons from equal participation. Thus, it is a social responsibility to ensure that different physical and psychological abilities are taken into consideration and barriers are removed and diminished. Opposing this is the **medical** definition, looking at a person's abilities. The medical view defines a disability as damage, trauma, illness or any other health issue that gives a person a negative difference from what is considered normal human bodily function. Both models distinguish between *impairment* and *disability*. The medical model defines an impairment is any loss or abnormality of psychological or physiological function, structure or appearance, and a disability as the lack of ability to function and live in a way that is seen as "normal". The social model views impairment similarly, but states it is the society that disables impaired people.

Derived from the medical definition is the view that a disabled person would benefit from treatment or other interventions in order to correct or minimize the function deficiency. The medical model is often critiqued for implying that the problem of exclusion lies within the disabled person, who is not equal to non-disabled and needs to be "fixed". The social model, on the other hand, grew out of disability rights organizations in the 70s and may be critiqued for not acknowledging that the society cannot accommodate or adapt for *all* lacking abilities in *all* contexts. Sometimes the two views clash; for example if a pediatrician wants a hearing impaired child to receive cochlea implants, while the child's hearing impaired parents refuse, as they do not consider deafness a disability.

Two alternate definitions exist trying to merge social and medical views. The **social adapted** model of disability is less polarized than the social model, viewing the disability itself as potentially limiting equal participation in a non-disabled community, at least to some degree. Though close to the social model, the social adapted model does recognize disability as something existing apart from society to some degree. However, the social adapted model points to contextual and environmental factors as usually creating the largest barriers for inclusion, and as more limiting than the disability itself. The **biopsychosocial** view focus more explicitly on the interaction between a persons health conditions and the contextual factors and the environment they are living in. Thus, the disability is connected both to biology, phycology and social factors – the bodily functions as well as the possibilities for participation in a specific social context. WHO's International Classification of Functioning, Disability and Health (ICF) is based on the biopsychosocial model (ICF 2002:9).

The **expert** (or professional) and the **charity** (tragedy) models also seem quite widespread. In the expert model, a disability must be identified and evaluated by a professional expert, who may then outline and suggest beneficial interventions and a plan for necessary treatment and assistance. This model may be viewed as an offshoot from the medical model (Langtree 2010). Both the medical model and the expert model indicate professionals should look after disabled persons, and as such that disabled persons themselves is not fully capable of making decisions about his/her life. As a contrast to these stances, the **empowering** (costumer) model of disability seeks to provide the individual with more autonomy, power, choice and control; stating that a disability is best understood by the individual disabled person and as such this individual should decide appropriate measures for treatment and assistance. Thus, the professional expert becomes more of an advisor and service provider.

In the **charity** model, a disability is viewed as a personal tragedy that is undeserved, and as such disabled people deserve sympathy, support and aid. The view is critiqued for depicting disabled persons as victims, deserving of pity. Langtree (2010) states charity and medical models are the ones most frequently used by non-disabled to define and explain disability.

Other perspectives are the **economical** model, the **legitimacy** model, the **spectrum** model, the **right-based** model, the **marked** model, the **rehabilitation** model, the **interface** model and the **moral** (religious) model (Rialland 2001, Smeltzer 2007, Langtree 2010, MDRC). Related to the charity model is the economic model, which define disabilities based on (in)ability to work, and to what degree a health condition affects a persons productivity and economy. While health care sectors typically use the medical model, policy makers use the economic model to regulate state welfare payments and subsidized employment. This represents a potential conflict in the disablement policy. The legitimacy model recognizes that *disability* can be defined in many different ways (value-based), and thus argues for determining disabilities and grounding person's rights based on their individual needs for assistance and adaptations. The viewpoint allows for multiple models to be considered as viable (Langtree 2010). Under the spectrum model, a disability can be of varying degrees – such as mild, moderate, severe or complete. The view is that humans have a variety of different functional levels along a continuous spectrum, and as such a disability should be defined from a set threshold for functionality within this spectrum.

Under the moral model views a disability as a self-inflicted punishment, thus disabilities may stigmatize an individual and/or a family. This is an extreme stance not commonly found in educated communities. Modern right-based views on the other hand highlights that everyone should have equal rights and not be discriminated against (MDRC). The disability activist stance states a disability should not affect a person's opportunities for participating in the society nor the access to products, goods and services offered by companies and governments. This right-based model is the reflected in disability acts, including the Norwegian anti-discrimination and accessibility act (DTL 2008) which also seems based on biopsychosocial or social adapted views (reduce barriers). Also related to minority rights and personal identity is the marked model, where emphasis is placed on the consumer power and cultural influence of disabled and their families. A disability is viewed as part of a personal identity. Costumers considering themselves disabled are regarded as influencial stakeholders in the marked.

Based on the medical model is the rehabilitation model, regarding a disability as a deficiency that that can be overcome through adequate therapy or exercise with the support of a rehabilitation professional (Smeltzer 2007, MDRC). Disabled persons may thus be viewed as not having put in the effort necessary, and the approach fails to consider permanent disabilities. In the interface model, interventions are defined collaboratively between health care personnel and persons with disabilities in order to overcome gaps between a medical diagnosis and environmental factors (Smeltzer 2007). This model is developed by a nurse, and alters the role of professional health care personnel compared to the medical model. Under this model, the medical perspectives are merged with social and empowering disability views.

2.2 Norwegian Policies

Several white papers account for government values on disability. White Paper No. 8 (Parliament 1998) focuses on how the Norwegian welfare state is built on solidarity and conscious choices. Disability is viewed as “a gap between the individual's abilities and demands from the environment and society”. The parliament states it will work actively for a “warm” society for all, ensuring equal opportunities for participation and independence through adaptation and compensatory solutions. In White Paper No. 40 (Parliament 2002) equality, self-sufficiency, active participation and personal and social responsibility is emphasized. The government underlines societal benefits related to all citizens being active contributors, and refers to the sector responsibility of working to include universal design in all sectors and the corresponding Program of Action for Universal Design from 2002 (KLD 2002). White Paper No. 17 (Parliament 2006) stresses the importance of eInclusion, aiming for all technological developments in ICT and media to be based on universal design principles.

For the ICT sector, the Discrimination and Accessibility Act (DTL 2008) states all ICT-solutions targeted to the public must be universally designed, and is focused on equal opportunities for participation. Success criteria for Universal ICTs are established in regulations on universal design of ICT solutions (KMD 2013), defining what the Norwegian anti-discrimination and accessibility act considers a universally designed ICT-solution by focusing on fulfilling web-accessibility criteria in addition to ensuring universally designed vending machines. The Agency for Public Management and E-Government (DIFI) further specifies the extensiveness and limits of the regulations (2016). The regulations came into force July 1st 2014 for new solutions, and January 1st 2021 for existing solutions (§ 11).

As such, there seems to be a persistant cross-political view that universal design of ICTs and services will ensure an inclusive eNorway. The committee report NOU 2001:22 (Manneråk et.al. 2001) finds that values such as full participation, equality, human dignity, a society for all, a cohesive society and better living conditions is viewed as established political objectives. Based on Norwegian policy, all Norwegian citizens are close to having equal rights and opportunities to make use of the rapidly pervading digital solutions for information, communication and interaction from public and private actors alike, in education, employment, healthcare, transportation, ICT and finances. It is assumed that from a political stance, cross-enterprise government policies are now viewed as ensuring the inclusion of all citizens. The challenge is, the report states, the inadequate realization of these objectives. The committee discuss the difference between open and hidden values, saying in Section 3.1: *“These deficiencies makes the ideals to some extent appear as words of honor one is not entirely willing to accept the consequences of.”*

2.3 Norwegian Universal Design Related Terms

The idea of universal design is to develop products, environments and services that make usage possible for all intended users, to the largest extent possible. This explanation of *universal design* is based on a quote from Ron Mace (NCSU 2008), who coined the term. Other variants exist, such as Bergman et.al. (1996) saying universal design is about designing products and environments for the broadest possible range of users. The Norwegian Directorate for Children, Youth and Family Affairs (Bufdir 2015) agree a range of universal design definitions exist, and highlights the United Nations Convention on the Rights of Persons with Disabilities (UN 2006) Article 2, and the Norwegian Discrimination and Accessibility Act (DTL 2008) § 13 as providers of similar, but not identical, definitions of universal design. For example, while services are not mentioned in Norwegian legislation, they are included in the UN definition, which also specify that adaptations may complement the design.

According to Persson et.al. (2014), the term *universal design* grew out of the movement for “barrier free design”, and originates from the US (NCSU). In Europe, the alternative term *design for all* is also commonly used, and Stephanidis (2001) argues these terms may be used interchangeable. In Norwegian, two different verbs exist that corresponds to *design*; “utforming” and “design”. Thus, the two terms above translates into four possible interchangeable terms in Norwegian; *universell utforming*, *universell design*, *utforming for alle* and *design for alle.* The first term, *universell utforming*, is the most commonly used, and is the term found in most white papers and Norwegian legislation.

Further, in Academia, *universal access* and *inclusive design* are also quite frequently used. The latter may be translated into two different Norwegian terms; *inkluderende utforming* and *inkluderende design*. The

Norwegian Directorate for Children, Youth and Family Affairs (Bufdir 2015) suggests the following Norwegian terms as overlapping (non-exhaustive list); *universell utforming, design for alle, utforming for alle, inkluderende utforming* and *universell design*. Due to the specific ICT regulations in Norway, some may also use *accessibility for all* (*tilgjengelighet for alle*) interchangeably with universal design.

2.4 Summary: The Use of Background Literature in This Study

Based on the above literature, relevant interpretations and models of disability to be investigated in this study are mapped out, and their different views as perceived and used by the author in the survey design are presented in a more thorough manner than what is possible in later sections of this paper.

The outlined Norwegian policies points to the expectancies and ambitions for the field of universal design within ICT, and the needs that should be accommodated – and in particular with regards to establishing similar understanding of how to implement the Norwegian anti-discrimination and accessibility act. This section paint an important backdrop for discussing our field, the interpretations and definitions of disability and universal design in the sample, and the user groups focused on in current practices.

The literature on universal design terminology informs the design of survey items investigation of definitions of "universal design" in the Norwegian sample, and sets the framework for what specific related terms should be compared with regards to interpretation and usage.

3 RESEARCH APPROACH

The study focuses on Norwegian domain experts developing universally designed IT-solutions. Survey research is used to map out definitions and interpretations. This article focuses on items designed to map definitions of the term *universal design* as a general term, of *universal design of ICT* specifically, as well as definitions of *disability* and what marginalized user groups are receiving attention in universal design of ICT processes – and how well this is aligned with reports on digital exclusion in Norway today. The survey used for data collection also covers epistemologies, methodological styles and practices as well as background data. In total, the survey has 21 items. This article focuses on reporting data from 5 specific survey items. The Norwegian Social Science Data Services (NSD) approves the study.

3.1 Target Group

The target group is identified using a non-probabilistic draw from a not easily well-defined population on the basis of established basic data (Lazar 2010). A list of domain experts is comprised through three steps; 1) members of the recent Norwegian network focusing on Universal Design and ICT (*Ressursnettverket Universell IKT*), 2) universal design experts identified through online survey among companies sponsoring Oslo Interaction Design Association (websites, twitter, blogs, conference presentations etc.), and 3) experts being referred by previously identified experts. The resulting list of survey recipients included 70 experts. At least 13 of these are well known for their expertise. Experts are selected for their visibility in the field over academic background and area of expertise. An estimate is that around 20-40 % is highly competent domain experts, while a further majority of around 30-50 % is fairly high. The final sample is representing major enterprises and institutions in the field universal design of ICTs, and is considered sufficient for seeking insights over generalizable results.

3.2 Survey Item Design

First, the study investigates how the domain experts understand the term "disability". The objective of the survey item is to investigate what views of disabilities are prominent among experts in the field, and whether the experts are in agreement or not. All disability definitions that seem potentially relevant for Norway are included; the social, medical, social adapted, biopsychosocial, expert, empowering, economical, spectrum, legitimacy, charity, marked and right-based. The rehabilitation and the interface models are not considered as relevant within for the ICT domain, but would be relevant to include for surveys in the health sector. Finally, the moral model is not commonly included, as it is assumed Norwegians no longer believe a disability is self-inflicted by the disabled person. The respondents are presented with a summarized brief description of main points in each model, and not with the names of the models. For each included view on disability, experts are asked for agreement on a 4-point Likert scale from full to partial agreement, and partial to full disagreement. This forces the respondents to take a non-neutral stand.

The second question in this paper is what marginalized user groups are receiving focus from the experts. A single-select matrix asks for degree of focus on a 5-point Likert scale for each of the user groups included; never, seldom, sometimes, often and always. The matrix attempts to cover user groups commonly mentioned in literature, public research reports and white papers as marginalized or digitally excluded. The categories are: persons that have Norwegian as foreign language, first-generation immigrants from non-western countries, mental illnesses, temporary disabilities, reading- and writing difficulties (including dyslexia), elderly, elderly over the age of 80 years, cognitively impaired, motor impaired, color blind, blind, partially sighted, hearing impaired, people not participating in the job marked and children and adolescents. The specificity of the categories *elderly over the age of 80 years*, *people not participating in the job marked* and *first-generation immigrants from non-western countries* are due to these (along with severely visually impaired) are reported as the most digitally excluded user groups in Norway (Slettemeås et.al. 2014). Categories are not mutually exclusive, as one user may belong to several categories. As the goal is to look into frequency distributions, this does not constitute any analysis challenges. In order to take into consideration that the matrix may not fully cover all relevant user groups, an open answer item asks experts if other user groups receive attention – and if so to what degree.

For investigating the general definition and understanding of the term *universal design*, a vertical multiple-choice item is designed that asks the experts to indicate all, if any, terms they view as synonymous or overlap well with “universal design”. In the choice list, all terms identified though a literature study and a document analysis as commonly used within the Norwegian field of universal design are included; in academic papers, in reports and white papers and in relevant international and national legislations. These are; *tilgjengelighet for alle* (accessibility for all), *utforming for alle* (design for all), *design for alle* (design for all), *inkluderende design* (inclusive design), *inkluderende utforming* (inclusive design), *universell brukskvalitet* (universal usability) and *universell design* (universal design). The item specifically investigates interpreted differences between related terms, and between *accessibility for all* and *universal design*. Finally, for researching specific definitions of universal design related to ICT, an open answer item is used asking the experts in their own words to describe the somewhat loose concept of “universal design of ICT”. The filtering item for the study was asking the experts to confirm they work within “universal design of ICT”. The open item may highlight their views on what this entail.

4 FINDINGS

26 of the 70 experts (37%) responded to the survey. 39 % of the respondents are women and 61 % men, which is considered an equal distribution to the ratio of 37 % women and 63 % men in the target group. Years of experience ranged from 2 to 25 years, with arithmetic mean 7.73 and median 7. This is considered high compared to the age distribution of a majority below 40 years of age. The impression is that many highly experienced experts are responding to the survey. No biases are identified the sample, and only completed responses are accepted.

4.1 Defining Disability

Table 1 shows the results for the item on agreement with included models of disability, with median value in **bold**. A shortened version of the item descriptions are provided in Table 1 along with the names of the models, which are described in more depth in the background section of this article. The responses show that aside from the **medical** and the **expert** models, a majority of the experts agree with *all* models. The **right-based** model of disability is the most commonly agreed upon, directly followed by the **social adapted** model, both agreed upon by 96 % of the experts.

A correlation matrix (nonparametric; Spearmans 2-tailed) shows several significant correlations. A strong highly significant correlation is found between **legitimacy** and **biopsychosocial** models (Sig. 0.000, Coeff. 0.700). The **legitimacy** model further correlates moderately and highly significant to the **spectrum** model (Sig. 0.006, Coeff. 0.526). The **spectrum** model also correlates with the **biopsychosocial**; moderately and highly significantly (Sig. 004, Coeff. 0.546).

The **medical** model, on the other hand, correlates moderately and highly significantly with **marked** (Sig. 0.002, Coeff. 0.582) and **economical** (Sig. 0.002, Coeff. 0.576) models, moderately with **biopsychosocial** (Sig. 0.027, Coeff. 0.433) and weakly with **expert** (Sig. 0.044, Coeff. 0.398) models. The **expert** model interestingly has a highly significant *negative* and moderate correlation to the **empowering** model (Sig. 0.004, Coeff. -0.551).

Finally, the **social adapted** model correlates moderately with the **marked** model at 0.429 (Sig. 0.029).

Model name: summarized view on disability	***Fully Agree***	***Partly Agree***	***Partly Disagree***	***Fully Disagree***
Right-based: *disabilities should not affect access to services, products or societal participation.*	**22 (84.5 %)**	3 (11.5 %)	-	1 (3.8 %)
Social adapted: *individual disability may somewhat limit, but mostly disabilities are socially created.*	13 (50 %)	**12 (46.2 %)**	1 (3.8 %)	-
Charity: *a disability is a personal, undeserved tragedy; disabled people deserve aid and sympathy.*	12 (46.2 %)	**8 (30.8 %)**	4 (15.4 %)	2 (7.7 %)
Legitimacy: *disabilities can be defined in many ways, thus rights should be based on personal needs.*	12 (46.2 %)	**8 (30.8 %)**	1 (3.8 %)	5 (19.2 %)
Marked: *disabled and their families is a large and influentional customer base with consumer power.*	11 (42,3 %)	**8 (30.8 %)**	6 (23.1 %)	1 (3.8 %)
Spectrum: *a disability is defined along a range of seriousness based on functional ability levels.*	11 (42,3 %)	**8 (30.8 %)**	3 (11.5 %)	4 (15.4 %)
Empowering: *the disabled person should be in charge of any treatment or assistance plan.*	10 (38.5 %)	**11 (42,3 %)**	5 (19.2 %)	-
Biopsychosocial: *disability defined by interaction between bodily functions and specific social context.*	9 (34.6 %)	**13 (50 %)**	3 (11.5 %)	1 (3.8 %)
Social: *disability mainly socially created; societal responsibility to remove physical and social barriers.*	9 (34.6 %)	**12 (46.2 %)**	2 (7.7 %)	3 (11.5 %)
Economical: *disability defined by a person's ability to work and it's economical consequences.*	4 (15.4 %)	**12 (46.2 %)**	7 (26.9 %)	3 (11.5 %)
Medical: *a person's deviation from normal human bodily function that should be treated.*	3 (11.5 %)	8 (30.8 %)	**5 (19.2 %)**	10 (38.5 %)
Expert: *an expert, who also creates a plan for treatment and/or assistance, identifies a disability.*	3 (11.5 %)	7 (26.9 %)	**13 (50 %)**	3 (11.5 %)

Table 1: Models of Disability by Frequency of Agreement (median values in ***bold****)*

4.2 User Groups Receiving Focus

Table 2 presents an overview of the marginalized user groups sorted by their frequencies of focus, with the category that holds the median value in **bold**. The results indicate visually impaired users receive the most focus, followed by persons with reading- and writing difficulties, elderly, cognitive impaired and motor impaired. A higher percentage of experts focus often or always on these user groups than the percentages for sometimes or lower. For the next groups of users, the focus is more evenly spread; elderly over the age of 80 years, those with Norwegian as their second language, hearing impaired and temporary disabled. Next comes the groups that received the least attention by the experts, and are usually seldom or only sometimes in focus. These are first-generation immigrants from non-western countries, children and adolescents, persons with mental illnesses and unemployed.

In addition to user groups included in the matrix, the open item reveals users with fatigue, epilepsy and reduced health due to illnesses currently also receive some attention. One respondent highlight that users with severe combined sensory loss receive particular focus. The four last rows in the table overviews users mentioned in the open item. However, most respondents do not mention any further user groups.

	Never	**Seldom**	**Sometimes**	**Often**	**Always**
Partially sighted	-	1 (3.8 %)	4 (15.4 %)	**12 (46.2 %)**	9 (34.6 %)
Blind	1 (3.8 %)	-	5 (19.2 %)	**11 (42,3 %)**	9 (34.6 %)
Color blind	1 (3.8 %)	2 (7.7 %)	5 (19.2 %)	**9 (34.6 %)**	9 (34.6 %)

	Never	Seldom	Sometimes	Often	Always
Reading- and writing difficulties	-	4 (15.4 %)	5 (19.2 %)	**14 (53.8 %)**	3 (11.5 %)
Elderly	-	2 (7.7 %)	8 (30.8 %)	**10 (38.5 %)**	6 (23.1 %)
Cognitive impairments	-	3 (11.5 %)	8 (30.8 %)	**10 (38.5 %)**	5 (19.2 %)
Motor impairments	-	5 (19.2 %)	6 (23.1 %)	**9 (34.6 %)**	6 (23.1 %)
Elderly over 80 years	1 (3.8 %)	5 (19.2 %)	**8 (30.8 %)**	9 (34.6 %)	3 (11.5 %)
Norwegian as foreign language	-	6 (23.1 %)	**10 (38.5 %)**	8 (30.8 %)	2 (7.7 %)
Hearing impaired	2 (7.7 %)	5 (19.2 %)	**8 (30.8 %)**	8 (30.8 %)	3 (11.5 %)
Temporary disability	2 (7.7 %)	8 (30.8 %)	**8 (30.8 %)**	3 (11.5 %)	5 (19.2 %)
First-generation non-western immigrant	1 (3.8 %)	9 (34.6 %)	**9 (34.6 %)**	6 (23.1 %)	1 (3.8 %)
Children and adolescents	1 (3.8 %)	8 (30.8 %)	**13 (50 %)**	3 (11.5 %)	1 (3.8 %)
Mental illnesses	3 (11.5 %)	**13 (50 %)**	7 (26.9 %)	-	3 (11.5 %)
Not participating in the job marked	4 (15.4 %)	**10 (38.5 %)**	10 (38.5 %)	1 (3.8 %)	1 (3.8 %)
Illnesses				1	
Epilepsy			1		
Fatigue			1		
Combined and severe sensory loss			1		

Table 2: Marginalized User Groups by Frequency of Focus

4.3 Defining Universal Design

When asked to define "universal design of ICT" in their own words, 24 respondents provide a definition. However, two experts only define universal design of ICT recursively (for example saying "that ICT solutions are universally designed"). Of the remaining 22 definitions, 11 experts focus on the ICT-solution being designed in a manner so it is usable by either *all* (strict definition; given by 6 experts), or by as many as *possible* (definition found in existing laws; given by 5 experts). In addition, 2 add that no *adaptations* should be necessary (also found in existing laws) while 1 adds universally designed ICT-solutions should be usable in all possible *contexts of use* (user-centered definition).

Categorized Answers	**Frequency**	**Focus**
ICT solutions designed so… *Of which:*	11	
…*all* people has the opportunity to use them…	6	Strict definition (Visionary, utopian)
…all people, *to the greatest extent possible*, …	5	Legal-founded definition (DTL § 13, UN Art. 2, NCSU)
...without adaptation.	2	Legal-founded definition (UN Art. 2, NCSU/Mace)
…*in all contexts.*	1	User-centered definition (Contextual)
ICT solutions offering positive user experiences to all	2	User-centered definition (User Experience)
All have opportunities for participation, society designed for a range of individual human abilities	2	Barrier-free definition (Social Participation)
Accessible and WCAG2.0 AA compliant ICT solutions	2	Accessibility definition
ICT solutions are universally designed	2	Recursive definition
N/A	2	N/A

Table 3: Universal Design of ICT Definitions

Only two experts define "universal design of ICT" as providing positive user experience to all users, thus focusing more on user experiences than legal definitions (viewed as a user-centered definition). Further, two experts emphasize societal participation, and their explanations are viewed as focused on barrier-free societies. Finally, two experts focus on accessibility as the defining component of "universal design of ICT", such as WCAG 2.0 AA compliance. The categorized answers, frequencies and focuses are displayed in Table 3.

Synonymous/overlaps very well to *universell utforming* (universal design):	**No**	**Yes**
Design for alle (design for all)	4 (15.4 %)	22 (84.6 %)
Universell design (universal design)	5 (19.2 %)	21 (80.0 %)
Inkluderende design (inclusive design)	9 (34.6 %)	17 (65.4 %)
Utforming for alle (design for all)	10 (38.5 %)	16 (61.5 %)
Tilgjengelighet for alle (accessibility for all)	10 (38.5 %)	16 (61.5 %)
Inkluderende utforming (inclusive design)	14 (53.8 %)	12 (46.2 %)
Universell brukskvalitet (universal usability)	15 (57.7 %)	11 (42.3 %)

Table 4: Universal Design Related Terms by Percentage of Synonym Agreement

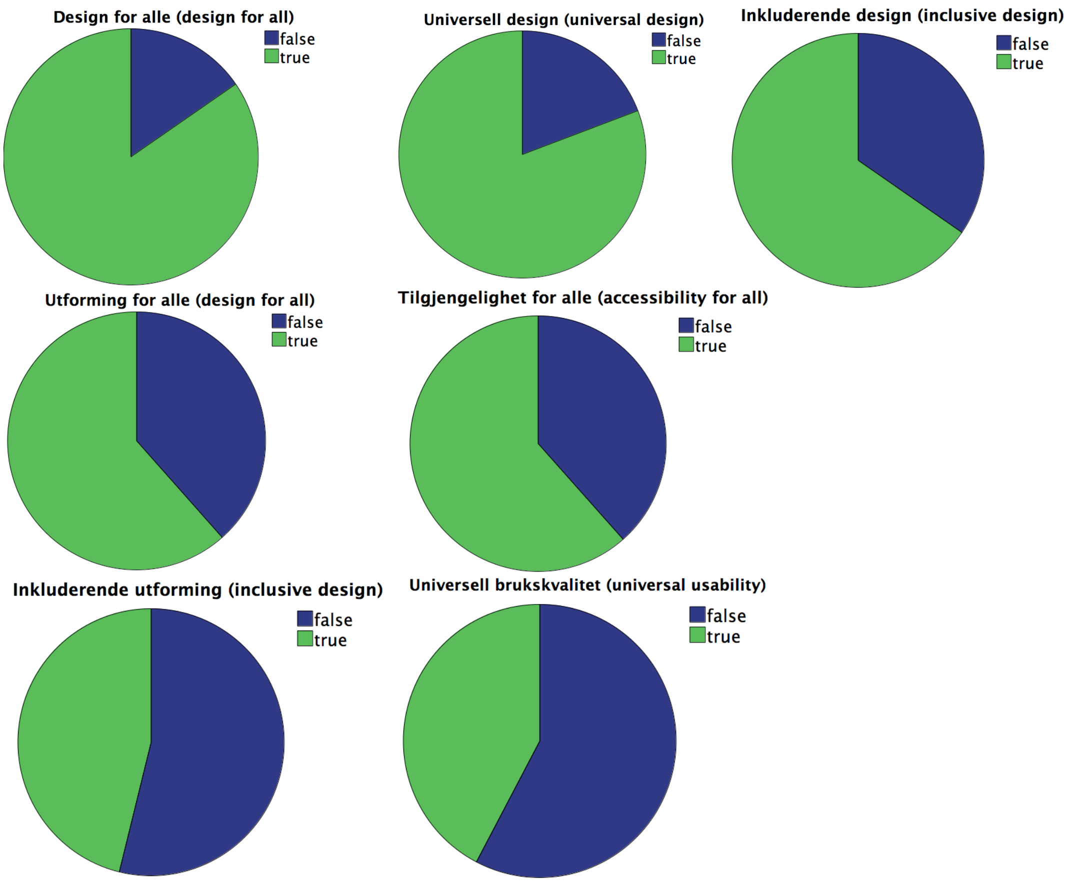

Figure 1: Percentage of Synonymous Overlap Agreement to "Universell Utforming" (Universal Design)

Table 4 overviews the responses to the question of which terms are synonymous to, or overlapping very well with, the commonly used term for universal design in Norwegian – universell utforming. There seems to be differences in term interpretation and usage in the Norwegian sample. No term is agreed upon as synonymous to or overlapping very well with universal design, nor is any term agreed upon by all Norwegian experts as non-synonymous to universal design. A majority of 61.5 % distinguish between universal design and accessibility for all, and as such the sample is split on whether "accessibility for all" should be regarded as synonymous to "universal design" or not. The most agreed upon as synonymous to "universal design" is the term "design for all" (84.6 %), as well as the English translation of universal design (80 %). Figure 1 shows the data visualized as pie charts.

5 DISCUSSION

The investigation into how domain experts understand the term "disability", and whether the field is in homogenous in these views or not, is perhaps the most sensitive as well as the most interesting question in the study. Though mapping out the views and models used to understand and define disability has been conducted within e.g. the health sector, this has not yet been attempted in the ICT sector. Such views may influence the field, but are largely unknown, tacit and implicit knowledge. Overall, there seems to be an acquiescence response to most of the models' views on disability, which was somewhat unexpected. This means the experts agree with and hold several different views on and interpretations of disability at the same time. A majority of the sample agrees with all models aside from the **medical** and the **expert** views.

The study identifies the **right-based** as the most dominant view on disabilities, with 96 % agreement of which 84.5 % fully agree. The exact survey text (translated) for this model is; *a disability should not affect a person's opportunity for participation in society or access to products, goods or services offered by companies and authorities. Everyone should have equal rights.* Directly following is the **social adapted** model that also has 96 % agreement of which 50 % of the experts fully agree, stating (translated)***:*** *a disability may in itself somewhat limit participation in a non-disabled society, but mostly barriers are created by the environment and context.*

Somewhat surprisingly, as many as 77 % agree with the **charity** view of disabled persons as someone deserving aid and sympathy. The survey text (translated) for this model is; *a disability is something that has undeservingly afflicted someone, and disabled persons deserve sympathy, support and help.* This view on disability was described by literature as common among non-disabled. As the experts are expected to have had direct contact with capable disabled users, it was assumed that more capacitated and nuanced views would instead be more widespread (such as marked, legitimacy, empowering or spectrum views).

Even though the sample is low, several correlations are identified. The strongest at 0.7 is found between biopsychosocial and legitimacy models. The responses show experts that strongly agree with **biopsychosocial** views on disability, also tends to agree more with **legitimacy** and **spectrum** models. These are all viewed as pragmatic models that recognize that disabilities can be understood and defined in different ways. It seems about three quarters of the experts partially or fully hold such pragmatic stances.

Based on the data, it can be hypothesized that **right-based, social adapted** and **charity** views are all quite commonly dispersed in the field, and that agreement with these popular stances do *not* represent a divergence among the domain experts. The assumed split between those agreeing more with social models and medical models is *not* identified. However, the **expert** model has a negative and moderate highly significant correlation to the **empowering** model. Thus the survey is able to measure opposing views related to who should be in charge of assessing an impaired or disabled person's need for treatment and assistance – the first pointing to the expert being in charge, and the second empowering the individual. The frequencies further indicate that the **empowering** view is the more popular of the two.

The question is then how the disability views and models influence the universal design practices. The experts are perhaps not likely to mainly seek to treat individuals for example through focus on ability enhancement and assistive technologies, as medical and expert models point of views could suggest. If the pragmatic and biopsychosocial models had been the most prominent, one could perhaps argue that experts are viewing disability along a spectrum, where we all may be contextually or partly less abled on a scale, and thus we are designing for ourselves and focused on usage contexts and practical usage. The prominence of the charity model may however indicate a culture where "we" are designing for "them", and experts aim to help "less fortunate" disabled individuals – though the results are of course more nuanced than this, with agreements with the marked model and the empowering model also. Likewise, the prominance of the right-based model may indicate that experts may be focused on doing edge-case design with an emphasis on making sure right-based minimum levels of access to participation is ensured in line with the right-based model, but not aiming for universal usability. Are we mainly motivated by a feeling of helping someone, by a perceived duty to minimize barriers, or by the socio-economic cost savings? One may hypothesize based on the data that the experts may feel a responsibility towards minimizing physical and digital barriers in order to ensure a minimum of inclusion for unfortunate disabled persons in need of our profession. Such a viewpoint would be in line with the three most dominant models.

Looking at what user groups receive the most focus, it is clear that visually impaired receive the most attention. This is positive, as blind and persons with severely reduced sight are reported as among the four groups in danger of exclusion from the eSociety. However, the data does not fully align when comparing the survey results with the report from Slettemeås et.al. (2014) on exclusion in the Norwegian eSociety in relation to digital inclusion barriers, ICT-usage, access and digital literacy. Are we focusing on disabled user groups over other marginalized groups of individuals?

First, partially sighted receive the most attention, with blind as the second most important user group followed by color blindness. Further, elderly as a mainstream group receive focus quite often, while the less digitally literate and more vulnerable subgroup above 80 years of age are somewhat less focused on. Taking the perspective of *mainstreams* versus *extremes*, it may be argued that if access to elderly above the age of 80 years is possible, focusing more frequently on this subgroup of extremes would both include mainstreams as well as ensure eInclusion for a vulnerable edge. The same can be said for the relationship between the groups "Norwegian as foreign language" and "first-generation non-western immigrant"; the first and more mainstream user group receives more frequent attention than the more extreme and vulnerable subgroup.

The last user group reported to be among the most excluded is people not participating in the job marked. Simultaneously, these are the users receiving the *least* attention in the survey matrix. These results may indicate that for example users with fairly good vision but some visual impairment receive a more focus than user groups currently reported as being excluded and falling behind in the eSociety. This statement is not intended for pitting user groups against each other in a priority discussion, but rather as an observation aiming at critical reflection upon existing practices, with the aim of making sure all user groups in danger of exclusion at this time receive the necessary attention from the expert community. A strengthened recruitment of *extremes* whenever possible could be relevant, and especially when recruiting elderly and non-native speakers, as these edge groups are reported excluded. Likewise, an increased focus on barrier-free design, users outside the workforce and users with low digital literacy may be needed.

When asked about terms, a clear majority agrees *design for alle* (design for all) and *universell design* (secondary translation for universal design) holds the same meaning as *universell utforming* (universal design). However, even for these terms, there are dissents – 4 experts on *design for alle* and 5 experts on *universell design*. As such, no terms are begin agreed upon by all as highly overlapping or synonymous. Likewise, no term is refuted by all. This points to different interpretations and uses of terms related to universal design among Norwegian experts, and as such there seems to be no tacit agreement on definitions and translations in universal design terminology. In particular, it is viewed as somewhat worrying that the Norwegian translations of English terms do not necessarily hold the same meaning in the sample – if *utforming* and *design* holds different meanings in the Norwegian community, what is this difference and should this be clarified with regards to the international community and legislation?

A majority of 16 experts (61.5 %) distinguishes between *accessibility for all* and *universal design*, while two experts emphasize precisely accessibility as key to what they consider the definition of universally designed ICT-solutions. Though *universal design of ICT* is interpreted and explained differently within the sample, a majority of the experts seem to base their understandings on legal definition, such as § 13 in the Norwegian anti-discrimination and accessibility act (DTL 2008) and Article 2 in the UN Convention (UN 2006) and/or more academic and visionary definitions such as provided by NCSU (2008). But, if laws are referred to without any additional explanations of how they are interpreted by the respondents, and the experts may not hold the same definitions of key terms within the legislation, we may not work towards the same goals. Some emphasize that accessibility is the most essential part of universal design of ICT. Is there a consensus that ensuring opportunities for participation through technical and physical accessiblity is the most important? Or do we believe it is equally important to test solutions in real-life to remove socially and contextually created barriers? Are we mainly aiming for practical universal usability for as many as possible, or for edge-case accessibility and inclusion of groups in danger of exclusion? Based on the data it seems the expert community is split on understanding universal design as synonymous and/or largely overlapping with *universal usability* and *accessibility for all* (see Figure 1).

When respondents state they are working within *universal design of ICT* it seems there could be a range of different subfields they work within. Thus, if asked for experience or proficiency in the field, competence referred to could differ. As the backgrounds of the experts in the sample are quite diverse, it may be that the field *universal design of ICT* includes several sub-fields that should be shed light on in order to better understand our diversity and communicate our professional competences. It could also be that the diversity and heterogeneity in the field indicates there is no one field of *universal design of ICT* at all, but rather that professionals within the different and often cross-disciplinary professions related to the field of computer science acquire specific expertise in universal design relevant to their particular field. As such, perhaps the different types of universal design expertices should be viewed as specialized competence within existing professions, such as for example specialized visual design expertice, user research expertise, user testing expertice and web development expertice.

Without commonly agreed upon definitions and interpretations of our professional vocabulary, it is difficult to know if we are thinking the same thing when using the same words. Different points of view, based on different interpretations of disability and universal design, may result in significantly different methodological approaches, practices and professional expertise. This makes it challenging to ensure a similar interpretation of laws and universal design work practices; what is our common agenda, and do we agree on it?

5.1 Limitations of the Study

The validity and reliability of the findings are limited due to the low and local sample. Results should thus be seen as indicative rather than confirming.

6 CONCLUSION

This paper uses survey research to look into the different views on disabilities and definitions of universal design among an expert community on universal design of ICT in Norway, in an effort to clarify how these issues are viewed and how they may affect the implementation of universal design work. To the author's knowledge, mapping out the views and models used to understand and define disability has not yet been attempted in the ICT sector. The findings indicate several model views are present simultaneously and overlapping in the sample. The *right-based* and *social adapted* models are the most prominent, while *medical* and *expert* models are the least popular. Overall, the sample seems to hold quite pragmatic and fluid views on disability, focusing on the societal responsibility to ensure participation and access despite individual limiting disabilities. An interesting diverging disability view among the experts in the sample is indicated related to who should control treatment and assistance, as a moderate negative highly significant correlation show those agreeing with the *empowering* model (individual control) tend to disagree more strongly with the *expert* stance (professional control).

The results show there are different opinions on how terms related to universal design should be interpreted and used in the field of *universal design of ICT*. No universal design related term is agreed upon by all Norwegian experts as synonymous, or by all as non-synonymous. A little over 60 % distinguish between universal design and accessibility for all and as such the sample is split on whether the term "accessibility for all" is synonymous to "universal design" or not. Likewise, there does not seem to be an agreed upon understanding or definition of what working in the field *universal design of ICT* entails, and thus what the competence of a "universal design of ICT"-expert is. Explanations of the field seem derived from common definitions of universal design, including academic definitions as well as laws and regulations concerning the sector, which are well known in the sample. The terms used in these definitions are suspected interpreted differently among the experts based on the sampled data.

The paper also investigates user groups are receiving the most attentions in universal design and inclusion and accessibility work. Comparing frequencies on user group focus in the sample to those users reported as excluded in the Norwegian eSociety, three of the four excluded user groups are shown to receive quite infrequent attention, with median values within the categories *sometimes* or *seldom* being focused on. Overall, visual impairments are receiving the most focus from the experts. The analysis however shows people not participating in the job marked are likely a highly vulnerable group for exclusion that is also lacking attention. Further, increased edge-case recruitment of extremes in subgroups among elderly and non-native speakers is suggested, as these users are reported at-risk for exclusion while the data show they are currently given infrequent focus.

The paper concludes that establishing a more unified interpretation of what it means to work within *universal design of ICT* is likely to be beneficial – and in particular responsibilities related to relevant legislation such as the Norwegian anti-discrimination and accessibility act, including if current practices are excluding certain groups of individuals. In addition, there may be a need to discuss if sub-fields within *universal design of ICT* should be defined, to better reflect different types of universal design expertise – or alternatively if universal design expertise should be defined as specialized competence within existing ICT fields.

6.1 Future Research

Survey data on universal design methodology from experts within the field continue to be gathered, both nationally and internationally. Future studies will look into disability views and user group focus in the international community, and whether there are global differences. Investigating disability views in a larger national sample as well as internationally is viewed as highly interesting, as this may be tacit and implicit knowledge influencing the field. A follow-up in-depth interview study of the topic among key stakeholders in Norway is also being considered.

Finally, the need for mapping out the field *universal design of ICT* in more detail could be explored or discussed. If better defined and framed, a more solid population to draw samples from for further studies on practices and methodologies in the sector could be identified.

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COMPARING USER-CENTERED PRACTICES IN AGILE VERSUS NON-AGILE DEVELOPMENT

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ABSTRACT

A large variety of methods and techniques are being used within user-centered design. This article explores the differences in methodology and strategy when doing user-centered design within agile versus non-agile development processes. Methods and techniques reported in user-centered agile development is analyzed and compared with those used in non-agile processes. The findings indicate systematic differences, pointing to the fact that the term "user centered" does not carry the same meaning when used within the agile framework compared to the non-agile design methodology. This discrepancy is something we believe is of interest to the IxD/UX-community as well as the agile community.

1 INTRODUCTION

Interaction design (IxD) is a multidisciplinary field, encompassing a variety of approaches. Systematic investigations of work practices and knowledge on the effect of these are areas of interest for interaction design researches. As agile development has in recent years had a growing popularity (AgileScout, 2013), more of the interaction designer's work is done within the framework of agile process models. A study conducted by VersionOne (2013) report a significant increase in the number of companies employing agile development strategies, and using agile teams. Scrum – as perhaps the most well known method – is the most forward trend. At the same time, the focus on user interactions, user experience and employing user involvement as a strategy to ensure usability has increased.

User-centered design (UCD) is a widely used design strategy within IxD today, with a broad range of methods, strategies and techniques being employed. Agile process models are mainly developed with regards to software engineering (AgileManifesto), but with the increased interest in user-centered processes, it has recently been attempted to integrate the methods of UCD into agile development processes. In 2011 Silva da Silva et.al. conducted a systematic review to shed light on what practices for UCD was used within agile development processes (Silva da Silva et.al. 2011). Their review identified some common strategies and topics, and they suggested an agile process model they deemed fitting for integrating UCD into agile development. The agile user-centered methodology suggested based on their literature survey appear somewhat different than the values and focus of traditional user centered design methodology. We found this an interesting topic to study further. This article therefore investigates methods utilized in user-centered agile processes compared to those reported used in non-agile user-centered processes. Our starting point is an update of Silva da Silva et.al.'s review (2011) to verify the agile UCD method use, with a subsequent survey on methods reported used in non-agile user-centered development and finally an analysis and comparison of the findings.

2 METHODOLOGY

By discussing what is already known, one can point out shortcomings and contradictions surrounding the existing knowledge (Jesson et.al. 2011). Machi and McEvoy (2009) describe how a literature survey may provide distinct contributions through creating new perspectives. The research question for this study was whether or not there are differences in the user-centered methodology utilized in "traditional", non-agile processes compared to those being used when user-centered design are mated with agile development processes. Thus, a review of literature is a fitting research method for investigation (review research).

A systematic review is a type of literature survey that attempts to identify, assess and systemize *all* empiric evidence adhering to the pre-determined selection criteria for the study (The Cochrane Library). Silva da Silva et.al.'s is such a systematic overview (2011). This article is however less ambitious in terms of the number of databases and search-string keywords. It is more aligned with a comparison study, looking into methods reported in published literature on user-centered but *not* agile processes compared to the methods used in cases reported as user-centered *and* agile. The article categorizes and compares the methodological approaches. In addition, the focus of the literature is analyzed - whether reporting using only expert-driven methods versus also including user-involved techniques, whether using only low-contact methods versus utilizing medium to high-contact methods also (se Figure 1) and whether focusing solely on interface usability design and testing versus emphasizing all four phases specified in the ISO 9241-210 standard for human-centered design (se Figure 2).

2.1 Terminology

Agile development is terminology used for strategies that rely on an incremental approach to development (Sommerville 2011). An *incremental* process develops a larger system by partial deliveries. An *iterative* process describes a strategy where something is produced, then evaluated, and next refined. Agile processes have several similarities to models for user-centered design, as both recommends incremental and iterative strategies. Scrum is an example of an agile process model practicing incremental and iterative development; the model suggests *sprints* typically lasting from 2-4 weeks where partial deliveries are produced and tested/evaluated (Scrum Alliance 2013). In this literature survey, *agile* covers development strategies such as Scrum, XP and lean.

The term *user centered design* (UCD) is used for processes focusing on users' needs and abilities in design, development and evaluation of systems and solutions. According to Usability Professionals' Association, UCD is "*an approach to design that grounds the process in information about the people who will use the product*". The term is however quite loosely defined and used. Hartson and Pyla (2012) explain UCD as focusing on people, not technology – thus surpassing usability and including focuses on user experience and user-interactions.

There are different degrees of user involvement included within user-centered strategies. UCD includes strategies were the knowledge of users needs lies within the designer and developer. Here, the user has no physical presence in the process, and does not give explicit contributions. On the other hand, UCD includes participatory design (PD) strategies, were the user is considered part of the design team. User representatives are included throughout the process, and users' ideas and opinions are clearly voiced. As a middle ground we find strategies that include users to some degree, where users provide input and are somewhat involved. Figure 1 illustrates the different degrees of user involvement within UCD; from knowledge of the user gathered by the designer, via direct feedback and input from users, to users actively participating with their own ideas as co-designers.

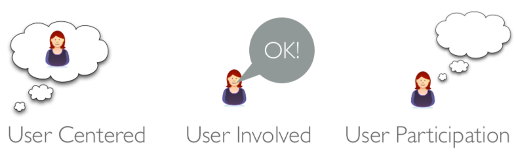

Figure 1: Different degrees of user involvement within UCD

Further, specific methods may have different degrees of *user contact*, often categorized as of "high", "medium" or "low" contact. The degree is defined through the amount of direct/indirect contact one has with the user. Methods that provide in-depth, direct contact with users and involve users actively in a process are "high contact". Examples are PD techniques and workshops with users. In the "low" category is methods were one does not, or only indirectly, meets and involve users – such as web-analysis, and surveys, or personas and scenarios where a fictitious, representative user is created. Of "medium" contact are methods with some direct contact and/or indirect user involvement, such as using probes and design provocations. Note that categorizations may vary depending on specific usage in a case, for example different variants of interviews, observations and usability evaluations. Processes including high-contact methods will become more user-involved than those mainly utilizing low-contact methods.

UCD processes are commonly conducted based on the ISO 9241-210 standard (Figure 2), consisting of 4 phases; understanding context, specifying needs, producing design and evaluating solution. The first two phases are aimed at user research and analysis, while the latter two are aimed at producing design solutions. The standard specifies 6 principles: UCD as 1) based on explicit understanding of users, tasks and environments, 2) involving users throughout the design and development, 3) in an iterative process, 4) driving and refining the design through user-centered evaluation, 5) addressing the whole user experience and 6) multidisciplinary design team.

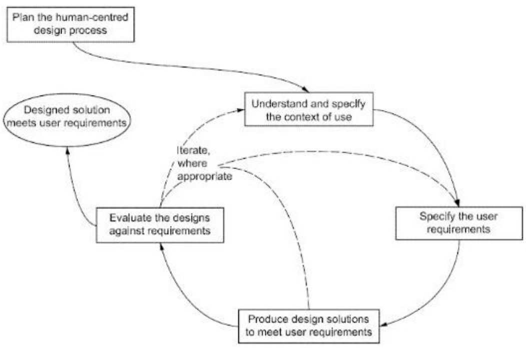

Figure 2: ISO 9241-210:2010 - Human-centred design for interactive systems

2.2 Methods Used in Agile UCD

An update on the 2011 Silva da Silva et.al. review was conducted to ensure findings are current and comparable, limited to the timespan 2011-2014 and completed in 2014. The following 5 databases were searched for new publications; IEEE Xplore Digital Library, Elsevier ScienceDirect, CiteSeer, ACM Digital Library and SpringerLink (the same as in Silva da Silva et.al. (2011) with the exception of the Scopus database). The search returned 30 articles (including Silva da Silva et.al. 2011). 16 of these are considered relevant; describing methods used in agile user-centered design and discussing agile/UCD integration. All included articles have been peer-reviewed. Table 1 lists these as *used*. Each of the paper authors have read and analyzed all the included articles from this search at least twice. Findings were subsequently shared, discussed and aligned. The results indicate there have not been substantial changes in methods used in user-centered agile processes in recent years.

Database	*Articles*	*Discarded*	*Used*
IEEE Xplore	8	4	4
ScienceDirect	1	1	0
CiteSeer	1	0	1
ACM	11	7	4
SpringerLink	9	2	7
Total	30	14	16

Table 1: Search results for agile UCD 2011-14 update

In Silva da Silva et.al. (2011) the keywords agile, "agile method", "agile development", "agile practice", "agile project", "agile lifecycle", scrum, "extreme programming", "lean development", "feature driven development", "dynamic system development" and "agile unified process" are used to search for agile processes. This article uses the same keywords in the search strings for agile processes. Further, Silva da Silva et.al. (2011) defines articles with any of the following keywords as within user-centered design; usability, "human-computer interaction", "computer-human interaction", "human factor", "user experience", "user-centered design" or "user interface". Thus, in relation to methods used in user-centered agile processes, "user-centered" was defined as focusing on UX, IxD, HCI, usability or UCD.

This provides a broad search, but was successful when screening for papers combining any of the above keywords with any of the keywords listed under search for agile processes.

2.3 Methods Used in Non-Agile UCD

When looking for articles on methods used in user-centered but *non-agile* processes, the search string suggested by Silva da Silva et.al. (2011) to capture *UCD* is too broad. As you see from Table 2 on search results in IEEE Xplore database only, refining the search by limited to articles from 2007 and 2010 respectively do not affect the search results substantially. A more specific search string is however arrived at if omitting the more general keywords *usability, human-computer interaction* and *user experience*. Including articles mentioning "*user-centered design"* AND *"user interface"* appears a reasonable search string. This search string emphasizes user-centered methods as related to the design and evaluation of an interaction or interface.

Further, articles on UCD in *non-agile* development processes is negatively defined in this survey – i.e. articles that do not mention the use of an agile approach. The excluding keywords are condensed to the following 4; *agile*, *scrum, "extreme programming"* and *lean.* Keywords and terminology limiting the search for agile, non-agile and UCD is not standardized (Silva da Silva et.al. 2011). This is a challenge. For example, asking for "NOT agile" in the search string may accidentally omit relevant articles using the term "non-agile". Note, that these search limitations may cause non-symmetry in the data sets that may negatively affect the strength of the validity in the comparison between agile and non-agile results.

Search string	***Articles***	***< 2007***	***< 2010***
usability OR "human computer interaction" OR "computer-human interaction" OR "human factor" OR "user experience" OR "user-centered design" OR "user interface" NOT agile NOT scrum NOT "extreme programming" NOT lean	28,214	16,385	9,802
"user-centered design" AND "user interface" NOT agile NOT scrum NOT "extreme programming" NOT lean	34	23	14

Table 2: Non-agile UCD search in IEEE Xplore (metadata)

The survey uses the databases IEEE Xplore Digital Library, CiteSeer and Elsevier ScienceDirect. In IEEE the search is limited to metadata, in CiteSeer to abstract and in Science Direct to the area of Computer Science. The final search results from these databases can be found in Table 3.

Database	**Articles**	**Discarded**	**Used**
IEEE Xplore	34	24	10
CiteSeer	66	60	6
ScienceDirect	29	25	4
Total	129	109	20

Table 3: Final search results for non-agile UCD methods

Some of the 129 resulting articles were discarded through screening due to lack of a consistent user-centered focus. Evaluation is an important part of user-centered design, however articles completely lacking a user-centered focus in design and development were not considered user centered even if they ended with user evaluations. The literature survey have thus placed emphasis on articles describing methods for UCD in the process towards becoming a product or system over those that solely focus on users in an evaluation phase. All included papers have been peer-reviewed. The two authors have gone through the included 20 articles independently for analysis and classification, each article from this search being viewed at least 3 times per researcher. Findings were iteratively shared, discussed and aligned.

3 RESULTS

3.1 Methods Used in Agile UCD

The analysis of agile UCD methodology before 2011 and from 2011-2014 indicates that methods and focuses are consistent and constant. The 2011 Silva da Silva et.al. review included 58 papers discussing the integration of UCD and agile development. Their information was grouped into 15 content related categories (Figure 3) on methods and strategies used in agile user-centered processes. A bottom-up approach was used for categorization in the survey update (Figure 4), which did not produce the exact same categories as in Figure 3. Still, the 16 new articles align themselves well with previous findings as discussed in 3.1.1-3.14. The most common topics within agile UCD seems to be: 1) arguments for little design up front (LDUF) or some design up front (SDUF), 2) the UCD team working one sprint ahead of the developers, 3) how agile/UCD integration improve collaboration between designers and developers, 4) using user stories to capture usability issues, 5) the use of low fidelity (lo-fi) prototypes and 6) the use of usability evaluations.

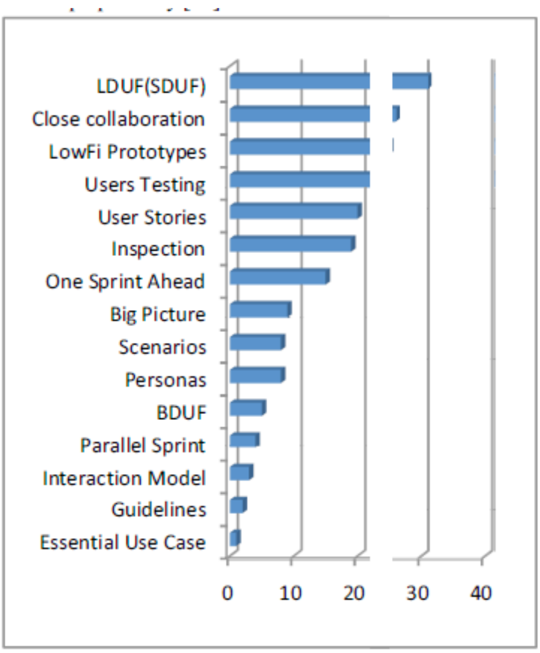

Figure 3: Content categorized by Silva da Silva et.al. 2011

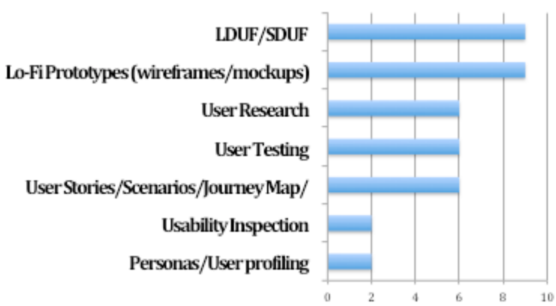

Figure 4: Methods reported used in our 2011-14 update

3.1.1 LDUF/SDUF

Only one of Silva da Silva et.al.'s 58 papers suggests big design up front (BDUF), all other argues against. 31 of the 58 included papers recommended strictly limited DUF (53 %). Of the new 16 papers, 9 recommend LDUF/SDUF (56 %). As such, the topic focus remains constant.

3.1.2 One Sprint Ahead

15 of the 58 review papers suggest the design-team work one – or two or three – iterations ahead of the developers (26 %). Some suggests starting the design work in Sprint 0. Likewise, in the survey update several new articles suggest the need for the interaction designer to work one or more sprints ahead of development, for example by Felker et.al. (2012) and Isomursu et.al. (2012). Descriptions of how designers work on the overall design in a sprint 0 is also quite frequent. Thus, the topic remains constant.

3.1.3 Team Collaboration

While Silva da Silva et.al. found information on how agile/UCD integration improves collaboration between designers and developers, the survey update finds collaboration described as more problematic. Thus, the focus on this third topic seems increased. Working one sprint ahead may in practice mean the development teams are working on implementing user-stories that the UX designer has long finished, while the UX designer works on other issues – e.g. user testing prior implementations (Isomursu et.al. 2012). Some articles even describe UX and implementation as two separate teams within the agile team. For example, Raison and Smith (2013) experienced in their study that several companies view UCD as an optional add-on, or even a blocker to the "real" development work. When not co-located, UCD was seen as irrelevant or purely a checkbox ticking exercise. Kuusinen et.al. (2012a) describe how lack of time for design may result in getting UX designs for implementation too late. Allowing SDUF and overall concept design in a phase 0 is a strategy to avoid "blocking" implementation work, but results in a less interconnected team.

A common argument is that it is key that UCD, IxD, UX and UI designers are highly integrated into or fully part of the agile team (Silva da Silva et.al. 2013a, Kuusinen et.al. 2012a, Silva da Silva et.al. 2013b, Kuusinen et.al. 2012b, Nielsen et.al. 2012, Raison et.al. 2013, Ferreira et.al. 2012). The role of the designer seems unclear – even when all members of the team understand UX as a discipline. To improve lack of co-operation between UX specialists and developers, more face-to-face time is suggested. In addition, a "culture gap" between designers and developers (Kuusinen et.al. 2012a, Kuusinen et.al. 2012b, Nielsen et.al. 2012, Raison et.al. 2013, Ferreira et.al. 2012] must be bridged. Kuusinen et.al. (2012b) describe how decisions as to when and how UX works was needed were not made by UX specialists, and how this led to the consideration of UX issues occurring too late in the process, as well as too inefficient utilization of the UX resource. Isomursu et.al. (2012) conclude that the integration of software engineering and UX design through working sprints ahead is not optimal, and that the desired levels of interactivity and agility are hard to achieve.

3.1.4 Methods Used in Agile UCD

Concerning specific design methods used, both surveys show use of prototyping and user stories are common along with personas and scenarios. Further, inspections and user tests are frequently conducted. Methods related to *understanding* the user and the context of use are not emphasized in studies or the proposed agile UCD process models. In the review, 7 out of the 58 papers (12 %) mention methods such as contextual inquiry and interview techniques (related to SDUF). 6 of the 16 update articles mention user research as a task to be included in the agile process (Silva da Silva et.al. 2013a, Kuusinen et.al. 2012a, Silva da Silva et.al. 2013b, Kuusinen et.al. 2012b, Nielsen et.al. 2012, Jia et.al. 2012]. But, only 4 of the 16 articles specify concrete methods (Silva da Silva et.al. 2013a, Kuusinen et.al. 2012b, Nielsen et.al. 2012, Jia et.al. 2012] (25 %) – these are interviews, observation and field studies. The lack of focus on methods for understanding thus remains a constant.

From the update survey, 6 papers report user-centered (but not user involved) methods related to *specifying usage* (Silva da Silva et.al. 2013b, Kuusinen et.al. 2012b, Jia et.al. 2012, Raison et.al. 2013, Asuncion et.al. 2011, Isomursu et.al. 2012) (38 %). Techniques used here are user stories, user journey maps, storyboards and scenarios. A few of these also mention personas and user profiling (Silva da Silva et.al. 2013b, Jia et.al. 2012]. This fits well with the Silva da Silva et.al. findings where user stories are commonly used (20 of 58 papers; 34 %), and personas and scenarios somewhat used. The topic of user stories to capture usability issues is thus continued.

Related to *producing design solutions*, 25 of the 58 papers (43 %) in Silva da Silva et.al. report the use of lo-fi prototyping and 9 of the new 16 (56 %) (Silva da Silva et.al. 2013a, Kuusinen et.al. 2012a, Silva da Silva et.al. 2013b, Kuusinen et.al. 2012b, Nielsen et.al. 2012, Jia et.al. 2012, Isomursu et.al. 2012, Felker et.al. 2012, Ferreira et.al. 2012). Based on the descriptions in the 9 most recent articles, the common approach is using paper prototypes, mock-ups, wireframes or sketching. In some cases, the prototypes evolve from lo-fi to higher fidelities during the process. None of the reviewed articles report use of user involved or collaborative design approaches such as for example design provocations (medium contact) or user-involved workshops or PD techniques (high-contact). The strong focus on lo-fi prototyping thus remains a constant.

Prototyping is usually linked with methods for *evaluation* in an iterative manner. The most common approach is user testing, for example user testing paper prototypes (Silva da Silva et.al. 2013a). Some also make use of expert usability inspections. 22 of Silva da Silva et.al.'s (2011) 58 review papers user tests (38 %) and 6 of our survey 16 (Kuusinen et.al. 2012a, Nielsen et.al. 2012, Jia et.al. 2012, Asuncion et.al. 2011, Isomursu et.al. 2012, Felker et.al. 2012) (also 38 %). The types of tests are often unspecified, but are usually formative and exploratory in nature. Some mention the use of the think-aloud protocol. For expert usability inspections, 19 of the 58 (33 %) report this strategy. In the follow up survey, 2 of the 16 (Silva da Silva et.al. 2013b, Faulring et.al. 2012) (13 %) use inspections. Both also do user testing. Specified expert inspections are heuristic evaluations and cognitive walkthrough.

Methods use and topics in the conducted update survey thus align well with Silva da Silva et.al. (2011):

- Overall, methods linked to understanding of users, tasks and environments are not receiving focus. Nielsen et.al. claim there is a push from doing user research to focusing solely on design (2012). This fits well with the findings.
- Further, methods used in design do not involve users.
- Focus is on integrating user testing and UX evaluations iteratively throughout the agile process through lo-fi prototyping one sprint ahead. Main challenges related to this seem to be collaboration between the developing team and the designer, clarifying/merging the role of the designer in the team and allowing the necessary time and culture for UX work. The findings indicate such challenges receive increased focus in newer literature.
- Processes are not seemingly grounded in in-depth understanding of user needs – at least not from the start. Step 1 in the ISO 9241-210 model (Figure 2) receives little focus in the overall processes.
- In general, the methods and strategies described indicate UCD processes to the left-hand side of Figure 1 (low to medium degrees of user involvement). Any extensive user contact is likely to first occur in the evaluation phase.

3.2 Methods Used in Non-Agile UCD

From the 20 included articles in this literature search, as many as 51 different methods were identified. Methods with strong similarities with respect to purpose, type and process stage used where thus grouped using a bottom-up approach to encoding, resulting in 10 categories of methods (Table 4) in order to facilitate data analysis. Most categories include several methods, techniques and variations. Some articles mention specific methods, while others do not specify what specific type of method is being used, e.g. stating *interview* and *usability tests* are used (Heisakari et.al. 2009). For those not specifying a type, the description of the execution usually enables a classification. If not, the label "other" is assigned to the specific type of method within a category. The categories Survey, Interview and Observation and Insight are closely linked to *understanding* the user and the context of use – step 1 in the ISO 9241-210 model (Figure 2). The methods in these categories are considered within *user research*. 3 articles report the use of surveys (Slagle et.al. 2010, Granic et.al. 2006, Plaisant et.al. 1997). 9 articles use interviews and 9 observations (Figure 5). 10 papers report other methods for gaining more insight and understanding (Figure 6). In total 13 out of the 20 articles included in the survey (65 %) conduct user research.

Category	*Description*
Survey	Use of surveys sometime in the process
Interview	Use of interviews, from early contextual interviews to phone interviews.
Observation	Any use of observation in the process.
Insight	Other analyzing and specifying methods to further insight, e.g. user analysis. Often utilized in early phases.
Scenario	Use of scenarios, use cases, storyboards or other narrations specifying usage.
Workshop	Use of workshops and user involved group work through different techniques. Commonly used in the design-phase.
Prototypes	Visual or functional design realizations from lo-fi mock-ups and paper sketching to more advanced medium/high fidelity (hi-fi) clickable wireframes and testable interactive prototypes.
User testing	Person(s) from user groups tests product.
User evaluation	Direct or indirect input from user(s), without user testing tasks.
Expert evaluation	Evaluations and inspections conducted by experts (non-users).

Table 4: Description of the 10 categories of methods

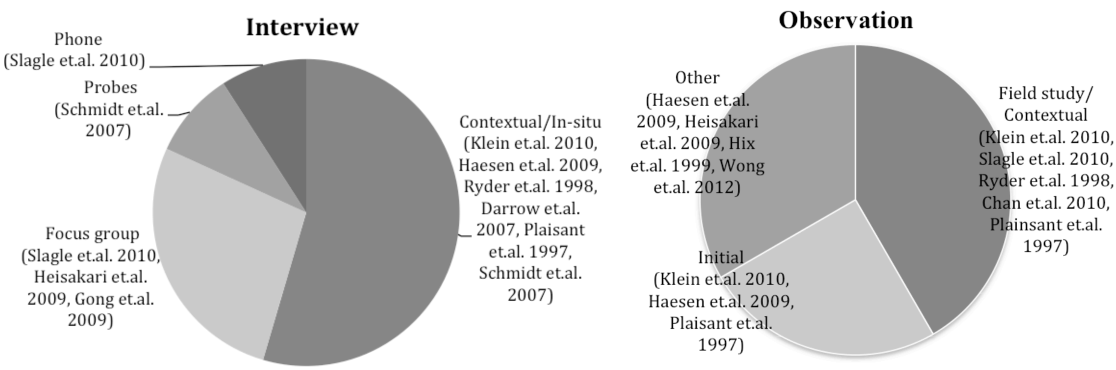

Figure 5: Interview and Observation techniques

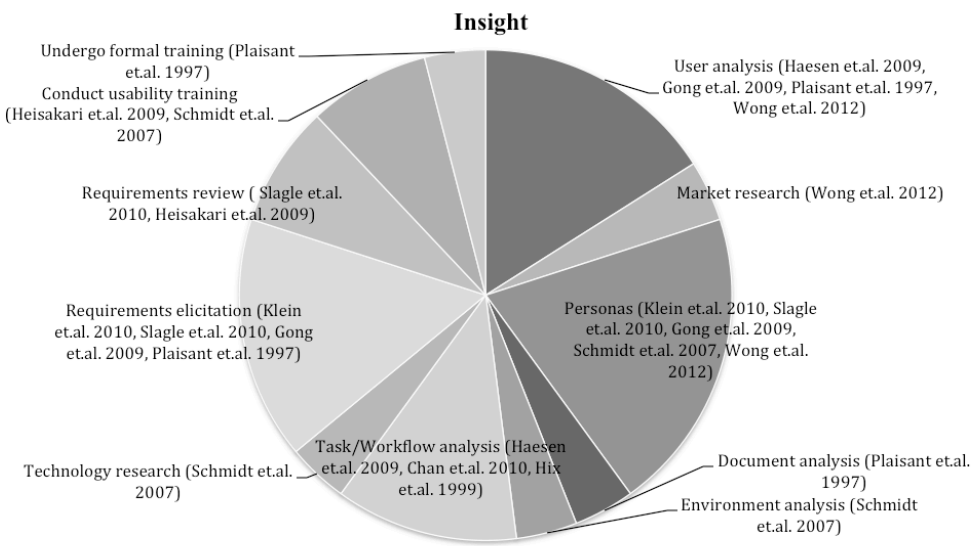

Figure 6: Other methods providing Insight (analysis/research)

Regarding *specifying usage* (step 2), 13 articles (65 %) reported use of Scenario-related methods (Figure 7). Related to step 3 *producing design solutions*, 16 articles (80 %) reported use of prototyping techniques (also Figure 7). Here, use of paper prototypes, mockups, wireframes etc. is considered lo-fi. Medium/hi-fi prototyping is grouped and defined as prototypes that are more advanced, and clickable or interactive. Within the prototyping articles, 7 also included user-involved design methods (Figure 8) (35 %). Here, half did not have a PD approach, but used group work and discussions, brainstorming, moodboards and more in design-related workshops. The other half conducted PD, also utilizing a variety of techniques.

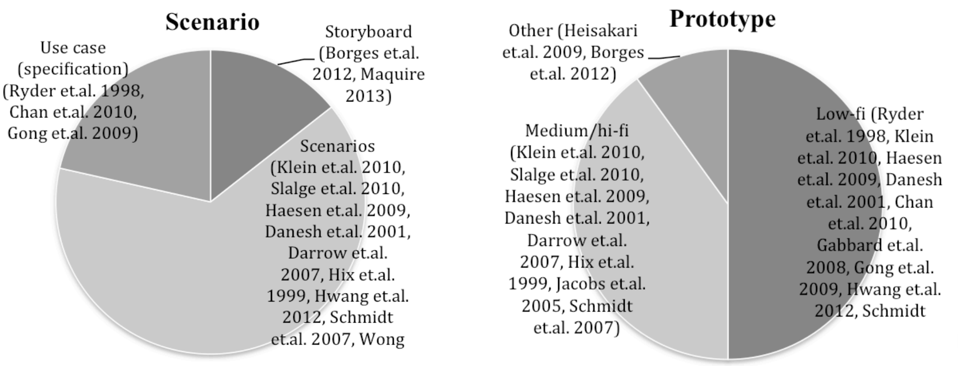

Figure 7: Scenario-related and Prototyping techniques

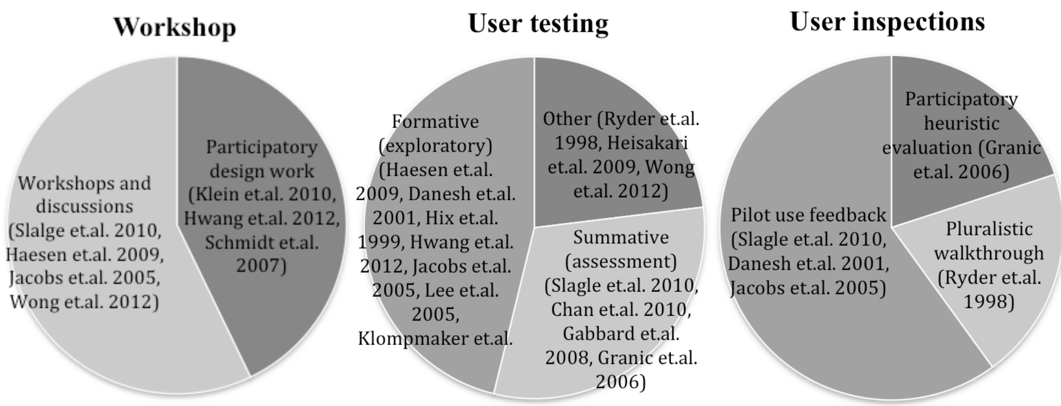

Figure 8: User-involved design Workshops, User testing approaches and User inspections

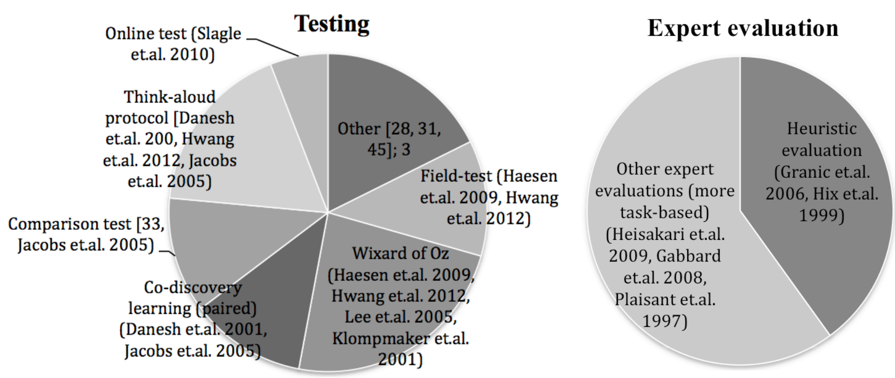

Figure 9: User testing techniques and protocols and Expert evaluations

Finally, related to methods for *evaluation* and the ISO 9241-210 model step 4*,* 14 articles (70 %) report user testing. Figure 8 presents the overall user test approaches. Next, 5 articles (25 %) report the use of other user evaluations such as user inspections and pilot use feedback *in addition to* user tests (also Figure 8). Figure 9 presents the use of specific test techniques and protocols. A final 5 articles (25 %) utilize expert evaluations (Figure 10), but only a somewhat dated paper (Plaisant et.al. 1997) relies *solely* on expert inspection (no user testing).

3.3 Comparison of Methods Used

Looking at the methods in non-agile UCD processes compared to those in agile processes, many similarities can be identified. However, there are indications of a difference in methodological repertoire and user-centered practice. First, methods with a high degree of user contact ("high-contact methods") are very rarely described in reviewed articles on agile UCD. This is especially evident when looking at the methods employed for *producing design solutions*. Here, agile papers never mention the use of workshops or user involvement, while 35 % of the non-agile articles utilize the users input.

Though prototyping should perhaps not be classified as a user-centered method in itself, it is evident that it plays an important role in development processes and IxD/UX/UCD, both agile and non-agile. Prototyping is typically paired with usability evaluation in an iterative process. But, while agile processes mainly use prototyping and user testing iteratively to ensure usability, non-agile processes also place more emphasis on involving users in phases other than usability evaluations. Here, just over half of the articles use high-contact methods such as participatory design and workshop techniques, field studies and contextual in-depth user research strategies. High-contact methods do not replace prototyping and user testing, as Table 5 displays. Rather, non-agile user-centered processes include more user-centered methods, in earlier phases and increase user contact and user involvement.

Second, the methodological richness reported in non-agile articles seems quite a bit larger than in agile processes. This seems to be particularly true for methods related to understanding users and providing insights, where agile UCD heavily rely on personas while non-agile UCD has a richer method spectrum. Agile and non-agile UCD processes differ less in methods utilized for *specifying usage* and *evaluation*.

Method:	***Agile***	***Non-agile***
Prototyping	55 % (41:74)	80 % (16:20)
Scenarios/user stories	35 % (26:74)	65 % (13:20)
Observations/field-studies	14 % (10:74)	45 % (9:20)
Interviews	15 % (11:74)	45 % (9:20)
User profiling/personas	5 % (4:74)	35 % (7:20)

Table 5: Use of common, specific method types

Methods used for:	***Agile***	***Non-agile***
User Research/Insight	15 % (11:74)	65 % (13:20)
User-centered specification	35 % (26:74)	65 % (13:20)
User-involved design/PD	0 %	35 % (7:20)
User evaluation	38 % (28:74)	70 % (14:20)
Expert evaluation	28 % (21:74)	25 % (5:20)

Table 6: Use of methods related to their purpose

Third, there seems to be a difference in focus or values. Many of the agile papers focus on suggesting a model for integrating design work related to implementation of features. In this suggested integrated process models few specific methods are mentioned. Aside from user-centered scenario-based techniques and user evaluations, agile papers seem to focus more on a model for integrating design work related to implementation of features, than to user research and analysis. Thus, even though agile methodology strives to merge with user-centered, it seems the IxD and interface design aspects are given focus over UCD values such as in-depth user knowledge, user involvement and contextual design. Even though half of the more recent agile UCD articles do mention user research, as Table 6 shows, it appears this part of the UCD process is given much more emphasis in non-agile processes. Here, the category "user research" has expanded from one into three new categories; methods for observations (used by 9 articles), interview techniques (used by 7 articles), surveys (3 articles) and other analytical strategies (11 articles).

4 DISCUSSION

Within UX studies and UCD there is usually an initial phase where some in-depth activities related to identifying and understanding the user and the context of use. Based on the survey findings, such methods have little focus in agile processes, as Adikari et.al. also notes (2013). Instead, early agile work is more focused on developing interface design solutions. The methodology typically applied in agile UCD is narrower than non-agile UCD methodology, and mainly focusing on rapid evaluation/design iterations – not on anchoring the process is user needs. Methods aiming at providing and maintaining an understanding of users, context and requirements are somewhat neglected. User-centered methods in agile processes aside from testing are mainly linked to elaborating user stories into scenarios on use. This strategy makes sense, as the scenarios and stories may be utilized as test cases and in expert reviews later on. However, there should be awareness of the fact that agile processes in general do not include or involve users in the design process aside from tests. High-contact methods and user involvement are rarely being reported used. Some do report to use personas and user profiling, but these methods are also not directly involving contact with users. Methods on user profiling should be based on user research and user knowledge according to user-centered methodology, but the reviewed articles do not emphasize user research methods in their processes. Thus, agile UCD seems to break with the traditional values of UCD.

A core value of UCD is to start with an understanding of the users needs, and keep the focus on the user throughout the design and development process. While most of the articles describing the non-agile processes support a strategy where users are regularly contacted for input, reviewed agile articles are more focused on process aspects. It could be argued that the reviewed agile processes are more customer-focused than user-focused compared to their non-agile counterparts. The focus is instead towards integrating iterative design and prototyping practices with development, allowing usability evaluations prior to implementation. Thus, within agile UCD it seems to be a strong focus on design practices and iterative development and evaluation of design solutions, e.g. the latter two phases of ISO 9241-210, and less focus on user research and understanding. Isomurso et.al. warn of the danger that user stories evolve and start to live their own lives, and the connection to original UX targets lost (2012), in such processes.

Another core principle in UCD is involving the users in the design process, from start to finish. The possible different degrees of user involvement in a UCD process, and differences in user contact between specific methods are however not considered in agile UCD, and are not a part of models or recommendations. The overall degree of user involvement throughout agile UCD processes is less than in non-agile processes, and possibilities for participatory strategies and in-depth analyses seem limited. Non-agile user-centered processes on the other hand, often use high-contact methods throughout the design process. Thus, while reported non-agile UCD processes spans the whole range in Figure 1 from *centered*, through *involved* and to *participatory*, agile UCD processes all remain user-*centered*.

Compared to Silva da Silva et.al. (2011), more recent agile UCD trends are discussing challenges relating to collaboration issues and cultural differences between developers and designers. There might also be an increase in focus on user research. Still, the initial UCD step of understanding needs is not emphasized. Methods related to understanding and specifying context of use and analyzing and investigating user needs seems to be downplayed in agile user-centered processes compared to non-agile UCD. Overall, agile UCD seem to have low levels of user involvement throughout the processes. A possible explanation may be that the costumer (client) replaces the role of users in agile UCD, and especially in early phases.

A key challenge reported in literature on agile UCD is to create good communication and collaboration within the cross-disciplinary team, specifically between designers and programmers. It is portrayed as hard to accomplish an ideal collaboration through the current integration strategies of one (or more) sprint(s) ahead and SDUF (Sprint 0 overall concept design). It is recommended to fully integrate any IxD/UCD/UX-person(s) in the agile team, and methods and process recommendations aim to ensure the iteration of design solutions and multi-disciplinary teams, even when time is pressed. These are topics debated in the articles, however there are few reflections on how the core principles in UCD are attended to in the agile framework. There do not seem to be a UCD culture across the agile team within ”agile UCD”. Instead, from our point of view, agile UCD is integrating visual design and interaction design into the agile process, but not reflecting upon the differences between an IxD and UCD design approach. Our survey indicates issues related to agile and UCD integration are deeper than collaboration issues. There are indications that “user-centered” does not carry the same meaning and values when used within the agile framework compared to the traditional non-agile UCD methodology.

5 CONCLUSION

The comparison indicates systematic differences in methodological practices in agile versus non-agile user centered processes with regards to the breath of methods used, degree of user contact and the type of strategies employed. The non-agile papers align themselves well with traditional user-centered methodology, with early user contact and the use of user-involved techniques and medium-to high-contact methods as part of the process. The agile papers systematically point to projects less focused on grounding the process in an in-depth understanding of user needs, knowledge of the context of use and on active involvement of users throughout the process – even though these are among the core principles within UCD. In papers proposing UCD and agile integration there seems to be little reflection on the degree of user contact and user involvement throughout the process. The focus of design-work integrated into agile UCD processes seems to be focused on visual design and interaction design disciplines. The initial Sprint 0 start-up phase appears to be treated as a phase for expert work on overall design, which is related to visual design and interaction design, instead of being viewed as a phase for user research and UCD. As such, agile UCD seems more expert-driven and costumer-focused. Though the term “user-centered” is the same, agile processes utilizes a more limited part of the traditional UCD methodology.

Findings from Silva da Silva et.al. (2011) on agile UCD methodology appears consistent with updated findings. This strengthens the validity of the findings, and of the indications that there are systematic differences between agile and non-agile UCD. A key challenge discussed by published literature in relation to agile UCD success is on the communication and collaboration between the designer(s) and the developers implementing the design. This survey indicates issues related to agile and UCD integration are deeper than collaboration issues. The findings may contribute to increased awareness and be useful in the on-going discussions on integration of agile development and user-centered strategies and the recommendations on agile user-centered design best practices and models. A next step would be to validate findings in relation to methods usage. Further, to investigate reasons for the differences – for example whether they are due to a lack of awareness of user-centered principles, different epistemological views or available resources and external constraints.

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Exploration of User-Centered Agile Development Practices

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Abstract

During the past decade, there has been a growing interest in how to integrate user-centered approaches in agile processes. This study researches the topic of Norwegian user-centered agile development through an exploratory interview study. Insight is given into how agile developers understand user-centered design, regard proposed integration models and perceive multidisciplinary cooperation and integration. The impression is that fundamental principles of agile and user-centered methodologies are not necessarily merged in integrated approaches. Findings suggest proposed parallel integration models are generally well received among developers, however the success of merged models seems to rest heavily on comfortable project constraints. An interesting insight from the study is how proposed parallel models may be disadvantageous to interdisciplinary collaboration in multidisciplinary teams.

Keywords: user-centered design, agile development, interdisciplinary, parallel integration

1 Introduction

IT-solutions are vital parts of modern Nordic business models, and software may be mission-critical as well as crucial for competitiveness. In order to get a competitive edge in a constantly changing market, responding quickly and exploiting new opportunities are essential, but as are creating great user experiences. Ensuring user experience design in agile development has heightened the need for a merger between agile and user centered methodology. Thus, there has been an increasing interest in how to integrate user-centered design (UCD) approaches into agile development processes (VersionOne, 2015), and several possible theoretical process models have been suggested (Miller, 2005; Sy, 2007; Beyer, 2010; Silva da Silva, Martin, Maurer & Silviera, 2011; Thorkildsen, 2014). As of today, several Norwegian development companies are attempting to develop their own integrated approaches merging the two methodologies. According to literature, they face several challenges. Literature report on a culture gap between designers and developers, with diverging principles and core values, which may cause collaboration and communication challenges (Beyer, Holtzblatt & Baker, 2004; Beyer, 2010; Salah, Paige & Cairns 2014b). For example, user-centered methodology focuses on early planning and user research to understand users needs and specify contexts of use, while agile methodology is focused on rapid production of functional software for costumer review. Research also indicate agile user-centered methodology does not fully integrate the principles and methodological breath of user-centered design (Begnum & Thorkildsen, 2015), and Raison & Schmidt (2013) claim the status of user-centered design is a key factor to the success of a methodological merger. As there is little knowledge on how suggested integrated approaches work in practice, this study seeks to explore the practices and views of agile developers in Norway. Focus is on the developers' understandings and perceptions of UCD, experiences with integrated user centered agile (UCA) processes and insights related to multidisciplinary team cooperation.

2 Background

User-Centered Design (UCD) is a methodological approach where the user is the focal point throughout the design and development process (Rubin & Chisnell, 2008). The main goal is to create solutions with high usability, fitting user needs and contexts of use. Basing design on user needs is essential to UCD, thus key aspects of the methodology are user involvement, user testing prototypes (including mockups, sketches, real or simulated use) and re-design (Gould & Lewis, 1985; Rogers, Sharp & Preece, 2011). The ISO 9241-210:2010 standard on Human-centred design (ISO, 2015) is often used as a best-practice approach for user-centered design processes; starting with initial planning then iterating the phases 1) understand and specify context of use, 2) specify user requirements, 3) produce design solutions to meet user needs and 4) evaluate designs - until a solution that meets user requirements is designed. ISO (2015) specify the following core principles: basing design upon an explicit understanding of users, tasks and environments, involving users throughout design and development, design driven and refined by user-centered evaluation, iterative process, design addressing the whole user experience and including multidisciplinary skills and perspectives on the design team. Gould and Lewis (1985) emphasize early and continual focus on users, empirical measurement of usage and iterative design as basic UCD principles. The exact levels of user contact and user involvement in UCD approaches are not specified, nor are there strong recommendations tied to methodology for user research, specification and testing (Begnum & Thorkildsen, 2015). Thus, some UCD processes emphasize indirect, low contact methods, while others utilize participatory design techniques and have high contact strategies.

UCD as a methodology does not belong to one particular academic field. The assumption is typical user-centered designers on Norwegian agile projects belong to professions such as Interaction design (IxD), User Interface (UI) design, Information design, Visual design and Web design. These professions overlap, and all are viewed as belonging within the area of User eXperience (UX) design (Saffer, 2010:20). Since UX also covers physical design, the term IxD may be chosen to specify focus on software products (Cooper, Reimann & Cronin, 2007). This article uses the term "UX/IxD" for any (user-centered) designers on agile teams.

Like UCD, agile methodology is based on iterative software development processes and relies on multidisciplinary teams. The Agile Manifesto (2001) presents 12 principles of agile software, valuing Individuals and interactions over processes and tools, Working software over comprehensive documentation, Customer collaboration over contract negotiation, and Responding to change over following a plan. Agile development typically run short iterations focused on producing working code, recommending early and frequent deployment (incremental delivery) (Petersen & Wohlin, 2010). The iterative approach facilitates a high tolerance for changes from one iteration to the next, involving the costumer in development and testing in order to continuously detect errors, changing needs or priorities (Constantine, 2001). Agile methodology thus represents a fundamental shift from traditional linear and plan-driven software development with emphasis on delivery in phases.

A number of different agile practices exist, such as eXtreme programming (XP), Scrum and Kanban. While XP is emphasizing specific techniques for agile development, Scrum suggests a process framework for agile management (Sommerville, 2011). The agile Scrum team is to be self-driven, with the project manager (Scrum master) acting as a facilitator. In Scrum, iterations are labeled “Sprints”. The team commits to implement tasks (Sprint backlog) from a to-do list prioritized by the costumer (Product backlog) within an estimated time frame. Main activities in Sprint planning and Sprint review is updating back-logs and estimates. Daily stand-up meetings ensure close team collaboration. Kanban approaches focus less on management and more on flow, visualizing the workflow and limiting the number of unfinished work in progress – encouraging collaboration to resolve congestions.

Though UCD and agile methodologies have similarities, they also have diverging principles and processes that complicate a merger (Beyer, 2010; Beyer et.al. 2004, Salah et.al. 2014b). A contrast between user centered and agile methodologies is the focus on requirement specification. While user-centered processes place emphasis on understanding and specifying requirements (which could be viewed as big design up front – BDUF), agile approaches is based on detecting costumer requirements as you go, little design up front (LDUF) and just-in-time (JIT) production. The agile approach may lead to limited focus on overall design, be based on weak or faulty assumptions about users and context of use, or create solutions fitting the business needs of the costumer rather than users needs (Constantine, 2001). There are indications of differences in methods utilization in agile versus non-agile user-centered development processes (Begnum & Thorkildsen, 2015), and this indicates there could be differences in user-centered culture, perceptions and understanding between design professions and agile developers. Raison & Schmidt (2013) highlight successful integration could depend on organizations valuing user-centered design perspectives and Salah, Paige and Cairns (2014a) reveal lacking managerial awareness of the importance of UCD on resulting quality may lead to integration and collaboration challenges. Examples are lack of allocated time for upfront activities and lack of support and time for UCD activities including user testing. Generic principles for an integrated methodology have not yet been arrived at, though this work has started (Bhrel, Meth, Maedche & Werder, 2015).

Integrated process models for User-Centered Agile (UCA) software development often suggest parallel paths of design and development, where design activities are a Sprint ahead of development (Miller, 2005; Sy, 2007; Silva da Silva et.al, 2011; Nodder & Nielsen, 2009; Thorkildsen, 2014). Most models focus on integrating IxD and UI-design over UX and user involvement, and suggests some design up front (SDUF) through a Sprint 0 containing user research. Several researchers note that full integration of UX/IxD resource as team members as well as team co-location is important for successful merger (Raison & Schmidt, 2013; Silva da Silva, Silviera & Maurer, 2013; Brhel et.al, 2015).

3 Methodology

This paper investigates user-centered agile integrated development practices and perceptions through an exploratory interview study. An exploratory and flexible approach is deemed fitting for the investigation, as there is limited previous knowledge of Norwegian developers integrated work practices and views (Lazar, Feng & Hochheiser, 2010:180). The goal of the study is to provide an initial understanding of practices in the area of agile user-centered processes, as well as potentially identify interesting insights and hypotheses that may be explored further. Therefore, an in-depth qualitative approach was chosen even if this results in limited validity due to a local and small sample. The number of informants in this study is 7, which is slightly less than the desired target number of 10. The selection criteria are software developers/programmers that have experience working in agile projects as well as on inter-disciplinary agile projects where user-centered professionals (UX/IxD) are part of the team. Convenience sampling is used. The study is more situated than embedded, as the researchers are interaction designers with a somewhat limited experience in agile and user-centered projects. The authors thus have a partially critical distance to agile development culture.

A semi-structured method is utilized collecting qualitative data, aiming at pursuing information, questions and ideas identified during the study (Rogers, Sharp & Preece, 2011). The core research focus is framed through an interview guide. The guide is divided into three parts; one focuses on background data, a second focuses on the informants knowledge and experience with agile methodology and user-centered methodology, and a third target the informants reflections and insights related to integration and multidisciplinary collaboration. An example of a suggested parallel integration model (Thorkildsen, 2014) is presented to the informants as a tool for discussion. Interview questions are designed to be neutral and non-biased, avoiding double-barred questions, complex phrasings and biased or negative words (Lazar, Feng & Hochheiser, 2010). The interviews are audio recorded, and transcribed based on recording and notes prior to data analysis. Oral consent is used both for interview and audio recording separately.

Thematic content analysis is used to analyze the transcripts. Both emergent and a-priory coding is utilized during analysis, with an emphasis on emergent categories. Only two a-priory categories are used; *perception of user-centered design* (UCD) and *costumer versus user distinction*. In relation to understandings and perceptions of UCD focus is on coding the developers' knowledge, terms usage and descriptions in order to explore if their perception covers core aspects of the methodology as described in ISO 9241-210:2010 (ISO, 2015), and to investigate whether there is an awareness of who the *user* is within UCD methodology. Emergent coding is used to investigate the developers' experiences and insights into integrated UCA processes and multidisciplinary team collaboration.

4 Results

In the Results section, the informants background data is first described along with their level of experience with agile methodology. Next, the informants' perception and understanding of user-centered methodology is presented. Third, the informants experiences and insights related to multidisciplinary collaboration is reported, and the final section covers reflections and views on agile and user-centered merger.

4.1 The Informants Backgrounds

The informants work in 6 different companies (see Table 1). Two of the companies are categorized as *small* (< 29 employees), 2 as *medium* (30-99 employees) and 3 as *large* (> 100 employees). Two of the companies are more streamlined towards delivering a specific type of software, while the other are more general IT-consultancies. Six of the informants are male, and one is female. Two informants have dual positions as developers *and* managers.

Table 1. Informants Overview

Informant	Gender	Age	Company	Size	Position
”Are”	M	20-30	SW company A	Small	Developer
”Dan”	M	30-40	Consultancy A	Large	Developer /Manager[1]
”Per”	M	30-40	Consultancy B	Large	Developer /Manager[2]
”Pia”	F	20-30	Consultancy B	Large	Developer
”Roy”	M	30-40	Consultancy C	Medium	Developer
”Tor”	M	30-40	Consultancy D	Medium	Developer
”Jon”	M	30-40	SW company B	Small	Developer

The informants are asked on their experience with agile development, measured by an estimated number of agile projects they have participated in, as well as their total years of experience as developers. Based on a qualitative assessment of these data they are categorized as having *novice*, *intermediate* or *expert* agile proficiency. Further, the types of agile experiences are explored. Three main types of agile methodologies are identified; Scrum-based, Kanban-based, and hybrid processes that are modified versions of Scrum (no longer adhering to basic Scrum-principles). Table 2 presents agile experience data.

Table 2. Agile Experiences

Informant	Agile Proficiency	Agile Methodology Experience
“Are”	Novice	Hybrid
“Dan”	Expert	Scrum/Hybrid
“Per”	Expert	Scrum/Kanban/Hybrid
“Pia”	Expert	Scrum/Kanban Hybrid
“Roy”	Novice	Hybrid
“Tor”	Expert	Scrum/Hybrid
“Jon”	Intermediate	Scrum/Hybrid

4.2 Perceptions of User-Centered Design

Descriptions of UCD vary among the informants and most are very general. For example, “Jon” and “Tor” explains UCD as developing software *“*with the user in mind*”* and “Per” as “focusing on users’ needs”. Only one of the informants – “Roy” – is uncertain as to what UCD is and describes it as *“related to user involvement”* which is a correct assumption, but is unable to elaborate. Compared to ISO 9241-210 the most noticeable UCD knowledge missing from discussions is related to the overall process and phases typically involved in UCD, and the principles of basing design upon a deep understanding of users, contexts and addressing the whole user experience. Instead, “Jon” and “Tor” highlights usability aspects rather than UCD methodology; focusing on ergonomics, solutions that are easy to learn and easy to use, as well as aspects such as readability and font size, while “Per”, “Dan” and “Pia” focus on specific methods for user research and evaluation, such as interviews, personas and user tests. On the other hand, 4 of the 7 informants mention user-contact or involvement, and of these 3 emphasize early involvement. Table 3 presents categorized aspects mentioned.

[1] Project Manager
[2] Technical Project Manager

Table 3. User-Centered Design Descriptions

Aspect of methodology	Mentioned by
User focus	"Per", "Jon", "Tor"
User involvement	"Are", "Dan", "Pia", "Roy"
Early involvement	"Are", "Dan", "Pia"
User research (including interviews)	"Dan", "Per", "Pia"
Personas	"Per"
User testing	"Dan", "Per"
Interface design	"Tor"

The informants easily separate a *costumer* from a *user* theoretically; however report that in UCA practice the two are often blurred. "Dan" explains costumers convey business requirements, while users convey user requirements – an important distinction sometimes forgotten in real life. "Jon" describes how the costumer may feel there is no need for user involvement – for instance due to costumer confidence in already knowing user needs. Both "Jon" and "Tor" describes scenarios in agile development where the costumer represents the users and controls the dialogue with end-users. "Dan" and "Jon" states end-user needs may be given a low priority due to limited resources, and how constraints related to organizational issues may outweigh user needs. All informants agree that UX/IxD contributions are highly relevant within agile development. Two developers, "Dan" and "Pia", emphasize the importance of UX/IxD for identifying needs in project startup. As such, there seems to be an awareness of UCD principles related to involving users throughout design and development. The more experienced developers are able to give somewhat detailed descriptions, but the impression is still that this study was not able to fully capture knowledge, perceptions and attitudes towards UCD among the Norwegian developers.

4.3 Agile and User-Centered Integration

All informants emphasize resource constraints as vital for a successful integration of user-centered and agile methodology. They express positive attitudes to Thorkildsen's parallel integration model; see Figure 3 (2014). However, the informants mention a number of different aspects influencing whether such a process model is beneficial, such as: budget, project size and time-frame, type of costumer and priority given user-centered work over other requirements, type of solution being built, type and size of company delivering the solution, human resources and project manager. In addition, some weaknesses related to collaboration are reflected on related to parallel models; "Per" points out that a parallel approach may separate design-work from development, which is not considered beneficial for team collaboration. "Tor" points out that development may take more time than design and need more Sprints, making a parallel model disadvantageous. Informants seem somewhat split on the importance of Sprint 0 design up front and the need for L/S/BDUF. Several developers argue increased focus on requirement and needs specification is necessary for projects that are large, risky or have inexact or innovative solutions. Table 4 summarizes feedback related to agile and user-centered integration.

Table 4. Integration of UCD in Agile Processes

Insight	Informants
Parallel model seems beneficial	*All*

Parallel model seems disadvantageous	“Per”, “Tor”
Fitting project constraints significant for model benefit	*All*
Sprint 0 is always important	“Dan”, “Pia”, “Roy”
Sprint 0 is not necessarily important	“Are”, “Per”, “Tor”, “Jon”

4.4 Multidisciplinary Collaboration

As Table 5 presents, the informants have different perceptions of the current cooperation between UX/IxD resources and developers. “Jon” reports on limited UX/IxD contributions in agile projects because of part-time UX-resources, limiting the opportunity to follow the agile process continuously. “Dan” and “Per” experience fairly good cooperation; “Dan” due to the prominent focus UX has in his organization, while “Per” report a good cooperation both with full and part-time UX resource. “Tor” suspects there are conflicting interests and priorities between UX/IxD resources and developers. The novices “Are” and “Roy” have limited reflections on the topic. Informants are fairly pleased with the current situation, but there are some challenges. Described challenges are mainly related to A) UX/IxD resources not being full members of the team; instead specialized and spread out on different projects, B) team members have narrow competences, limiting opportunities for collaboration and support compared to a team where developers and designers have some academic overlap, and C) limited continuous cooperation and dialogue between team members. Some developers share UX/IxD resources with several other teams without difficulty, such as Per, however there are challenges related to following an agile methodology when remote designers do not become full members of the team. Most of the informants believe a continuous, closer, more interdisciplinary and cross-task team collaboration throughout the project could be beneficial. Per and Tor express the partnership could be better if UX-designers had programming skills, allowing demand-driven task distribution.

Table 5. Views on Collaboration

View	Informant
Current multidisciplinary team collaboration is conflict-free	“Are”
Current multidisciplinary team collaboration is fairly conflict free	“Dan”, “Per”, “Jon”
Current multidisciplinary team collaboration is challenging	“Pia”, “Tor”
Closer continuous team collaboration and dialogue is needed; Discussing technical aspects in relation to design possibilities	“Pia”, “Per”, “Jon”
Closer continuous team collaboration and dialogue is needed; UX/IxD resources should be full members of the team	“Per”, “Tor”, “Jon”

5 Discussion

In general, the agile developers are positive to a merger between the two methodologies and towards the parallel example model. However, the informants highlight a number of aspects and constraints related to project conditions believed to influence whether a parallel model is appropriate. A main insight from this study is how informants believe more interdisciplinary approaches would be beneficial, especially related to UI design, and how the suggested parallel models may be disadvantageous in this respect. Existing models support multidisciplinary work, where people from different disciplines work together, each drawing on their disciplinary knowledge and perspectives to contribute to coordinated work tasks (additive). However, the models do not seem to support *interdisciplinary* or *transdisciplinary* practices, integrating and synthesizing knowledge and methods from different disciplines in collaborative cross-task work (holistic).

Interviewed developers express they would like to be more involved in discussing UI design options and technical consequences of design. Some also mention the benefit if designers are able to code, so all tasks can be assigned to all team members. It might be unrealistic to expect UX-designers to be expert programmers, but it could be that a certain level of interdisciplinarity in both developers and designers on UCA teams would be beneficial and should be recommended. The suggestion of larger academic overlap between team resources is an interesting idea that could potentially facilitate a closer and more continuous cross-task collaboration, support team efforts in reaching deadlines and resolving congestions. It could also increase team affiliation among team members and allow designers to be dedicated to fewer teams at once where appropriate.

Agile development is all about multidisciplinary team efforts; people from different disciplines working together to reach common goals. Agile teams are ideally autonomous self-driven teams where teamwork is essential; aiding each other in solving tasks and reaching deadlines. The proposed parallel models may separate the designers from the developers; asking them to work in parallel with the designers one sprint ahead instead of continuously pulling together from the same backlog and solving congestions and complications. Discrepancies in workload sizes between the parallel processes are described as a major challenge in parallel processes. If design work takes significantly longer than development in a sprint, or visa versa, the parallel model becomes inefficient. Existing models do not seem to support the notion of a team pulling together to complete tasks, limit the number of unfinished work in progress, encouraging collaboration to resolve congestions and distributing the workload. Instead, based on the views and experiences of the practitioners in this study, the success of parallel processes seem to rely on fairly generous project constraints and resources.

Overall, the developers are positive towards UCD and UX/IxD work. Informants are able to make a theoretical distinction between *costumer* and *user*, but report that in practice the two are blurred, and project constraints seem to affect IxD/UX work such as user involvement and user testing prior to development work. Challenges reported by Constantine (2001) and Salah, Paige and Cairns (2014a) related to agile and user-centered merger thus seem relevant, warning that lacking managerial awareness of UCD on resulting quality may lead to integration and collaboration challenges. If project constraints tighten and UX activities are affected more than those available for development, this may potentially increase workload discrepancies, the need for developers to make design decisions themselves in order to prevent delays, thusly undermine design work and cause collaboration issues.

The work on generic principles for an integrated methodology is currently based on a theoretical literature study approach (Bhrel, Meth, Maedche & Werder, 2015), and could be strengthened by a more practical approach. This study is only deemed partially successful in measuring in-depth perceptions on UCD amongst the interviewed developers. As it is still somewhat unclear how informants perceive the potential value and impact of UCD on quality, and whether their views are based on superficial or general knowledge, the thematic semi-structured approach in this study is deemed insufficient in adequately capturing in-depth views on IxD, UCS and UX work among the developers. A more specific approach using more detailed questions could thus be complementary; e.g. asking UCA-developers to rank UCD principles compared to agile principles. Likewise, it would be interesting to explore attitudes towards agile development among UCA IxD/UX resources, and compare rankings between the groups.

6 Conclusion

This exploratory study provides new insights into the challenges of user centered and agile merger. In particular, the study discusses how the parallel workflows proposed by current UCA integration models may be counterproductive to efficient multidisciplinary team collaboration, due to the separation of design and development decisions which may lead to UX-work being done part-time and/or detached from the agile team, the risk for workload discrepancies which may lead to ineffectiveness, communication issues, and undermined design decisions and the need for generous constraints to ensure cooperation between design and development and sufficient UX-work. Instead, a closer and continuous interdisciplinary collaboration throughout the project process is suggested, focusing on a productive team-driven communication and cross-task workflow in order to create a more efficient process of solving tasks and distributing workload, and interdisciplinary decision making. In this respect, the idea of larger academic overlap between the individual team resources is proposed to support collaboration, arrive at better design decisions, strengthened team affiliation and dialogue. Improved or alternative integrated process models may be needed to better supporting interdisciplinary work as well as UCA-projects with limited available resources. Further studies aim to validate findings from the limited sample of this study, and further the work on deriving shared, general methodological principles for UCA.

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Challenges in Agile Universal Design of ICT

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Abstract

Universal design (UD) of ICT is about creating solutions that are usable and accessible for as many end-users as possible. Currently, agile development is a common approach in ICT-projects. This article investigates the challenges for ensuring UD in agile ICT-projects. We propose the term «agile universal design» (AUD) to denote UD in agile ICT-projects. Through a scoping review, we find that traditional user-centered and quality control activities may be seen as disruptive in the agile process. On the other hand, promotion of stakeholders and user involvement throughout the development process and in all phases fit well with UD approaches. Seven practical AUD challenges are identified and point to the fact that securing high quality usability aspects for users with a diverse set of needs require more than limited early attention followed by mere sporadic user focus. We find main AUD issues to be: a) capturing, communicating, keeping track of and quality assure requirements from stakeholders and users in the process towards developing a final solution, b) balance time spent on user-involved activities with development activities. The article discusses the challenges and the need for more research on AUD methodology.

Keywords: Agile, User-Centered, Universal Design, ICT-projects, Best-Practice

1 Introduction

The focus on universal design (UD) has increased steadily over the last decades. In Norway UD regulations enacted in July 2014 (BLD 2017; KMD, 2013), state all new ICT-solutions (including most apps) targeted to the public must adhere to a minimum accessibility level. As of 2021, all new ICT-solutions must also be universally designed. As a result, companies have been required to alter their practices, integrating UD in ICT design and development. There is ongoing industry and research focus on integrating user-centered design (UCD) approaches into agile development – suggesting user-centered agile (UCA) approaches (Miller, 2005; Sy, 2007; Beyer, 2010; Silva da Silva, Martin, Maurer & Silviera, 2011). However less focus is granted to extending the user-centered focus to UD within an agile framework – exploring AUD (agile UD). Agile and agile-like development approaches are currently common in ICT-projects. This article focuses on identifying challenges and current practices for AUD, in order to pave the way for future research. Our overall research question is: *What are key challenges for ensuring UD in UCA projects?*

2 Background

The word «agile» is often applied to a development process which follows a certain set of practices, usually including face to face communication, iterative feedback loops and incremental delivery of software. Agile developments have a set of beliefs which underline such practices, focusing on achieving efficiency and reduced waste (Preece, Sharp & Rogers, 2015). Scrum and Extreme Programming (XP) are two of the most popular agile models, where software is delivered after 1-4 week long «Sprint» increments (Scrum Alliance, 2013).

Human-centered (also called user-centered) design is defined as anchored in user needs, with user focus in all phases of design and development (ISO, 2010). Begnum and Thorkildsen (2017) indicate methodological differences agile versus non-agile projects implementing UCD. UCA projects have less focus on methods directed at understanding needs and contexts of use, and more focus on interface design, while non-agile UCD projects value higher levels of user involvement earlier. UCA projects tend to prioritize implementing features over early user-involvement and understanding (Silva da Silva, Martin, Maurer & Silviera, 2011). This can result in processes which to a lesser degree consider user needs, and where direct user contact only occur in the evaluation phase. UCD teams often directly involve users and stakeholders – workshops are frequent in design and insight phases – and use a larger variety of methods (Begnum & Thorkildsen, 2017).

The 2005 Disability Act defines UD of ICT as the design of any services or systems created through an electronics-based process so that they may be used, accessed and understood to the greatest extent (NDA, 2017). The Norwegian Agency for Public Management and eGovernment (DIFI) defines the minimum criteria to be AA conformance of WCAG 2.0, with a few guideline exceptions (DIFI, 2017). Beyond adhering to regulations and requirements, the focus of UD of ICT is on achieving usable and accessible solutions. Harder & Begnum (2016) conducted an interview study with designers and developers on projects having recognized success with UD in ICT. Factors that promote and obstruct UD were identified, mainly related to anchoring an understanding of and culture for UD on organizational levels merging UX and UD work and having the time for these activities, early and iterative quality assurance (QA) and user testing, and team collaboration. Nine of the thirteen projects followed a fully agile development, while two implemented agile elements into existing processes.

3 Research Approach

A scoping review is undertaken to explore and refine the research question**.** A scoping review allows the researcher to form and synthesize current knowledge on a specific topic. The goal is to provide the opportunity to identifying gaps in current knowledge and pave the way for future research; using the scoping review as a starting point for a larger research effort (Jesson, Matheson & Lacey, 2011). Unlike traditional literature reviews, it doesn't necessary rely on the newest published research. Instead the search may be based on two or three key articles to provide a set of theories. This scoping review is based on Begnum & Thorkildsen

(2017) and Harder and Begnum (2016). Both articles indicate that anchoring a user focus in early in the project affect UD and UCD. Collaboration between designers and developers also seems key, as communication influences efficiency of user research work and strengthens a common focus. Based on Begnum and Harder (2016), the assumption is that successful UD requires high-contact user-centeredness, i.e. methods that involve users directly. As Begnum and Thorkildsen (2017) found indications that UCA processes may be «less» user-centered than non-agile user-centered processes, it is an interesting perspective to evaluate the «user-centeredness» of AUD. Based on the analysis of previous work, the following sub-questions guided the scoping review: Which practices emerge to ensure UD in agile ICT-projects? How does AUD practice compare to identified promoting factors for UD success in ICT-projects?

3.1 Searching, Screening and Analyzing Literature

Agile methodology search terms are derived from Begnum and Thorkildsen (2017) who suggest that “agile” covers “lean”, “scrum” and “extreme programming”. Further, “sprint” is considered a central part of any agile process and included as search term. “Universal Usability”, “Inclusive Design”, “Design for All”, “User-Sensitive Inclusive Design” and “Ability-Based Design” are all overlapping terms for UD (Harder & Begnum, 2016). We chose to focus on actively and broadly used terms, thus omitting “universal usability”, “user-sensitive inclusive design” and “ability-based design”. Thus, our initial search string was: (scrum OR "extreme programming" OR sprint OR agile OR lean) AND ("universal design"OR "inclusive design" OR "design-for-all").

Table 1. Final Search Results.

Database	Search String	Returned	Included
IEEE	("agile development" OR "agile methodology" OR "agile process" OR scrum OR "extreme programming" OR sprint) AND ("universal design" OR "inclusive design" OR "design for all")	21	3
Springer-Link	"universal design" OR "inclusive design" OR design+for+all OR e-inclusion OR disability OR impairment OR accessibility AND "agile development" OR "agile methodology" OR "agile process" OR scrum OR "extreme programming" OR sprint NOT medicine OR obesity OR "body composition" OR geriatric OR cardiology OR "lean mass" AND “computer science”	101	8
ACM	"universal design" OR "inclusive design" OR design+for+all OR e-inclusion OR disability OR impairment OR accessibility AND "agile development" OR "agile methodology" OR "agile process" OR scrum OR "extreme programming" OR sprint OR lean NOT medicine OR obesity OR "body composition" OR geriatric OR cardiology OR "lean mass"	42	3
Total		**191**	**14**

Oria is a cross-database search which was our starting point to identify which databases should be included, consequently identifying ACM, IEEE and Springer-Link as relevant.

Individual search returned 1 result from ACM, 165 from Springer-Link and 124 from IEEE. However, iteratively adapting the search to the three different databases yielded more precise results, reviewing keywords used in relevant articles returned. For all three databases, the revision (agile OR lean) to ("agile development" OR "agile methodology" OR "agile process") yielded better results. In Springer-Link, the search term "computer science" was added to narrow its broad range of topic, whereas ACM digital library tends to yield very specific results. Both needed a broader set of terms to cover UD; "e-inclusion", "disability", "impairment" and" accessibility". Further, Springer-Link and ACM limit the number of irrelevant medical results through exclusion terms "Obesity", "body composition", "geriatric", "cardiology" and "lean mass". For IEEE these search terms were distracting Final searches returned 191 results, see Table 1.

The goal was to select 10 to 15 peer-reviewed articles. A combined focus on UD and agile is required for inclusion. Some form of discussion of both topics together, directly or indirectly, was considered fitting to ensure relevance. In addition, UCD was an inclusion criterion, with involvement of users as per the ISO–standard (ISO, 2010). The articles had to focus on how to include marginalized users or ensure UD. They may target a single group, i.e. people with hearing impairments, as long as findings can be generalized to other groups. 14 articles were included. They are read using the SQ3R approach; a survey, question-based and focused re-reading approach (Jesson, Matheson & Lacey, 2011). We use an open and interpretative analysis approach to iteratively summarize and form emergent theories on topics within AUD.

4 Findings

Seven issues emerge as important challenges to solve in order to ensure UD in agile projects.

4.1 Requirements are hard to elicit

Involving users with severe disabilities introduces added challenges with regards to needs elicitation and collaborative communication. Guerrero-García et.al. (2017) suggest artifacts and metaphors can be helpful to elicit needs, such as capturing project vision and persona on worksheets to display so that they are constantly visible. This helps the team focus design on the variety of different users with different needs, providing functionality specific to users of different abilities. Together with scenarios they help communicate needs of users that cannot be present in a cycle or phase (Gkatzidou, Pearson, Green & Perrin, 2011). Among stakeholders scenarios and personas may be particularly useful to elicit requirements and user needs, as these can help contextualize the problems. User and task-focused representations are preferred to traditional software developments such as use cases (Prior et. al. 2013). In some cases, a user advocate can improve communication between users and agile team (Gkatzidou, Pearson, Green & Perrin, 2011; Prior, Waller, Black & Kroll, 2013). Needs can be elicited from experts if users are unavailable.. When eliciting needs with experts it is important to validate these needs later with target users (Røssvoll & Fuglerud, 2013).

4.2 Insights are hard to keep track of

As requirements emerge they must hold a manageable form, and a challenge is keeping track of insights iteratively gathered from user-centered activities during the agile process; especially insights related to needs and context of use (Guerrero-García, González-Calleros &

González, 2017). Agile prefers "working software" to "comprehensive documentation" (Agilemanifesto.org 2001), and advocates documentation should be kept to a minimum. Modifying the agile rules too much can create production blocks. But as good communication is found to be a prerequisite for successful UD, especially in communication between developers and designers, there is a need for certain documentation to be present. A common language among users, stakeholders and team members is presented as a prerequisite for eliciting needs and co-design in agile development (Raike et. al., 2008; Memmel, Reiterer & Holzinger, 2007). Use of UCD techniques combined with efforts of information and documentation sharing is promoted. Several propose to include experts and other stakeholders in user-centered work to assure data collected from end-users are not missed (Guerrero-García, González-Calleros & González, 2017; Røssvoll & Fuglerud, 2013; Gonzalez et. al., 2013). Røssvoll & Fuglerud suggest gathering requirements in one document make them easier to manage (2013). Some researchers suggest additional sprints or time dedicated to work on documentation (Williams et. al., 2015; Guerrero-García, González-Calleros & González, 2017). In addition to being discussion pieces, hi-fi prototypes can thus save valuable resources in the team (Memmel, Reiterer & Holzinger, 2007).

4.3 Limited User Requirement Oversight

The cycles and iterations of an agile process compensate for limited early insights as opposed to more traditional waterfall-like development models (Kaneyama, Goto & Nishino, 2015). As agile processes are adaptive to changing requirements, they are viewed as well suited to UD and collaboration with users (Williams et. al., 2015; Raike et. al., 2008). Nonetheless, one of the main problems addressed is how changing requirements affect the development process of inclusive systems. It is widely recognized that initial sprints should include methods to learn about users and contexts of use (Prior et. al., 2013, Kaneyama, Goto & Nishino, 2015; Scandurra, Holgersson, Lind & Myreteg, 2013; Guerrero-García, González-Calleros & González, 2017). Techniques such as observation of users' daily activities, document analysis and interviews with users and stakeholders are among those recommended. Further, as full up-front user requirement oversight is not likely, continuous user involvement and emergent requirement discovery should extend a shorter up-front requirements elicitation phase (Raike et. al., 2008). Reaching a common and correct understanding of needs is necessary to achieve accessibility and usability (Gonzalez et. al., 2013; Scandurra, Holgersson, Lind & Myreteg, 2013; Memmel, Reiterer & Holzinger, 2007). The need for continuous close collaboration with stakeholders, experts and (disabled) users seem to increase in AUD compared to UCA.

4.4 User Involvement Takes Time

User-involved approaches are widespread in the scoped literature, with stakeholders and users appearing as frequent collaborators for requirements elicitation and design. To integrating UD with agile development, user needs are identified prior to and during development, ensuring usable software is being developed (Memmel, Reiterer & Holzinger, 2007). User-involvement in certain activities is presented as imperative to success, such as evaluation (Scandurra, Holgerssob, Lind & Myreteg, 2013). However, it may be time-consuming and costly to do a user-centered project, and even more so focused on UD and involvement of marginalized user groups. Researchers imply agile processes don't inherently support UCD work, and that user involvement may delay or alter the agile process – necessitating an integrated approach (Gkatzidou et.al., 2011). Gkatzidou et.al. (2011) and Williams et.al. (2015) find that methods such as workshops result in a lot of design alternatives and design feedback, and working with this data can slow down development. Bonacin, Baranauskas and Rodrigues (2009) highlight that adapting user-centered techniques to an agile schedule is challenging as developers struggle to balance tasks when also required to participate in non-coding tasks.

4.5 Quality Assurance Takes Time

Based on the elusive nature of requirements related to eliciting, keep track of and communicating, QA is also challenged. User needs must be evaluated continuously in inclusive design processes (Lucke & Castro, 2016). Failure is typically recognized later in the process when users evaluate the solution, resulting in added cost (Gkatzidou, Pearson, Green & Perrin, 2011). However, assessing accessibility early can reduce cost, which usually accumulates with late assessments (Reichling & Cherfi, 2013; Scandurra, Holgersson, Lind & Myreteg, 2013). It is recommended that end users test prototypes early and throughout the process (Røssvoll & Fuglerud, 2013). Williams et. al. (2015) suggest testing with at least hearing-impaired, visually impaired and cognitively impaired users. Traditional user tests take time to prepare and carry out. Testing in each cycle can add time delays (Røssvoll & Fuglerud, 2013). As user-involved QA takes time and effort, and frequent user-evaluations slows down the process, getting the time and money to adequate ensure UD seems a major AUD challenge. Efforts are thus made to adapt or develop new evaluation techniques tailored to agile processes (Memmel, Reiterer and Holzinger, 2007). Bonacin, Baranauskas and Rodrigues (2009) model evaluation workshops at the end of each development cycle. Williams et.al. (2015) run user-trials between sprints instead of traditional post-sprint meetings. Other researchers prefer informal expert assessments as means of evaluation reducing the need for user trials and detect major usability issues prior to testing with end-users (Kaneyama, Goto & Nishino, 2015; Røssvoll & Fuglerud, 2013; Gonzalez et. al., 2013).. However, expert evaluations must also be validated with user tests (Røssvoll & Fuglerud, 2013).

4.6 No AUD Process Model to Guide

Custom process models can be developed by teams with expert knowledge of development methodology, and adapted to specific design situations (Bonacin, Baranauskas & Rodrigues, 2009). However, as of today there is no general AUD process model available, and projects must design AUD development processes on their own. In Bonacin, Baranauskas and Rodrigues (2009) model, user involved design is in focus. Users can contribute with experiences and ideas for conceptualization and design, and later evaluate. Gkatzidou et.al. (2011) in their UIDM model (users, innovators, developers and modelers) ensure stakeholders are included in every step of planning, implementation and evaluation.

4.7 Lacking Team Effort Undermines Efforts

In order to achieve UD, a solution must have “usable accessibility” as well as “technical accessibility” (Reichling & Cherfi, 2013; Røssvoll & Fuglerud, 2013). To ensure inclusiveness and usability for all, it is important to shift from focus on implementing a quantity of features, to value UD and UX feature qualities. Having the team knowledge to achieve “technical accessibility” is further essential. It can be difficult for inexperienced developers to interpret guidelines on their own and translate them into action (Law & McKay, 2007). Further, negative attitudes among team members can undermine efforts to ensure UD. The team should ideally also have enough knowledge to educate customers on best practice.

5 Discussion

Research efforts that seek to achieve inclusive or UD of ICT solutions consider user-centered methods useful (Gonzalez, et.al., 2013; Bonacin, Baranauskas & Rodrigues, 2009; Røssvoll & Fuglerud, 2013). Begnum and Thorkildsen (2017) indicate that agile UCD processes are less user-centered than non-agile UCD processes, but this does not hold true for the literature-based AUD practices. Instead, the AUD processes largely favor collaborative and user-involved design methodologies. A lot of focus is given to user-involved methodology, including stakeholders, experts and end-users. The literature suggest a high degree of user-centeredness in agile processes ensure UD. These activities may be time-consuming but are believed to save time and cost later on. Research however implies that there are difficulties adapting these methods to the agile process. Issues arise when UCD work is required to be done in a timely fashion (Bonacin, Baranauskas & Rodrigues, 2009). This is particularly true for elicitation and design phases, where a proper understanding of user needs anchors the process. A general impression is that experts and stakeholders are perhaps involved as "stand-ins" to a much larger extent than what is needed in comparison to direct end-user focus.

There are also issues related to communication and documentation in all parts of the process. A poor user needs understanding can be a product of a lack of communication between team members, lack of triangulation of research methods or inclusion of experts or stakeholders. It is as such challenging to capture, communicate and quality assure requirements, ideas and insights from stakeholders and users with diverse abilities and disabilities. Comparing the discussion in scoped literature to Harder and Begnum (2016) highlights the need for knowledge among team members of agile processes and UCD techniques. Members need to understand UD values and the proper usability engineering methods to adapt these to development processes that fit the specific context and users.

Begnum and Thorkildsen (2017) confirm prototypes and scenarios are used to facilitate design discussions. A number of articles deal with how to avoid added cost of doing UD, usability and user-centred work in agile projects. However, there appears to be few attempts to adapt design methods to be more agile. There is more focus on adapting the agile processes to make room for the UCD methods and techniques within the cycles of development, and some attention is given to making user evaluation more efficient.

User testing every cycle is experienced as cumbersome and costly, while too much expert review without user feedback risks less usable and accessible solutions. Expert evaluation is a common method used in development cycles, and is considered efficient and timesaving. A general practice seems to be that experts and stakeholders test the solution before it reaches end-users, allowing the team to fix obvious usability and accessibility issues and as such save resources. It's recommended that evaluation work start as early as possible to avoid increasing cost. A common recommendation is having evaluation work run one sprint ahead of development work. There seems to be a need for more research on making quality assessment methods more fitting for AUD, for example increased re-usability of design artifacts.

When comparing best practice recommendations to Harder and Begnum (2016), we see similarities in the key factors promoting successful UD. Most notably is the emphasis on accessibility and UD from the very start and throughout the process, with the inclusion of external and internal experts. Also mutually recognized is the importance QA and interdisciplinary cooperation based on a common understanding of UD. Including developers as part of user-testing first hand with disabled users is explicitly mentioned at least once, while most focused on including the entire team. While Harder and Begnum (2016) find that UD should be included in all phases, the AUD literature is less explicit about this and is focused on including user-centered and participatory methodology in all phases. What was not emerging from the AUD literature was the importance of an UD culture within organizations. This could be due to researchers working independently on developing solutions and not being part of an organization. However, the AUD literature is concerned with minimizing costs between UD and usability work. As such, the importance of ensuring adequate resources are allocated to UD efforts within a real-life project is recognized. This, as well as the need to elicitate real user needs from early phases, seems to be the driving force behind the importance of UD anchored on organizational levels.

Comparing Harder and Begnum (2016) with the AUD literature highlights AUD workflow issues. Some researchers note the agile process is not fully compatible with UCD methodology, calling for more knowledge on how to more efficiently employ UCD methods in agile processes in order to reduce cost (Røssvoll & Fuglerud, 2013). Harder and Begnum (2016) identify tentative promoting and obstructing factors critical to the success of UD. These findings required more work with regards to generalizability, and this also appears to be a common issue within the reviewed literature. Literature on the topic largely reveals prevalence of context-dependent frameworks and models with principles, guidelines and methods that seek to ensure UD of ICT solutions. Røssvoll & Fuglerud (2013) find best-practice recommendations should be adapted to individual projects with care and consideration to the specific situation. This is understandable, as proposed frameworks and models reviewed are adapted to specific problems for a certain user group, as such there is little generalizability.

When comparing our findings to Begnum and Thorkildsen (2017), literature points to a including a wider set of user needs and early, to a larger degree involve end-users in order and iteratively quality ensure UD in agile ICT development. Promotion of stakeholders and user involvement throughout the design and development process is deemed important to ensure UD quality, however how to integrate the recommended activities into the an agile process without delaying or adding to much extra cost is still not clear. Findings indicate the agile processes are suitable to emerging requirements and iterative design efforts, but that high levels of user-involvement and frequent quality control evaluations may be perceived as disruptive to the agile development process. In order to balance the agile rapid speed of development with the necessary degree of user-centered anchoring, trade-offs must be made. Real-life AUD process issues are relevant for future research efforts. There seems to be a large focus on how iterations and sprints can be altered to make room for the UCD work, especially in early and late phases of projects. Future AUD models could focus on a set of defined principles important to ensuring the goals, accessibility and usability, as well as agile principles. Such modeling may help ensure a common understanding of accessibility throughout the team as well as guide the process activities and workflow.

6 Conclusion

This article uses the term AUD to denote UD in agile ICT-projects. A scoping review was undertaken to provide an overview of current AUD challenges, to pave the way for future research. Seven AUD challenges are identified: 1) Requirements are hard to elicit, 2) User-centered insights are hard to keep track of, 3) User requirement oversight is limited, 4) User-centered activities takes time, 5) Quality assurance takes time, 6) AUD process model to guide development is lacking, and 7) Lacking team collaboration undermines UD efforts. Synthesizing the findings, we find key AUD challenges related to a) capturing, communicating, keeping track of and quality assure requirements from stakeholders and users as part of the agile development process, and b) balance time spent on user-involved activities with development activities.. Further AUD research should focus on strategies for continuous needs elicitation and QA, creating a general AUD process model and provide guidance on how and when to merge user-involvement into agile development with minimal team disruption.

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PROMOTING AND OBSTRUCTING FACTORS FOR SUCCESSFUL UNIVERSAL DESIGN OF ICT

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ABSTRACT

The focus on Universal Design (UD) has increased steadily over the last decades. Web content accessibility standards and guidelines have been created, and specific legislation is in place in several countries to further UD. However, there are limited insights into the actual practices regarding successful implementation of UD in ICT-projects. This study aims to provide such insights through an interview study with 13 individuals affiliated with 12 ICT-projects that have been successful in ensuring UD. The data from the interviews is analyzed in-depth through a thematic analysis, in search for theoretical interpretations that may generate the basis for a proposed best practice for UD in ICT-projects. Our data identify 13 promoting and 6 obstructive factors related to the implementation of UD, spanning three levels - organizational, process and individual. Our findings both coincide and expand previous research findings. The study highlights the link between user-centered design, usability focus and universal design. On process level, early and continuous focus on UD and usability, in iterative approaches, with frequent quality assurance and user contact, and interdisciplinary collaboration seems to be good practice. Our findings emphasize the importance and influence of having a solid anchoring of UD at all levels (a "UD culture"), as well as individual competences and personal qualities of team members and stakeholders. Main findings are summarized in six factors; "UD anchoring", "UD competence", "Focus", "Collaboration", "Iterative process" and "QA (Quality Assurance)". Future work aim to verify findings, model practice factors, contribute towards reliable best practices and design a tool indicating the UD maturity of a project.

1 INTRODUCTION

The necessity to ensure that the one billion individuals with various disabilities can use information and communication technology (ICT) in the same way as individuals currently not experiencing disabilities, is acknowledged by The International Telecommunication Union (ITU) (Msimang 2014). Today, ICT-solutions are more frequently linked to civil rights, for instance voting. It is therefore vital to avoid discriminating against any part of a country's population when digitalizing such services. Legislation regarding UD is only present in certain countries, and may vary from one country to another. In some countries only certain providers, such as official public web sites, are affected by UD legislation. Therefore a synchronized international effort might be essential in order to create a common UD standard (Vanderheiden & Treviranus 2011, Abascal et al. 2015).

There are both ethical and commercial benefits of UD. To exclude disabled users from receiving the benefits of new technology is unfortunate. By doing so, there is also a risk of eliminating a considerable group of potential customers; for instance those with physical and cognitive limitations, ageing people, individuals with low socioeconomic status, low literacy skills, children and individuals who do not speak the native language (Fuglerud & Sloan 2013, Cremers et al. 2014, Scott, Spyridonis & Ghinea 2015, Abascal et al. 2015). In Norway, the government initiated an ambitious goal for the country to be universally designed by 2025 (Anti-Discrimination and Accessibility Act 2009). A section of the Norwegian legislation for UD is dedicated specifically to ICT. However, despite this legislation, as few as five of Norway's 50 most visited websites met the minimum criteria for universal design in 2014 (Aune 2014). According to Rygg and Brudvik (2015) a sample survey performed by the Agency for Public

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Management and eGovernment (DIFI 2016) to check web accessibility on 304 Norwegian websites returned disappointing results regarding Norway's standards for UD. There were large variations amongst the sample web sites, and scores ranged from 18 to 79 percent of the possible obtainable points in their measuring system, with an average at 51 percent.

In order to provide more insight into possible best practices, this study investigates ICT-projects that have received awards or honorable mentions due to the quality of universal design in their projects. Through an interview study with 13 designers and developers affiliated with 12 successful projects, this article explores recommended practices for high-quality universal design in Norwegian ICT projects.

2 PREVIOUS WORK

The concept of Universal Design (UD) was introduced in the mid-eighties and has been applied to several fields, where ICT is one of the more recent ones (Røssvoll & Fuglerud 2013). There are various terms used overlapping with UD; Universal Usability, Inclusive Design, Design for All, User-Sensitive Inclusive Design and Ability-Based Design to name a few. Petrie, Savva and Power (2015) performed an analysis of 50 different definitions of web accessibility. They searched for a better way of understanding what researchers and practitioners consider the core components of web accessibility. This demonstrates how open the field of universal design is, and why it is difficult to have *one* common understanding.

When working towards assuring accessible ICT-solutions a main goal is to meet all the requirements specified by the World Wide Web Consortium (W3C) Web Content Accessibility Guidelines (WCAG). Several researchers agree that accessibility standards and guidelines are necessary tools to ensure UD (Røssvoll & Fuglerud 2013, Schulz et al. 2014, Scott, Spyridonis & Ghinea 2015). However, there seems to be a growing consensus that compliance with these guidelines alone is not adequate for achieving universally designed ICT-solutions. A large cross-sector survey performed amongst web development projects in Brazil, with 613 participants, reports a lack of consciousness regarding accessibility issues in web development processes (Freire, Russo & Fortes 2008). The study suggests educating web developers in how individuals use assistive technologies, and implies that it can be very effective to show developers how a user struggles with their solutions. Cremers et al. (2014) argue that the most suitable approach to UD is by enriching inclusive design methods with qualitative methods from anthropology to enable personalized systems. Sachdeva et al. (2015) on the other hand, explore how to make technology affordable and socially accepted using social and systemic innovation alongside already existing technical innovations.

For an ICT solution to be completely accessible, a distinction between technical and usable accessibility must be in place (Røssvoll & Fuglerud 2013, Garrido et al. 2013, Schulz et al. 2014, Abascal et al. 2015, Aizpurua, Arrue & Vigo 2015, Jung et al. 2015). A gap is identified between the theory of inclusive design and the industry practices. According to Fuglerud and Sloan (2013) there is a heavy focus on standards in the requirements provided by the legislations, without any emphasis on the development process. Seven key principles for an inclusive design process are identified in the literature *1)* holistic and interdisciplinary teams and/or process, *2)* based on user-centered design principles, *3)* adopting and applying accessibility standards and guidelines, *4)* using an iterative development, *5)* focus on users with disabilities, - early and throughout, the entire design process, *6)* use of empirical evaluations with various impairments represented and *7)* focusing on the entire user experience (Fuglerud & Sloan 2013, Røssvoll & Fuglerud 2013, Schulz et al. 2014, Scott, Spyridonis & Ghinea 2015).

3 RESEARCH APPROACH

Due to the nature of our research topic, we consider it appropriate to use an exploratory and qualitative approach for data collection. Semi-structured in-depth personal interviews are selected in order to maintain a solid foundation and framework, exposing the respondents to the same questions and themes while simultaneously allowing for flexibility and follow-up questions (Rogers, Sharp & Preece 2011). The interview guide is divided into two main sections. The first part concerns personal experiences related to practices for successfully achieving UD in Norwegian ICT projects and consists of 5 questions. The second part concerns methodological style and epistemologies and consists of 10 questions. In addition 6 questions map out background variables about the informants. The entire guide consists of 21 questions. This study focuses on the first section of the interview guide and the questions concerning UD practices in Norwegian ICT projects. Questions are neutrally formulated to avoid creating bias.

A prerequisite for participation is affiliation with an ICT project linked to success in regards to UD. "Success" is defined as either having won an award or getting an honorable mention for efforts concerning UD. Based on this, 12 ICT-projects is included, and 13 informants representing these projects recruited for the study. The 13 informants are interviewed over a total of 11 interviews: 9 individual interviews and 2 group interviews where two informants are interviewed together.

All participants received written information about the study, and gave their written consent for participation and for audio recording of the interview. The averaged duration of an interview was 45 minutes. The recordings were transcribed verbatim. In addition to recordings, hand-written notes were made throughout the interviews. The study is reported to the Data Protection Official for Research (NSD) as part of a larger study on quality assuring universal design.

3.1 Data Analysis

A thematic content analysis was selected for data analysis. There are few pre-defined codes in the existing literature. Therefore, emergent coding (also called "open coding") was chosen for a bottom-up analysis of the transcribed interviews. After completing the interviews, the 13 transcripts were reviewed in order to form an initial overview of and familiarization with the data. Questions giving overlapping answers were identified: regarding specific practices in successful projects (Q7), the preferred methodologies in an imagined project (Q8) and general practices that promote UD (Q9). Overlapping questions regarding negative practices were also identified: practices inhibiting UD (Q10), and factors affecting the choice of methods (Q13). As a consequence of the overlapping responses, the transcripts were analyzed as a continuous text, as opposed to questions consecutively.

The textual material from the transcripts was analyzed and each emerging theme was given a respective code. A second transcript review was conducted separately by the two authors with the goal of identifying unique thematic codes in the text. Upon reviewing the total of codes, two overarching categories were identified, one considering positive *promoting* aspects, and one considering the negative *obstructive* aspects. For researcher 1 this resulted in 103 thematic codes across the 13 transcripts, separated into 75 promoting and 28 obstructive. Researcher 2 identified 104 codes: 75 promoting and 29 obstructive. Final codes for each category are specified in the tables in sections 3.1.1 and 3.1.2 for increased transparency, but please note that as the full list of thematic codes is too extensive to be presented as part of this article, it will instead be made available by the authors upon request.

Weber states the ultimate goal of reliability control is to ensure that different people code the same text in the same way (Lazar, Feng & Hochheiser 2010). Inter-coder reliability was thus calculated between two coding researchers. 88 % of the 150 promoting codes have a perfect or nearly perfect overlap. A further 10 % are overlapping, but without an exact match. This is due to researcher 1 focusing more on detailing codes related to understanding the concept of UD, while researcher 2 focused more on organizational culture and resource prioritizing. Overall, there is a 98 % overlap between promoting codes. Only 3 codes clearly differ; researcher 1 has a code on innovative abilities while researcher 2 has one on access to assistive technologies (ATs) and another on the link between securing usability and UD.

For the 57 obstructive codes there is a 95 % overlap. Again there are 3 diverging codes: researcher 1 has a code on handling resistance, while researcher 2 has one related to lacking utilization of available UD resources and another on the challenge of frameworks and tools in violation of the Web Accessibility Initiative (WAI) by the W3C (W3C 2016).

All the positive thematic codes within the overarching promoting category were then divided into groups based on what type of practices they referred to: organizational level, project process level or individual level. These groups were based on the data, thus emerging – not predefined. The same was done for all the negative codes within the overarching obstructive category. In order to quality control the categorization process, codes and code-categories were again discussed amongst the researchers, and codes cooperatively sorted and categorized. The result was 13 promoting and 6 obstructive categories, see sections 3.1.1 and 3.1.2.

Through iterative transcript reviews by the two researchers, frequencies were also mapped out for 1) how many informants mention codes associated with each category, and 2) how many times in total codes associated with each category are mentioned. Since a grouped category includes several thematic codes, the frequency-of-mention per category embraces all included codes in the category. Informants who answer together in a group interview, on behalf of *one* project, are still counted as two individual informants. A total of ten transcripts reviews are completed as part of the analysis; four for coding and categorization and six for frequency mapping.

3.1.1 Promoting Categories

Promoting, positive categories are divided into organization level, project process level and individual level practices; 5 categories on organization level, 6 on process level and 2 categories on individual level (a total 13 categories). The finalized categories from the thematic analysis of UD *promoting factors* are presented in Table 1, Table 2 and Table 3. Note that codes in the category *Resources* are relevant both for organizational aspects and for specific project processes, and the category is here placed on organizational level due to perceived more focus on overall resources, but could also have be placed on process level.

Category	**Description**	**Codes**
Top level Focus	UX/UD-department UD specialist group Ensuring UD competence Disabled co-workers Good-practice library	1, 18, 20, 28, 48, 49, 64, 76, 78, 86, 89, 109, 133, 143, 149
Resources	Available ATs, Human resources, Economic resources	19, 94, 95, 96, 115
Anchoring	Understanding, awareness and competence at all management levels Internalized UD culture UD strategy Usability strategy	2, 6, 10, 11, 41, 45, 69, 71, 77, 79, 80, 81, 82, 83, 84, 90, 91, 102, 138
Reputation	External recognition (awards, nominations...) Presentation, conferences Visibility (internal/external)	7, 70, 73, 74, 85, 87, 88, 144
Legislation	Legislation gives priority Feedback and support from supervisory authority	27, 145, 146, 147

Table 1: Organizational Level Promoting Factors

Category	**Description**	**Codes**
UD Focus	Early; from needs analysis Throughout project process Requirement specification Costumer/resource priorities In solution- and UI-design Across groups; design for all UD process maturity Agency collaboration	4, 12, 47, 54, 57, 59, 60, 92, 97, 98, 99, 100, 101, 108,148
User Focus	Personification of users (persona/user stories) Early testing – from sketch Frequent user feedback Frequent QA-inspections Test accessibility + usability Continuous low-cost formative (guerilla) testing High-quality user testing with disabled users User needs prioritized Real user feedback	5, 21, 33, 34, 35, 38, 39, 42, 43, 50, 51, 61, 62, 63, 67, 68, 93,107, 119, 120, 125, 126, 127, 128, 129, 130, 132, 150
Quality Assurance	Clear UD quality demands Test code, design, content	9, 22, 23, 26, 52, 53, 56, 116, 117, 118,

Category	Description	Codes
	Early code/unit quality check Milestone (planned) controls Automated validation Internal inspections (peer-inspections, basic needs, simple ATs, accessibility) External expert inspections (advanced ATs and needs)	121, 122, 123, 124, 134, 135, 136
Agile	Iterative development with continuous feedback Flat structure: distributed, personal responsibility	24, 25, 36, 46, 72, 103, 105, 106, 131
Cooperation	Cross-disciplinary teams Interdisciplinary design, QA, discussions and user testing Established collaboration, roles and dialogue Co-location and full team-member positions	15, 29, 30, 58, 65, 110, 111, 112, 113, 114
Simplicity	Simple/Mobile UI/code first Start with common minimum	37, 104

Table 2: Process Level Promoting Factors

Category	Description	Codes
UD Competence	Understand UD principles Across groups; universal Beyond “disability” Education/experience	8, 40, 55, 66, 142, 143
Personal Qualities	Enthusiasm Empathy Innovative Collaborative	3, 13, 14, 16 17, 31, 32, 44, 75, 137, 139, 140

Table 3: Individual Level Promoting Factors

3.1.2 Obstructive Categories

Likewise, obstructive, negative categories are sorted into organization level, project process level and individual level practices; 1 category at organization level, 4 categories on a process level and 1 category on individual level (in total 6 obstructive categories). The finalized categories for thematic analysis of *obstructive practices* are presented in Table 4, Table 5 and Table 6.

Category	Description	Codes
Lack of Anchoring	Lack of UD understanding Lack of usability culture Resistance to UD	6, 8, 10, 11, 18, 20, 24, 28, 29, 31, 42

Table 4: Organizational Level Obstructive Factors

Category	Description	Codes
Focus	Lack of UD focus and priority Lack of user focus Lack of UD QA	2, 17, 30, 32, 40, 44, 45, 48
Process Issues	Lack of interdisciplinary cooperation in design & tests Sequential process model with testing and UD at end	9, 15, 20, 23, 25, 26, 27, 33, 36, 37, 38, 39, 40, 43, 46, 52, 53, 54
Technical Challenges	Frameworks & trends not supporting accessibility	12, 21, 56, 57
Constraints	Time, Budget, Resources Lacking competence Lacking test equipment User unavailability	1, 13, 16, 19, 22, 34, 35, 41, 50, 51, 55

Table 5: Process Level Obstructive Factors

Category	Description	Codes
Lack of Competence	Lack of knowledge and understanding Lack of interest	3, 4, 5, 7, 14, 47, 49, 50

Category	Description	Codes
	Negativity Inexperience	

Table 6: Individual Level Obstructive Factors

4 Findings

The study investigates a total of 12 successful ICT projects. Table 7 presents an overview of the 13 informants from these projects, of which five are women and eight are male. They include five developers, and both front-end and back-end development is represented. Further, four are interaction designers, one a functional designer and one a graphic designer. Finally, two are UD advisors. One of the advisors has a background as developer. There are a total of eight agencies companies represented. Seven of the informants represent consulting agencies, three represent state agencies and three represent private firms, see Table 7. Consultants are associated with projects from both public and private sector. Five of the informants are affiliated with more than one successful project and several of the informants are affiliated with the same projects. Several participants want data to be held anonymous due to confidentiality agreements in their respective projects. As a consequence, all data is kept anonymous and more information on the agencies and projects is not made available.

No	Age	Gender	Title/Discipline	Agency
1	30-39	Female	Functional Designer	Consultant Agency #1
2	> 30	Female	Interaction Designer	Consultant Agency #1
3	40-49	Male	Interaction Designer	Consultant Agency #2
4	30-39	Male	Interaction Designer	Consultant Agency #3
5	40-49	Female	Visual/Graphic Designer	Consultant Agency #2
6	30-39	Male	Developer	Consultant Agency #4
7	50-59	Male	Developer	Consultant Agency #2
8	> 30	Female	Developer	State Agency #1
9	40-49	Male	(Web) Advisor	State Agency #2
10	40-49	Male	Senior UD Advisor	State Agency #1
11	30-39	Female	Developer	Private Agency #1
12	40-49	Male	Developer	Private Agency #1
13	30-39	Male	Interaction Designer	Private Agency #2

Table 7: Informant Profiles

Table 8 displays the informants' years of experiences (rounded up), numbers of projects mentioned during the interview, self-rated competence (informants have evaluated their competence level on a scale from 1-7, where 1 is inadequate and 7 is excellent) and motivations for working with UD. Motivation is categorized as either *personal* or connected to *legislation*, where 'personal' reflects a personal interest in UD, while 'legislation' represents an interest that arose after the Norwegian legislation on UD went into effect. In order to increase readability all agencies and mentioned projects are numbered in Table 8, with asterisk (*) on projects proven successful on UD and not only included based on efforts (as described in section 3 on inclusion criteria).

No	Experience	Competence	Project	Motivation
1	9 years	5	#7* #14*	Personal
2	4 years	5	#7* #14*	Personal

No	Experience	Competence	Project	Motivation
3	5 years	6	#5* #15	Personal+ Legislation
4	4 years	5	#6* #13	Personal
5	5 years	5	#5* #4* #12*	Legislation
6	10 years	6	#1* #16*	Personal
7	13 years	7	#5* #12* #11 #10	Personal+ Legislation
8	1 year	4	#1*	Legislation
9	15 years	5	#2*	Legislation
10	13 years	6	#1*	Personal
11	2 years	5	#3*	Personal + Legislation
12	8 years	6	#3*	Personal
13	16 years	7	#8* #9*	Personal

Table 8: UD expertise and motivation

1 Factors Promoting UD

Tables 9, 10 and 11 summarize frequencies for UD promoting practices mentioned in the interviews – the counted sums of mentions of thematic codes for each specific category across all the transcripts. They also present which informants mentions codes associated with each category. Table 9 display frequencies on organization level. The importance of an established internalized UD culture, including ensuring available human resources with UD competences, is recognized. Many of the informants mention legislation as a useful tool for getting UD prioritized.

Category	Mentions	Informants
Top-level understanding	18	8 (No. 1,4,6,8,9,10,11,12)
Resources	28	11 (No. 1,2,3,4,5,6,7,9,10,11,12)
Anchoring	17	10 (No. 1,2,3,4,6,7,8,10,11,12)
Reputation	12	3 (No. 6,11,12)
Legislation	18	9 (No. 1,2,4,5,7,10,11,12,13)

Table 9: Organization Level Promoting Frequencies

Category	Mentions	Informants
UD focus	59	12 (No. 1,2,3,4,6,7,8,9,10,11,12,13)
User focus	53	12 (No. 1,2,3,4,6,7,8,9,10,11,12,13)
Quality Assurance	37	12 (No. 1,2,3,4,6,7,8,9,10,11,12,13)
Agile	10	5 (No. 1,4,6,10,13)
Cooperation	37	11 (No. 1,2,4,5,6,8,9,10,11,12,13)
Simplification	6	5 (No. 1,3,4,12,13)

Table 10: Process Level Promoting Frequencies

Table 10 shows promoting practices on process level. UD and user focuses are recognized as the most important factors on ICT projects process levels: *"…UD must be present from the very beginning of* *development, and permeate all aspects of the project delivery"*. Early and continuous focus on UD is mentioned by 12 of the 13 informants, as is having a strong user focus. Codes linked to both categories are frequently mentioned in the interviews. 10 informants emphasize early and frequent user testing as well as high-quality user testing with disabled users. On the link between user focus and UD focus, one informant states: "*Focus on usability in general furthers universal design, because the two walk hand in hand. It is often easier to take usability to heart, and the though of making it usable for all. That is a good gateway to the theme of UD"*.

Continuous quality assurance and interdisciplinary cooperation are also highlighted frequently and by most. These aspects are also tied to user and UD focuses. Several specify the importance of including UD quality demands and requirements criteria. 12 informants express the value of quality assurance (QA), seven of which focus on external quality control in the form of specialized expert UD evaluation, while five mention automated tools and internal technical code reviews. One informant explains: *"we chose two solutions; firstly we hired a specialist at UD in front-end development who would participate in the development team to our supplier. Secondly, we used specialists in UD as external quality advisors in the development of requirements, design, UX, etc. These specialists participated either in meetings with our supplier when different solutions were discussed, or were contacted directly to check whether a proposed solution was good according to UD."*

11 informants promote cross-disciplinary dialogue, collaboration connecting visual design, technical code, content and usability and interdisciplinary problem solving. Involving developers in user testing is highlighted; increasing UD engagement and providing first hand evidence of hardships experienced by disabled users. Informants aim to integrate UD in all phases and all design and development work. A little less than half of the informants mention how iterative and/or agile processes promote UD.

Category	**Mentions**	**Informants**
UD Competence	34	11 (No. 1,2,3,4,6,7,8,9,10,11,12)
Personal qualities	25	13 (No. 1,2,3,4,5,6,7,8,9,10,11,12,13)

Table 11: Individual Level Promoting Frequencies

Table 11 shows promoting factors on individual level. Here, informants mention how important it is to have sufficient UD competence attached to a project. Key persons such as project owner, designers and developers need to have a holistic understanding of UD rather than only focusing on legislated WCAG criteria. Many mention overlapping needs and how UD benefits individuals without impairments e.g. using mobile technologies or experiencing challenging contexts of use, and highlight the necessity of motivations to ensure usability for all. One says: "*In my experience, it is effective to compare UD to usability in general, and to look at it from an elevated perspective where UD is not simply about having 'visually impaired or blind people also able to use a website'. UD is the other side of usability, and when you focus on UD, you also focus on usability – that way the solution becomes better for everyone.*"

Several informants say at least one person with a strong professional UD enthusiasm is needed for increasing UD competence and engagement in team members and stakeholders. Some personal qualities in people working on projects linked to UD successes are also pointed out; user empathy, a positive interest in UD and an openness to learn and evolve. Many of the informants show signs of possessing these qualities themselves during the interview.

2 Factors Obstructing UD

Tables 12, 13 and 14 summarize the frequencies for practices obstructing UD mentioned in the interviews. Table 12 presents the frequencies on organization level.

Category	**Mentions**	**Informants**
Lack of Anchoring	26	13 (No. 1,2,3,4,5,6,7,8,9,10,11,12,13)

Table 12: Organizational Level Obstructive Frequencies

Category	Mentions	Informants
Focus	18	8 (No. 1,2,3,4,6,7,8,10)
Process Issues	20	8 (No. 1,2,3,4,6,7,8,10)
Technical Challenges	5	4 (No. 10,11,12,13)
Constraints	23	11 (No. 1,2,3,4,6,7,8,9,10,11,12)

Table 13: Process Level Obstructive Frequencies

Category	Mentions	Informants
Lack of Competence	23	9 (No. 1,2,4,6,8,9,10,11,12)

Table 14: Individual Level Obstructive Frequencies

All informants point out lack of anchoring of UD on top levels as obstructive. The interviews indicate that if UD-culture is not anchored in the organization, UD is likely not to be prioritized in processes. Thus, constraints may become an issue. Also, all informants mention that budget constraints affect the process, and most mention at least once during the interviews that tight constraints limit the capability to succeed. Time constraints are quite frequently mentioned as an important factor, as is available competent human resources and available test resources – including user unavailability. Further, lack of anchoring and focus is tied to lack of individual UD competence, as the priority and time resources to ensure employees have the needed knowledge and skills are not allocated. More than half of the informants mention that a lack of knowledge and experience regarding UD will damage the team's ability to implement UD.

The informants exemplify how lack of knowledge and UD culture is manifested in resistance and counterarguments such as "why do we have to spend time on this, it only applies to 1% of the users" and "there are only 1000-1200 blind people in the country, why on earth are you doing this?" Process model issues are also quite often mentioned. Informants especially warn against sequential processes with a late UD focus, and no or little early testing and quality assurance. Most informants mention interdisciplinary collaboration and cross-disciplinary communication is an important promoting factor for UD, and about half of the informants specifically point out that cooperation can be an issue. A few mention technical challenges such as frameworks or trends that do not support UD principles.

5 DISCUSSION

The study identifies a set of positive and negative factors affecting the implementation of UD in Norwegian ICT projects. The positive factors may be seen as indicators as to what may *promote* successful implementation of UD, while the negative factors on the other hand may be seen as indicators of *obstructive* elements. An interesting tendency in the data is almost all the negative factors identified are merely *opposites* of a corresponding positive factor, such as *the lack of* anchoring, competence, resources or interdisciplinary cooperation. This inclination supports the notion of the positive factors being important promoting practices. It also indicates there might be hygiene factors present – something that is very negative if not present in a sufficient manner, at an acceptable level (Burke & Barron 2007, p. 288).

There are two factors that all the informants mention in some manner: 1) an understanding and *anchoring* of UD and usability culture at all levels, and 2) *UD competence*; stakeholders holding necessary understanding and skill sets, including personal qualities and enthusiasm. The need for a proper *understanding* of what UD actually is and proper *anchoring* are mentioned by 11 informants as *promoting* factors a total of 35 times, and by all 13 informants a total of 26 times as an *obstructive* factor.

Further, there are some factors *almost* all the informants mention; 3) UD and usability *focus* in the projects, including prioritizing time to do user-centered and QA activities, 4) interdisciplinary team *collaboration* – both related to process level cooperation and personal qualities of colleagues, and 5) an *iterative* process model with 6) early and frequent *QA* and user testing.

These six factors are therefore interpreted as *particularly important* for ensuring UD. They are all related, and could be divided into more or fewer factors depending on the desired level of detail. It is worth noting that even though all informants mention resources as an element in relation to method selection, it is not necessarily mentioned as a promoting or obstructive factor, but rather as a consequence of and requirement for other factors. It might be a hygiene factor. Most informants do not primarily call for more resources to do UD activities beyond ensuring the necessary competence; time to learn new skills if needed during the process and considering external QA control.

The informants mention *human resources* as vital for UD, pointing to *UD competence*. The need to give QA and testing priority is also emphasized, tying *time resources* to obstructive/promoting practices. As such, increased costs related to UD seem to be mostly tied to time, pointing to the necessity of UD *focus* in requirements and processes. Several mention how an early UD-positive "usability for all" focus in an iterative process limits the need for extensive resources. The lack of funding and/or time may as such be viewed as a consequence of missing anchoring, thus further implying that without proper anchoring, UD practices will be obstructed.

The important factors identified in this study coincide well with seven key principles identified for an inclusive design process in the literature (Fuglerud & Sloan 2013, Røssvoll & Fuglerud 2013, Schulz et al. 2014, Scott, Spyridonis & Ghinea 2015). First, having a *holistic and interdisciplinary team and/or process (principle 1)* was mentioned by 11 of 13 informants in this study and grouped in the code category *cooperate* which was mentioned 37 times. The fact that this was brought up more than once per informant, suggests that it is of great importance for successful implementation and that the team plays an important part. Several of the informants mention the term "interdisciplinary" and there were also several mentions of how important good communication and co-location is. Not being able to talk directly to the other team members is identified as obstructive, and a root cause for misunderstandings and difficulties.

Basing the process on user-centered design principles (principle 2) is also strongly supported in our findings. Early and frequent *user focus* is mentioned as many as 53 times by 12 of the 13 informants. A quite intriguing finding is how several of the informants describes a 'proper understanding' of UD as the recognition of *a link connecting UD and general usability*; and how making a solution universally designed, also makes it more usable for *all users*. Several informants share this vision, and agree that it is important for management, costumers and team members to see this link in order to fully understand *why* UD is important. This is consistent with the literature key factor; *focusing on the entire user experience (principle 7)*.

Further, the informants also support *using an iterative approach (principle 4)* to development, and specify how separating UD from the design and development process is adverce, as is delaying UD focus until towards the end of a project and treating UD as one step in a sequential process. 12 informants mention having an early focus on users with disabilities as well as a continuous focus throughout the design process (*principle 5*). This study coded and grouped these thematic mentions as "UD focus". "UD focus" is the category mentioned the most frequently across both obstructive and promoting categories – 59 times (see Table10).

12 of the 13 informants mention various degrees of internal and external *quality assurance* such as the *use of empirical evaluations with various impairments represented (principle 6)*. QA is mentioned as a promoting factor 37 times and is the third most frequently mentioned code category. Allowing all parts of the team, including developers, to witness usage difficulties is mentioned several times during the interviews. Depending on the informants' descriptions and focuses, these topics were coded both under the promoting categories *Cooperate* and *UD Competence* and the obstructive category *Process Issues.*

Linked to the ability to *adopt and apply accessibility standards and guidelines (principle 3)* all informants mention the importance of having the right *resources* and the right *competence*, and 9 informants specifically mentioned *legislation.* The need for project requirements specifying UD is emphasized in the category *UD focus*.

Principle 3 is also tied to UD competence and personal qualities, which are highlighted in the interviews. Four of the five developers interviewed report a personal motivation for UD, five out of six if the UD advisor with a developer background is included. Paired with the fact that *all* the designers interviewed specifically mentioned how the developers on their team were interested in, and took UD seriously; the study may suggest that having a *developer* with high *UD competence* may be an important promoting factor. This finding also coincides with the study performed in Brazil by Freire, Russo and Fortes (2008). None of the informants mention difficulties with understanding the WAI accessibility guidelines, but several mention how in-depth understanding of usage issues related to advanced ATs (such as screen readers) are challenging.

Finally, the results from this study are aligned with studies exploring implementation of a user-centered design in agile processes (Raison & Schmidt 2013, Begnum & Thorkildsen 2015, Silva da Silva et al. 2015). These studies also points out that anchoring of user-centered design at a business level may affect how well implementation will work in an agile process. The identified key factors in this study are thus not necessarily unique for the implementation of UD in an ICT-project, but may also be true for user centeredness, usability and user experience work in general. Several informants link user focus, usability focus and UD focus. Iterative and interdisciplinary user-centered processes with early and continuous UD focus and UD QA seems to be best-practice approaches. Having user contact is further regarded as important when designing for disabled users, including allowing developers and non-designer team members to witness usage difficulties.

The findings in this study are reinforced by previous findings in the literature and vice versa. The validity of the findings are further supported by the fact that two researchers performed the analysis; coding, categorizing, determining frequencies and interpreting the data, and came to similar conclusions. It can however be argued that this study to a larger degree than in previous studies emphasizes having some form of top-level *anchoring* of UD as necessary in order for other promoting practices to fall into place. Without an understanding of what UD is among stakeholders such as leaders and costumers, projects will not be granted the right resources they need to succeed. Resources identified as important by the participants are not mainly linked to budgets, but rather to the necessary competence and authority to prioritize focus on users and QA, making it possible to maintain an early and continuous focus throughout the process.

3 Limitations of the Study

This study identifies a set of promoting and obstructing factors based on a limited number of successful projects; therefore there is a potential that the study could have identified more, or entirely different, factors had a larger population been represented. It may also be speculated on whether or not interviewing only "successful" projects makes this a non-representative population. Finally, the definition of "successful" could be discussed – e.g. what awards and/or honorable mentions should be regarded as valid for "success" inclusion.

6 CONCLUSION

This study explores successful practices for the implementation of UD in Norwegian ICT projects. The data is based on an in-depth interview study of 13 informants across 12 UD-successful projects. A thematic analysis identifies a set of positive and negative factors that are interpreted as *promoting* and *obstructive* practices for ensuring UD in ICT solutions. Six important promoting factors are identified: 1) *UD anchoring*, 2) *UD competence*, 3) *focus* (on UD, users and usability), 4) *collaboration* (in interdisciplinary teams), 5) *iterative* approaches and 6) early and frequent *QA* and user testing. Identified negative and obstructive factors are mainly absence of a corresponding positive factor, and may as such be seen as a confirmation that the positive factors identified are in fact "success factors".

Findings coincide well with related literature. The factors emerging from the transcripts in this study are categorized on three levels; organizational, project process and individual. This study therefore provides insight into the relationship between factors, including the positive effect of an anchored UD culture on organizational top-level to promoting process practices outlined, as well as ensuring competence and understanding on an individual level. The study also highlights the importance of human resources with UD competence and the presence of positive personal qualities and UD enthusiasm.

6.1 Future Work

Further research will initially focus on confirming the insights by increasing the number of informants as well as the number of successful projects. The findings in this study should be strengthened with regards to generalizability. Comparative case studies may also be considered, where factors identified as crucial for success in this study are absent or present. Through further studies new aspects may appear, and relationships and dependence between factors may become clearer. Next, the aim is to model the identified practice factors, and based on this design a measuring tool suitable for providing an indication of how prepared a project is to implement UD ("UD maturity").

Future research may also focus on the integration of both UD and UX work into the agile approaches commonly used in Norway ICT project processes. The overall goal is to be able to make contributions towards more reliable best practices based on verified success factors, as well as attempt to create a measuring tool for ICT-projects related to UD that can be used to indicate to what degree a project is likely to achieve UD based on organizational, individual and process properties.

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UNIVERSELL UTFORMING OG DIGITAL EKSAMEN I UH-SEKTOREN: 5 ANBEFALTE TILTAKSPUNKTER

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SAMMENDRAG

E-læringssystemer er nå utbredt i norsk universitets- og høgskolesektor (UH-sektor). Dette er på mange måter positivt for universell utforming, da nye IKT-løsninger åpner for inkludering. E-læringsverktøy må imidlertid være universelt utformede, slik at studenter med funksjonsnedsettelser kan benytte seg av verktøyene på lik linje med andre studenter. Denne studien ser på dagens praksis rundt ivaretakelse av universell utforming i anskaffelse og bruk av digitale eksamensløsninger. Dette gjøres gjennom en kartleggende spørreundersøkelse i UH-sektoren, og påfølgende dybdeintervjuer med representanter både fra UH-institusjoner og leverandører. Studien identifiserer en rekke utfordringer, blant annet en uklar praksiskompetanse på universell utforming og få universelt utformede normalløsninger i UH-institusjoner. Studien peker på sentrale forbedringsområder i anskaffelsesprosesser, særlig knyttet til at UH-sektoren undervurderer hvilke konkrete krav de kan stille til teknisk tilgjengelighet fra tilbydere, til nå ikke har etablert ansvar for å sikre oppfyllelse av DTL lovverket i anskaffelse av IKT-løsninger til sektoren, prioriterer funksjonalitetskvantitet og legger lite vekt på akseptansetesting av løsningenes praksiskvalitet. Det foreslås en iterativ prosessmodell for å sikre krav til og kvalitetssikring av universell utforming, og anbefales følgende fem tiltakspunkter for å fremme universell brukskvalitet ved anskaffelse av e-læringsverktøy generelt, og digitale eksamensløsninger spesielt: 1) flytt fokus fra individuell tilrettelegging til universelle normalløsninger, 2) ha konkrete krav for universell utforming som del av kravspesifikasjonen, gjerne basert på kriteriesett for universell brukskvalitet, 3) ansvarliggjør tilbydere for teknisk tilgjengelighet ved eksplisitt etterspørsel, 4) sikre institusjonelt ansvar for universell utforming gjennom økt kvalitetskontroll, og 5) baser anskaffelsesprosesser på artikkelens foreslåtte prosessmodell.

1 INTRODUKSJON

For personer med funksjonsnedsettelser øker sannsynligheten for å komme seg ut i arbeid 4,5 ganger dersom de har høyere utdanning (Bufdir, 2015b). Det er derfor svært viktig for norsk sysselsetting, og den individuelle arbeidstaker, at alle studenter har gode muligheter til høyere utdanning. Det antas at rundt 1/3 av norske universitets- og høgskole (UH) studenter har en form for funksjonsnedsettelse, skade eller kronisk sykdom (TNSGallup, 2012). Omkring 15 % melder at dette påvirker deres studiegjennomføring.

Bruken av e-læringsverktøy i UH-sektoren er stor, og øker – blant annet med innføring av digitale eksamensløsninger (Larsen, 2016; UNINETT, 2015). For å oppnå lik mulighet til utdanning må disse verktøyene, også kalt digitale læremidler, være universelt utformet (Bocconi, Dini, Ferlino, Martinoli og Ott, 2007). Universell utforming dreier seg om å utvikle løsninger som kan brukes av flest mulig. Fokuset på universell utforming av IKT-løsninger økte med Diskriminerings- og tilgjengelighetsloven (DTL) (Barne- og likestillingsdepartementet, 2013), som pålegger IKT-løsninger rettet mot allmennheten å være universelt utformede. 20. september 2017 ble UH-sektoren eksplisitt omfavnet av forskriften til denne loven (Kommunal- og moderniseringsdepartementet, 2017). Forskriften fastsetter at alle digitale læremidler skal være universelt utformede fra 1.1.2021, og alle nye digitale læremidler etter 1.1.2018 fra senest 1.1.2019. Det er imidlertid gjort lite forskning på ivaretakelse og kvalitetssikring av universell utforming ved utvikling eller anskaffelse av e-læringssystemer.

Denne studien er eksplorativ og kvalitativ, og undersøker hvordan universitets- og høgskolesektoren forholder seg til universell utforming og digitale eksamensløsninger i dag, med mål om å kunne bidra til en positiv utvikling i sektoren. Studien søker å identifisere og drøfte problemområder og mulighetsrom,

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med fokus på bedring og kvalitetssikring av utviklings- og anskaffelsesprosesser. Følgende tre relativt brede forskningsspørsmål ble formulert:

1. Hvilken kompetanse på universell utforming finner vi i norske UH-institusjoner, og hvordan forholder de seg til dagens lovgiving (DTL)?
2. Hva er dagens praksis i norske UH-institusjoner for å ivareta universell utforming i anskaffelse og bruk av digitale eksamensløsninger?
3. Hva er de potensielle forbedringsområdene knyttet til identifiserte praksiser i norsk UH-sektorer?

2 BAKGRUNN

Studenter med funksjonsnedsettelser har de samme rettighetene som andre studenter, og bør kunne forvente å få den samme utdanningen som medstudentene (Klironomos, Antona, Basdekis og Stephanidis, 2006). I lys av dette har de også rett til å bruke de samme digitale verktøyene for læring som medstudentene. Det er få pålitelige kartlegginger av antallet studenter med funksjonshemminger i UH-sektoren, og hva som klassifiseres som en "funksjonshemming" varierer også i noen grad. Denne studien har tatt utgangspunkt i TNS Gallup sin spørreundersøkelse fra 2012, der studenter fra 7 UH-institusjoner ble spurt om ulike aspekter ved deres arbeidsmiljø (TNSGallup, 2012). Responsraten var på 34 %, med 8532 responderende studenter. De fleste opplyser om miljøutfordringer knyttet til astma og allergier (17 %), mens 9 % nevner mental helse, 5 % muskel eller skjelettplager, 4 % andre kroniske eller langvarige sykdommer, 3,5 % lese-og skrive vansker, 1,7 % nevropsykiatriske utfordringer inkludert ADHD og autismespekter-forstyrrelser, 0,7 % alvorlige synsnedsettelser, 0,6 % en motorisk funksjonsnedsettelse, 0,5 % alvorlige hørselshemminger eller døvhet og 1 % andre funksjonsnedsettelser. 15 % melder at deres funksjonsnedsettelse, skade eller sykdom påvirker deres muligheter til å gjennomføre utdannelsen.

Konseptet om universell utforming (universal design) ble introdusert i midten av 80-årene, og gjelder for flere felt – inkludert arkitektur, transport og IKT (Røssvoll og Fuglerud, 2013). FN-konvensjonen definerer: "Med universell utforming menes: utforming av produkter, omgivelser, programmer og tjenester på en slik måte at de kan brukes av alle mennesker, i så stor utstrekning som mulig, uten behov for tilpasning og en spesiell utforming. Universell utforming skal ikke utelukke hjelpemidler for bestemte grupper av mennesker med nedsatt funksjonsevne når det er behov for det." (Bufdir, 2015a). Begrepet ble i Norge først nevnt i «Universell utforming: planlegging og design for alle» (Aslaksen, Bergh, Bringa og Heggem, 1997), og i forhold til fysisk utforming av bygg er universell utforming et kjent prinsipp. I forhold til IKT er det ikke like etablert hva universell utforming egentlig er (Begnum, 2016). Beslektede begreper som inkluderende design, inkluderende utforming, design for alle, universell design og utforming for alle benyttes til dels overlappende med universell utforming (Bufdir, 2015a). I Norge brukes også begrepene *tilgjengelighet* (accessibility) og *brukbarhet* (usability) (Lid, 2013, s30). Begnum (2016) finner at norske eksperter oppfatte disse begrepene noe ulikt, og foreslår å anse universell utforming som en tilleggskompetanse innen hver IKT-relaterte disiplin. Petrie, Savva and Power gjennomførte i 2015 en analyse av 50 ulike definisjoner av "web accessibility" med mål om å bedre forstå hva forskere og praktikere mener er kjernen av dette begrepet (Petrie, Savva og Power, 2015).

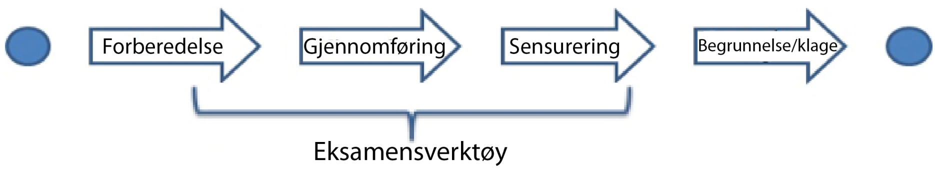
I forhold til IKT-løsninger benyttes gjerne *tilgjengelighet* om å sikre tekniske muligheter til å finne innhold og utføre oppgaver, oftest gjennom å følge WAI kriteriesett og etablerte standarder når man utvikler programvare. *Universell utforming* kan sees på som en fremgangsmåte for å designe løsninger der det tas hensyn til variasjoner i brukernes evner, og slik sikre god brukbarhet (brukskvalitet) for alle (Bufdir, 2015a). Tilgjengelighet anses gjerne som en forutsetning for universell utforming. Temaet har blitt mye omtalt de siste årene, og fokuset økte ytterligere med Diskriminerings- og tilgjengelighetsloven (DTL) (Barne- og likestillingsdepartementet, 2013), som pålegger IKT-løsninger rettet mot allmennheten å være universelt utformet. Lovens forskrift (Kommunal- og moderniseringsdepartementet, 2013) spesifiserer imidlertid kun konkrete krav til nettløsninger (WCAG 2.0 AA-nivå) og automater. Det er altså krav til *tilgjengelighet* som i stor grad reguleres.

Iwarsson og Ståhl (2003) mener det underliggende prinsippet for *tilgjengelighet* stigmatiserer ved å dele i 1) normalbefolkning og 2) divergerende befolkning med nedsatt funksjonsevne. I kontrast er *universell utforming* basert på prinsippet om at det kun finnes en populasjon bestående av individer med ulike egenskaper og evner (Iwarsson og Ståhl, 2003). Til forskjell fra *tilrettelegging* for enkeltstudenter vil et *universelt utformet* miljø komme alle studenter til gode, også de som ikke har behov for tilrettelegging.

Universell utforming i utdanningen omhandler både pedagogiske verktøy og fysisk læringsmiljø. TNS Gallups datamateriale peker på 5 hovedutfordringer for norsk UH-sektor i forhold til universell utforming: (1) orientering (informasjon), (2) mobilitet (navigering), (3) fokus (skjerming), (4) mental helse og (5) miljø. I TNS Gallup rapporten er det altså fokus på det fysiske miljøet, kanskje særlig i forbindelse med å løfte frem studenter med konsentrasjonsvansker og allergier. Lauring og Solhaug (2015) påpeker at "Ved snakk om universell utforming i skolesammenheng er det nesten alltid det fysiske skolemiljøet som får fokus. Men for å skape et universelt utformet læringsmiljø er det viktig å jobbe også med de digitale delene av læringsmiljøet". Målet om tilgjengelig utdanning nås ikke før hele utdanningsløpet er designet for alle studenter – uavhengig av funksjonsnedsettelser (Burgstahler, Corrigan og McCarter, 2004).

I målsettingen om å gjøre det norske utdanningssystemet til et av de fremste i verden på pedagogisk utnyttelse av IKT (Kunnskapsdepartementet, 2006), nevnes IKT-løsninger som sentrale for å sikre at alle får fullverdig deltakelse. Likevel har utdanningssektorens digitale læringsmiljø til nylig ikke vært regulert i noe lovverk, da myndighetene ved innføring av Diskriminerings- og tilgjengelighetsloven (DTL) antok at egen sektorlovgivning ville dekke dette. Det gjorde den imidlertid ikke. Konsekvensene av å ikke etterfølge krav om universell utforming i utdanningssektoren er imidlertid stor, både for den enkelte person og for samfunnet generelt. Et lovforslag fremmet 19.10.2015 om å legge sektoren inn under DTL-lovverket med revidert forskrift ble vedtatt og kunngjort 20.9.2017, og trer i kraft 1.1.2018 (Kommunal- og moderniseringsdepartementet, 2013). En av revideringene er i §2 der det spesifiseres at loven omfatter *digitale læremidler*. Digitale læremidler defineres i forskriften som "nettbaserte redskaper som kan brukes i det pedagogiske arbeidet, og som er utviklet med hensikt å støtte læringsaktiviteter".

E-læring er en forkortelse for elektronisk læring og omfatter verktøy for å motta pensum, oppgaver, arbeide med og diskutere disse, samt levere besvarelser. Det er altså et stor overlapp mellom det som i forskning blir referert til som *e-læringsverktøy*, og det den reviderte forskriften om universell utforming av IKT-løsninger kaller *digitale læremidler*. I forhold til det norske lovverket anses altså digitale læremidler og e-læringsverktøy, herunder *digitale eksamensløsninger*, som en type nettløsninger. Digitale eksamensløsninger kan altså anses som en spesifikk type IKT-løsning. I digitale eksamensløsninger er det normalt på plass funksjonalitet for å opprette, administrere, gjennomføre og sensurere eksamensoppgaver. Digitaliseringen kan deles i to hovedtyper: 1) fullverdig digital eksamen – digitalisering av hele arbeidsprosessen knyttet til eksaminering, og 2) digital gjennomføring – digitalisering av kun eksamensgjennomføringen (Indreråk, 2015). Denne studien fokuserer på *gjennomføring*, se Figur 1.



Figur 1: Digitalisering av arbeidsprosess (Indreråk, 2015)

Innføring av digitale eksamensløsninger i norsk UH-sektor er i følge Krumsvik (2006) et resultat av etterspørsel fra studentene, som har vokst opp i en tid der bruk av elektroniske verktøy er vanlig. I dag er det flere digitale eksamensløsninger i bruk i Norge. Mange institusjoner bruker LMSer (Learning Management System) til innleveringer av hjemmeeksamen. Andre benytter egenutviklede systemer, som for eksempel Det juridiske fakultet UiO og Handelshøyskolen BI. I tillegg finnes flere tilbydere av fullverdige digitale eksamensløsninger. Det er per i dag ingen offentlig dokumentasjon på hvem de største tilbyderne av digitale eksamensløsninger i Norge er. Inspera Assessment (Inspera) og WISEflow antas å være blant de to største, og tilbyr skybaserte fullverdige vurderings- og eksamensløsninger. Skybaserte løsninger krever ingen programvareinstallasjoner, og kan derfor tas i bruk når og hvor som helst, både til hjemme- og skoleeksamen. Løsningene tilbyr blant annet simultane prøvegjennomføringer, formative og summative tester, automatisk evaluering, adaptiv læringsprosess og arbeidsflyt gjennom hele verdikjeden.

Det viser seg at det ofte er et avvik mellom forventninger og resultater når nye IKT-løsninger blir introdusert i utdanningssektoren. Det synes å være en generell oppfatning at innføring av IKT-løsninger i seg selv vil føre til endringer – uten å se på formålet med løsningen (Cuban, 2001 i Krumsvik 2006).

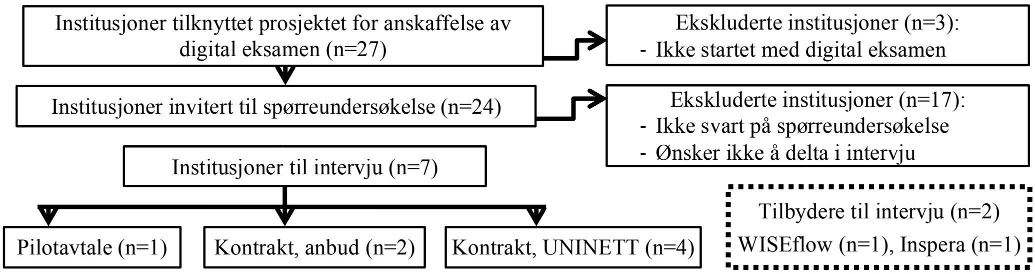
Lærere blir sjeldent konsultert når ny teknologi anskaffes, til tross for at det er disse som skal ta løsningene i bruk (Cuban og Tyack, 1998 i Krumsvik 2006). Krumsvik (2006) hevder at vilkårene for innføring av IKT i utdanningssektoren ofte bestemmes av andre enn institusjonene selv (Arnseth, 2000; Ludvigsen, 2000 i Krumsvik 2006). Khemani, Hagen, Ross, and Jamjoum (2013) støtter opp om dette, og sier det må foreligge retningslinjer for *hvordan* og *hvorfor* en løsning skal innføres for å sikre produktiv og konstruktiv utnyttelse. Ved implementering anbefales det å legge ekstra vekt på hva systemet skal brukes til, hvilke individuelle og generelle behov studentene har, samt de pedagogiske oppgavene systemet skal løse (Granić og Ćukušić, 2007).

3 METODIKK

I studien legges det vekt på å øke kunnskapen om universitets- og høgskolesektorens kompetanse og praksis rundt ivaretakelse av universell utforming i digitale eksamensløsninger, samt gi innsikt i mulighetsrom og utfordringer. Studien har ingen klare teorier, og det er i stedet ønskelig med en utforskende og åpen tilnærming. Vårt startpunkt er å forstå, fremfor å kritisere, selv om studien også kan sies å ha trekk fra kritisk kvalitativ forskning (Merriam, 2009). Siden våre forskningsspørsmål er rettet mot å utforske hvordan universell utforming forstås og ivaretas ved norske UH-institusjoner i dag, anser vi vår studie som eksplorativ. Eksplorative undersøkelser har som formål å utforske forhold eller fenomener som er helt eller delvis ukjente (Johannessen, Tufte, & Kristoffersen, 2010). Videre er formålet med studien å gå spesifikt inn i problemstillinger rundt anskaffelse og bruk av digitale eksamensløsninger. Når man går i dybden av en problemstilling ved å snakke med, eller studere et mindre antall deltagere ved hjelp av kvalitative metoder, regnes dette gjerne som en case studie (Lazar, Feng og Hochheiser, 2010). En case studie kan imidlertid også inneholde kvantitative metoder (Merriam, 2009). En case studie har heller ikke en presis definisjon; for eksempel definerer Yin (2008 i Merriam 2009) en case studie i større grad ut fra forskningsstrategien (empirisk undersøkelse), mens Stake (2005 i Merriam 2009) fokuserer på selve casen. Likevel anses ofte forskningsrapporter om spesifikke organisasjoner, prosesser osv. som case studier (Yin, 2003 i Marshall og Rossman 2011). Merriam definerer case studien som en dybdeanalyse av et avgrenset område (2009, s.40). I lys av dette, defineres vår metodiske tilnærming som en eksplorativ case studie.

Metodene som benyttes til datainnsamling er spørreundersøkelse og semi-strukturerte dybdeintervjuer (Leedy og Ormrod, 2014). Kvalitative studier fokuserer typisk på å belyse betydning, forståelse og prosesser ved rike, komparative og induktive dataanalyser, og samler gjerne data gjennom metoder som intervjuer, observasjoner og dokumentanalyser fra et målrettet utvalg (Merriam, 2009). I vårt studie gjennomføres imidlertid først en kartleggende spørreundersøkelse blant alle 27 UH-institusjoner som i 2015, da undersøkelsen ble sendt ut, deltok i det nasjonale anskaffelsesprosjektet for digital eksamen (UNINETT, 2014). Formålet er å få et overblikk over sentrale temaer tilknyttet problemområdet, spesielt tilknyttet vårt første forskningsspørsmålet, samt få en indikasjon på bredden i sektoren og identifisere representative og relevante informanter til dybdeintervjuer. Det ble gjennom målrettet (ikke-probabilistisk) rekrutteringsprosess til utvalg identifisert 1-3 personer tilknyttet UNINETTs nasjonale anskaffelsesprosess eller på forespørsel vurdert av denne kontaktpersonen som relevante mottakere av spørreundersøkelsen ved hver av de 27 UH-institusjonene, totalt 38 personer. Forespørselen etterlyser kontaktinformasjon til personer som jobber med 1) innkjøp av systemer, 2) studiestøttesystemer, 3) prosjektgruppe for digital eksamen eller 4) tilrettelegging for studenter med nedsatt funksjonsevne. Disse utvalgskriteriene bidrar til å sikre at det blir gitt kontaktinformasjon til personer som har et forhold til anskaffelse, bruk eller innføring av studiestøttesystemer og dagens praksis rundt tilrettelegging for studenter med nedsatt funksjonsevne. Duplikater blokkeres, så hver respondent kun sender inn ett svar.

Basert på svarene fra spørreundersøkelsen ble totalt 8 informanter fordelt på 7 UH-institusjoner inkludert til dybdeintervjuer, etter kriteriene: a) institusjonen har startet prosessen med digital eksamen (inngått pilotavtale eller kontrakt med tilbyder/via UNINETT), og b) institusjon og informant er villige til å delta i dybdeintervju for å få et rikere innblikk i holdninger og praksiser, og belyse vårt andre og tredje forskningsspørsmål.. Alle institusjoner som oppfyller kriteriene er representert. For å undersøke hvordan tilbyderne forholder seg til universell utforming i utviklingen av digitale eksamensløsninger, og gi ytterligere innsikt i hvilke utfordringer og mulighetsrom som finnes her, er det også gjennomført dybdeintervjuer med informanter fra Inspera og WISEflow. To ulike informantgrupper er altså inkludert i intervjuene: 1) ansatte ved 27 UH-institusjoner tilknyttet anskaffelses og/eller innføringsprosesser for digitale eksamensløsninger, og 2) ansatte ved de to tilbyderne Inspera og WISEflow. Figur 2 visualiserer flytdiagram for datainnsamlingen.



Figur 2: Datainnsamling og utvalg til spørreundersøkelse og intervjuer

3.1 Analyse

Analysen i denne studien har ikke som mål å verifisere hvorvidt en eller flere hypoteser stemmer, men for å generere beskrivelser som øker forståelsen av problemområdet og belyser forskningsspørsmålene. Det er heller ikke et mål å sammenlikne institusjoner i UH-sektoren opp mot hverandre, men snarere å skape et helhetlig bilde av sektorens muligheter og utfordringer. Studien anses å reflektere forholdene ved de norske UH-institusjoner der arbeidet med å få på plass digitale eksamensløsninger er i gang og samspillet med deres tilbydere, men med et lavt antall deltakere kan resultatene fra studien vanskelig sies å være generaliserbare, og bør heller anses som indikerende (Leedy og Ormrod, 2014; Lazar, Feng og Hochheiser, 2010, s.160). Dataene fra spørreundersøkelsen er kvantitative eller kvantifiserte, og analyseres ved deskriptiv statistikk. Kvalitative data fra intervjuene er analysert ved tematisk analyse, der individuelle svar kombineres slik at de utgjør et felles helhetlig sammendrag (Lazar, Feng og Hochheiser, 2010). Analysen kan plasseres innenfor en induktiv tilnærming (Patton, 1990 i Braun og Clarke, 2006). Dataene leses, kodes, kategoriseres og presenteres i en trinnvis prosess (Braun og Clarke, 2006). Temaer er identifisert ved bruk av en semantisk tilnærming, der man ser på de eksplisitte (ikke fortolkende) betydningene av dataene (Braun og Clarke, 2006).

4 RESULTATER

4.1 Spørreundersøkelse; kartlegging av kunnskap og praksis

19 respondenter, fordelt på 14 institusjoner (7 universiteter, 11 høgskoler og UNINETT) svarte på spørreundersøkelsen. Dette ga en svarprosent på 50 %, som anses god. Mer at etter fusjonsprosesser i 2015/16 er de 27 institusjonene nå redusert til 21, og de 14 responderende institusjonene representerer i dag 4 av disse. Spørreundersøkelsen inneholdt 21 spørsmål tilknyttet 4 temaer: A) kartleggende bakgrunnsinformasjon, B) Nåværende eksamenspraksis, C) Praksis knyttet til universell utforming og D) Kjennskap til lovgiving. Hovedfunnene presenteres i denne artikkelen.

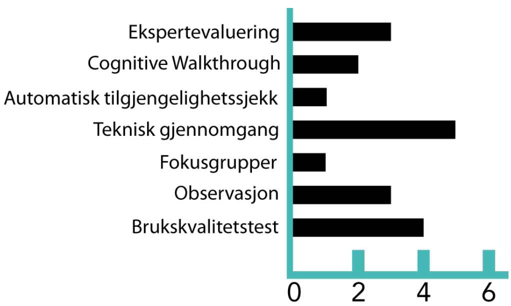
Variasjon i digitale eksamensløsninger: Kartleggingen viser en god spredning i bruk av løsninger fra WISEflow (7 stk.) og Inspera (5 stk.). UNINETT gjennomfører ikke eksamensavviklinger, og et par institusjoner benytter seg av andre løsninger. Noen institusjoner har inngått kontrakter via eget anbud, andre har signert avtale via UNINETT, se Figur 2.

Individuell tilrettelegging fremfor universelle løsninger: Svar omkring tilretteleggingspraksis ved eksamen er homogene. Den vanligste formen er utvidet tid på eksamen, eget rom med spesialutstyr og datamaskin med lese- og skriveprogrammer for å hjelpe studenter med dysleksi/lese- og skrivevansker. Ved tradisjonell papirbasert eksamensgjennomføring blir studenter med funksjonsnedsettelser ofte adskilt fra resten av studentene dersom de trenger spesialutstyr. Med digital eksamensløsning kan eksamen gjennomføres i samme lokale, med tekniske hjelpemidler installert på institusjonens/studentens datamaskin. To respondenter spesifiserer i et åpent spørsmål at tilrettelegging gjøres på individnivå, ut fra studentens behov og funksjonsnedsettelse, den ene slik: *«(...) den individuelle tilretteleggingen har som formål å veie opp for de ulemper funksjonsnedsettelsen medfører for den enkelte student, uten at studenten oppnår faglig fordel av tilretteleggingen.»*.

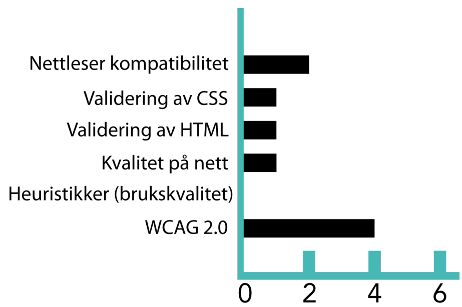
God kjennskap til universell utforming: 16 respondenter (84 %) svarer at deres 13 institusjoner (93 %) har middels til høy kompetanse, hvorav 8 svarer middels, 7 høy og 1 meget høy. 2 respondenter svarer de ikke vet, og 1 svarer at kompetansen på universell utforming er meget lav. Rundt halvparten oppgir at de kjenner forskrift om universell utforming av IKT-løsninger knyttet til Diskriminerings- og Tilgjengelighetsloven (DTL), og på hvilke områder denne har betydning for deres arbeid: 10 respondenter (52 %) fra 9 institusjoner (64 %). 13 respondenter (68 %) fra 11 institusjoner (79 %) oppgir at universell utforming er en del av kravspesifikasjonen ved innkjøp, selv om kun 5 har basert dem på DTLs forskrift.

Uklart hvem som har ansvar: Nesten 40 % av respondentene vet imidlertid ikke *hvem* som har ansvaret for å sikre universell utforming i anskaffelsesprosesser. Halvparten (47 %) beskriver et jevnt distribuert ansvar blant alle som jobber med innkjøp. Kun 3 respondenter beskriver at det finnes én person som har hovedansvaret for å sikre universell utforming.

Svak kvalitetskontroll: Over halvparten av respondentene har ingen erfaring med testmetoder (58 %) ved innføring av nye løsninger, og to tredjedeler har ingen erfaring med standarder/sjekklister (63 %). Figur 3 og Figur 4 gir en oversikt over oppgitt erfaring med henholdsvis testmetoder og standarder/sjekklister (flervalgsspørsmål). Samlet viser svarene at erfaring med metoder for kvalitetssjekk av løsninger er begrenset, med hovedvekt på WCAG 2.0 og teknisk gjennomgang. Kun én institusjon hentet inn kompetanse fra andre avdelinger ved institusjonen for å kvalitetsteste ny løsning før aksept.



Figur 3: Erfaring med testmetoder



Figur 4: Erfaring med standarder/sjekklister

4.2 Intervjuer: Informanter fra UH-sektoren

Gjennom intervjuene utforskes informantenes syn på og forhold til universell utforming og tilknyttet lovverk mer i dybden, tilknyttet deres arbeidsoppgaver og anskaffelsesprosesser, inkludert opplevde utfordringer og drivere. Tabell 1 presenterer et overblikk av de 8 informantene fra UH-institusjonene.

Informant	Virksomhet	Stilling	Løsning	Benyttet
I1	Universitet 1	Prosjektleder	Inspera	1 år
I2 & I3	Høgskole 1	Prosjektleder & Rådgiver	Inspera &WISEflow	1 år
I4	Universitet 2	Rådgiver	WISEflow	1,5 år
I5	Høgskole 2	Konsulent	WISEflow	0,5 år
I6	Høgskole 3	Seksjonssjef	WISEflow	1 år
I7	Universitet 3	Prosjektleder	WISEflow	3 år
I8	UNINETT	Prosjektleder	N/A	

Tabell 1: Oversikt over intervjuinformanter fra UH-institusjonene

Kompetanse bør samles: Institusjonene som helhet synes å ha god kompetanse på universell utforming, men den er spredd ut i organisasjonen. Inntrykket er at de som har størst kompetanse gjerne jobber med institusjonenes nettsider, og ikke trekkes inn i anskaffelsesprosesser som angår studentene. Det ønskes at kompetanse på universell utforming skal samles, og at dette miljøet skal sørge for at rutiner foreligger og ivaretas ved anskaffelse av nye løsninger. Det nevnes som viktig å få frem gode eksempler for å vise at universell utforming ikke er vanskelig og at universelt utformede løsninger gagner mange. Selv om alle har et bevisst forhold til begrepet universell utforming, er det totale inntrykket at det mangler kompetanse på hva universell utforming er i praksis. En informant uttaler: *«Det var ikke før jeg leste det her (intervjuguide og informasjonsskriv) at jeg forstod at dette (universell utforming) er relevant for min jobb. Jeg har ikke den tiden det trengs til å lete rundt og sette meg inn i dette.».*

Eksterne krav ønskes velkommen: På spørsmål om hvilke faktorer som kan hemme eller fremme universell utforming er det enighet om at et lovpålegg i utdanningssektoren vil være fremmende. Kompetansesenteret Universell trekkes også frem som en pådriver ved å bevisstgjøre og jobbe for et inkluderende læringsmiljø. I tillegg beskrives studenter med ekstraordinære behov som drivere. Informantene opplever at de som funksjonsfriske personer ikke alltid er i stand til å se behov, og dersom studentene krever lite blir dette derfor en hemmende faktor. De tror gode løsninger kan komme tidligere dersom studenter i større grad melder om behov og slik bidrar til bevisstgjøring.

Funksjonalitetsbehov i fokus: Teknologi nevnes som både hemmende og fremmende. Informantene sier teknologi muliggjør realisering av universell utforming, men at løsninger også kan ekskludere. Fire av informantene er prosjektledere for bestilling og innføring av eksamensløsningene. Disse beskriver relevansen av universell utforming på et overordnet nivå i tilknytting til sine arbeidsoppgaver. Det fortelles at det er lite oppmerksomhet på universell utforming under behovsanalyser ved nyanskaffelser, og at funksjonalitetsbehov får høyest prioritet i nye og kostbare løsninger. Det anses viktig at løsningene institusjonen tilbyr skal være universelt utformet, og at dette må tas hensyn til ved anskaffelser. Prosjektlederne sier likevel at det er funksjonalitetsbehov som får høyest prioritet.

Usikkerhet rundt tilgjengelighetskrav: Ved anskaffelse av digitale eksamensløsninger har flere i utvalget gjennomført egne anbudsprosesser, mens andre tester løsninger i forbindelse med felles anskaffelsesprosess ledet av UNINETT. Én informant forteller at de fikk seks tilbud da de la ut anbudet sitt, hvorav tre ikke var aktuelle. Av de tre gjenværende trakk én seg da de ikke kunne levere i henhold til krav. De to gjenværende tilbudene kom fra Inspera og WISEflow. Oppfatningen er at eksplisitte og obligatoriske krav til universell utforming vil medføre at ingen vil kunne tilby UH-sektoren en digital eksamensløsning. Informantene forteller at krav til universell utforming derfor er åpne, for eksempel: «Beskriv hvordan din løsning har tatt hensyn til personer med en synshemming?». Tilbyderne blir bedt om å beskrive hvordan enkelte scenarier er ivaretatt i løsningen, og institusjonene legger dette til grunn for etterprøving. Informantene opplever derfor de må være pragmatiske og benytte seg av løsningene som finnes, samt samarbeide med tilbyderne mot et felles mål.

Få universelle normalløsninger: De øvrige informantene (rådgivere, konsulent og seksjonssjef) nærmer seg universell utforming i form av tilrettelegging for studentene. De forklarer at normalløsningen for eksamensgjennomføring i dag er vanskelig å benytte for studenter med funksjonsnedsettelser: *«Det er vel det vi kaller tilrettelegging. Eksamenskontoret jobber mye med tilrettelegging i form av både fysiske og digitale hjelpemidler.».* Informantene forteller at hovedmålsettingen med digitalisert eksamensavvikling er å styrke studentenes læringsutbytte, gjennom bruk av nyskapende og studentaktive læringsformer som likner på arbeidshverdagen studentene skal ut i. Det påpekes at en målsetting med digital eksamen er å heve kvaliteten på eksamensarbeidet i alle ledd, samt å innhente effektiviserings- og forenklingsgevinster gjennom automatisk dataflyt mellom ulike systemer. Videre opplever informantene at mange gjennomfører eksamen raskere når de har mulighet for å jobbe dynamisk (klippe, flytte, slette, redigere). Det er imidlertid ikke alltid hensiktsmessig å digitalisere eksamen. For eksempel forteller informant I1 at 80 % av studentene innenfor kjemifag er fornøyde med digital gjennomføring, mens 20 % opplever det som tungvint å tegne formler og figurer. Det er også enkelte spesifikke utfordringer knyttet til universell utforming: om en eksamen gjennomføres med Insperas Safe Exam Browser (SEB) eller WISEflows FLOWlock – nettlesere som sperrer tilgang til andre programmer for å forebygge juks – forteller informantene at de er nødt til å gå utenom sikker nettleser for studenter som har behov for tekniske hjelpemidler. Dette løses blant annet ved å ta eksamen utenfor løsningen med tradisjonell tilrettelegging, eller ved å skru av sikker nettleser og øke vakthold i eksamenslokalet for å sikre at studenten ikke jukser

Tung individuell tilretteleggingsprosess: Det pekes videre på at individuell tilrettelegging er en tung administrativ prosess for både den enkelte student og institusjonen. For å få eksamenstilrettelegging må studenten først søke eksamenskontoret eller studieavdelingen. Når søknaden er mottatt avholdes et internt møte, med eksamenskontor, faglærer og eventuelt faglig leder, der det drøftes mulig tilrettelegging. Deretter blir det avholdt møte med studenten, der det i fellesskap enes om tilretteleggingen.

4.2.1 Oppsummering fra Intervjuer med UH-sektoren

Institusjonene gjør individuell tilrettelegging for enkeltstudenter fremfor å finne universelle løsninger. Tilretteleggingen beskrives som en lang og kostbar prosess, både for institusjonene og studentene. Det er usikkerhet rundt hvilke tekniske krav til universell utforming som kan stilles til tilbydere av digitale eksamensløsninger. Det virker å være et behov for å øke praksiskompetansen på universell utforming.

4.3 Intervjuer: Informanter fra Tilbyderne

Én representant for hver av de to største norske tilbyderne innen digitale eksamensløsninger er intervjuet. Etter ønske fra informantene oppgis ikke hvem som representerer WISEflow, og hvem som representerer Inspera. I stedet refereres det til Informant fra T1 (Tilbyder 1) og Informant fra T2 (Tilbyder 2).

Lite etterspørsel etter universell utforming fra UH-sektoren: Begge tilbyderne opplever seg omfattet av DTL da de leverer løsninger til offentlig sektor, og at løsningen derfor som hovedprinsipp skal være tilgjengelig for alle, uten behov for tilrettelegging. Universell utforming forstås som inkludering av grupper som ellers kan oppleve ekskludering, og beskrives av T1 som ufravikelige krav ved utvikling av nye grensesnitt. De fokuserer derfor på å lage tilgjengelig kjernefunksjonalitet – arbeidsflyt fra innlogging til levering av besvarelse – basert på WCAG 2.0, i tråd med norsk lovgiving og for å unngå å ekskludere studenter. Deres mål er at kjernefunksjonalitet skal fungere for alle, uavhengig av funksjonshemming. Utover kjernefunksjonaliteten har universell utforming lite fokus, og det oppfattes at dette først og fremst kommer av lite etterspørsel fra kundene (UH-sektoren). Det bekreftes at UH-sektoren ikke etterspør universelt utformede løsninger, men heller løsninger med mye og bred funksjonalitet: *«Det finnes nesten ikke et eneste innmeldt krav om universell utforming i forhold til funksjonalitet»* – Informant fra T1.

Videre forteller tilbyderne om hyppige kundemøter og samarbeid med Utdanningsdirektoratet, for å komme frem til gode løsninger på konkret funksjonalitet. Mens tilbyderne har teknologikompetanse, har Utdanningsdirektoratet kunnskap om hvordan digitale prøver og oppgavetyper bør utformes. Tilbyderen T1 har hatt fokus på universell utforming i erfaringsseminarer som avholdes med UH-sektoren, blant annet ved å invitere fagmiljøer som forklarer universell utforming i praksis. T1 har erfart at engasjementet øker når kundene får en demonstrasjon av hva universell utforming innebærer; *«Det viktigste begrepet er at det inkluderer flest mulig. Inkludering er et bedre ord fordi det er et valg man tar, mens universell utforming er hardt og kjipt pga. sjekklister og krav. Inkludering er hyggelig å snakke om.».*

God kompetanse på brukskvalitet og universell utforming: T1 forteller at virksomheten han representerer har et bevisst forhold til brukskvalitet, men noe mindre på universell utforming. Han beskriver at kompetansen har økt siste året, med eksplisitte krav til nettløsninger og kursing av designere og grensesnittutviklere. T1 vurderer deres eksamensløsning som middels god i forhold til universell utforming: *«Dagens løsning oppfyller mange krav, men ikke alle. Dagens løsning bruker en teknologi som ikke er skalerbar. På grunn av dette lager vi en helt ny løsning som blir tilgjengelig for eksamen høsten 2016. Denne skal oppfylle kravene, og være universelt utformet.».* I dag gjennomføres tekniske tester med et dedikert testteam. Parallelt er det inngått samarbeid med eksterne ekspertmiljøer, for å systematisere kvalitetssikringen av universell utforming i eksisterende og nye løsninger. T1 peker på at ikke all funksjonalitet skal følge WCAG 2.0, for eksempel ved oppgaver der studenter kun skal høre lydopptak én gang, og derfor må fratas muligheten for å styre lyd. Funksjonalitetsbeskrivelser brytes derfor ned til brukerhistorier, som refererer til WCAG 2.0-krav.

Virksomheten T2 representerer har to brukskvalitetseksperter med ansvar for universell utforming og brukeropplevelse. Disse vurderer løsninger opp mot kvalitet internt før overlevering til kunde. T2 vurderer deres løsning som svært god: *«Har ingen områder hvor vi tenker vi er dårlige, vi er veldig bevisste på det. Dersom man bruker teknologien for sikker nettlesereksamen, setter denne noen begrensninger til at man ikke fritt kan bruke forskjellige skjermlesere. Men vi prøver hele tiden å utfordre oss selv, og finne løsninger slik at systemet fungerer for alle.»*

Klare for å levere: Informantene forteller at er det til nå har vært det manglende fokuset innad i virksomheten som har hemmet realiseringen av universell utforming. Tradisjonelt har tilbyderne prioritert å teste andre ting enn tilgjengelighet, da universelt utformede løsninger har vært lite etterspurt. Det er fokus fra begge tilbydere på å levere de løsningene UH-sektoren trenger og ønsker. Den mest fremmende faktoren for realisering av universell utforming hos tilbyderne er risikoen for å miste kunder dersom løsningene ikke er universelt utformet. Kostnader i forbindelse med utskifting av teknologi nevnes som den siste hemmende faktoren.

4.2.2 Oppsummering fra Intervjuer med Tilbydere

Begge tilbyderne er bevisste på hva som *ikke* er godt nok i forhold til universell utforming i dagens eksamensløsninger; blant annet oppfylles ikke alltid lovpålagte WCAG 2.0 krav for kjernefunksjonalitet. I dag opplever de universell utforming som et overordnet premiss fra UH-sektoren, uten definerte krav. Tilbyderne formidler høy kompetanse i forhold til å kunne innfri dagens forskriftskrav til all relevant funksjonalitet, og ønsker økt fokus på universell utforming og sikring av brukskvalitet velkommen.

5 DRØFTING

Først, knyttet til *'Hvilken kompetanse på universell utforming finner vi i norske UH-institusjoner, og hvordan forholder de seg til dagens lovgiving (DTL)?'* finner vi at det er uklar kompetanse på og ansvar for universell utforming i anskaffelsesprosesser, og et manglende fokus i kravspesifikasjoner og manglende kvalitetssikring av løsninger. Norske UH-institusjoner har kommet godt i gang med innføring av digitale eksamensløsninger, og har grunnleggende forståelse av hva universell utforming er. Imidlertid er det en manglende praksiskompetanse på universell utforming i anskaffelsesprosessene. I tillegg plasseres gjerne ansvaret for å sikre universell utforming hos tilbyderne av eksamensløsningene, noe som ikke samsvarer med dagens lovverk. I DTL (Barne- og likestillingsdepartementet, 2013) og tilhørende forskrifter (Kommunal- og moderniseringsdepartementet, 2013; 2017) finner vi at det ledelsen i utdanningsinstitusjonene som er den juridisk ansvarlige part for at all IKT som er en integrert del av virksomhetens undervisning eller informasjonsformidling, og som virksomheten har innflytelse over, er universelt utformet. Dette inkludert alle typer digitale læringsmidler ("nettbaserte redskaper som kan brukes i det pedagogiske arbeidet, og som er utviklet med hensikt å støtte læringsaktiviteter"). Lovverket leses slik at ledelsene ved norske UH-institusjoner fra 1.1.2019 må forvente å kunne få både bøter fra DIFI og søksmål fra studenter og interesseorganisasjoner dersom dette ennå ikke er på stell.

Informantene ønsker klarere rutiner og ansvarsplassering. Med ny forskrift gjeldende fra 1.1.2018, peker vår studie på at en slik klargjøring absolutt er nødvendig. I tillegg peker empiriske data knyttet til suksessfaktorer for universell utforming i IKT-prosjekter på viktigheten av å inkludere personer med funksjonsnedsettelser inn i utdanningsmiljøer for å styrke bevissthet om og kompetanse på universell utforming (Harder & Begnum, 2016). Det å ha funksjonshemmede medstudenter og kolleger er viktig for å forankre forståelse av funksjonshemmedes utfordringer, muligheter, hjelpemiddelteknologi, og forenkler også brukerinvolvering og kvalitetssikring av løsninger ved å ha tilgjengelig eksperttestere med hjelpemiddelkompetanse og praktisk forståelse av universell utforming. Vi oppfordrer derfor UH-sektoren til å ansette personer med funksjonsnedsettelser i faglige og administrative stillinger, som et ledd i å øke kompetanse, bevisstgjøring og kvalitetssikring.

Vårt andre forskningsspørsmål '*Hva er dagens praksis i norske UH-institusjoner for å ivareta universell utforming i anskaffelse og bruk av digitale eksamensløsninger?'* avdekker at ikke spesifiseres eksplisitte krav til universell utfordring til tilbyderne utover kvalitative beskrivelser, ut fra en oppfatning av at tilbyderne da ikke vil kunne levere egnede løsninger. Dette fremstår som en ukorrekt antakelse fra UH-institusjonene basert på tilbydernes tilbakemeldinger. Tilbyderne ønsker å bidra med å hjelpe institusjonene i UH-sektoren med inkludering, men oppfatter på sin side at det kommer få krav. Dette antar vi de har helt rett i, siden det samstemmer for begge tilbyderne og med informasjonen gitt fra informantene i UH-sektoren. Studien avdekker dermed at tilbyderne vektlegger universell utforming som prinsipielt krav, men i praksis er løsningene funksjonalitetsrettede, i tråd med det de opplever at UH-sektoren etterspør. Det er videre manglende klarhet i hvem som har ansvaret for å ivareta universell utforming i bestilte eksamensløsninger, ikke bare internt i institusjonene, men også mellom institusjonen og tilbyder. Dette synes å være en ytterligere medvirkende faktor til at det i dag stilles få konkrete krav til universell utforming fra UH-sektoren til tilbyderne, inkludert få krav til testing, og det er manglende intern kvalitetskontroll hos tilbyderne før løsninger settes i drift. Studien avdekker også at tilbyderne tester løsningene med ekspertvurderinger, som det er strid om hvorvidt er tilstrekkelig for å avdekke faktiske tilgjengelighetsproblemer (bl.a. i Petrie og Kheir, 2007). Tilbyderne er klar over svakheter i nåværende kvalitetssikringspraksis.

Sluttresultatet er at digitale eksamensløsninger fremdeles krever individuell tilrettelegging. Informantene fremstår å føle personlig ansvar for at alle studenter skal få et tilrettelagt studietilbud, inkludert eksaminering. Det er derfor en kultur for å individuelt tilrettelegge, heller enn å arbeide mot universelt utformede normalløsninger. Ut fra beskrivelsene til informantene fremstår dette som en veldig kostbar prosess, både for administrasjon, faglærer, student og i enkelte tilfeller også ledelsen, der søknader utarbeides og behandles, flere møter holdes og alternative tilrettelegginger må utarbeides og vurderes.

I forhold til vårt tredje forskningsspørsmål, *'Hva er de potensielle forbedringsområdene knyttet til identifiserte praksiser i norsk UH-sektorer?'*, har vi identifisert følgende forbedringsområder:

5.1 Universelle løsninger er kostnadsbesparende

Dagens digitale eksamensløsninger krever fremdeles individuell tilrettelegging, som er en relativt kostbar prosess både for administrasjon, faglærer, student og i enkelte tilfeller også ledelsen, i form av saksgang og møtevirksomhet, planlegging og gjennomføring. Med digitalisering av faglig evaluering fremstår det et mulighetsrom for både økonomisk og menneskelig ressursinnsparing dersom det etableres flere universelt utformede fellesløsninger. Dette anser vi som et uutnyttet mulighetsrom. Målsettingen om effektiviserings- og forenklingsgevinster antas å kunne tas ut i større grad dersom eksamenstilretteleggingen vris fra individuelle tilpasninger over mot universelle løsninger. Det antas at en minskning i arbeidsbyrden for den enkelte student også vil kunne lette studiehverdagen og øke progresjon og trivsel. I tillegg vil studenter *uten* behov som utløser tilretteleggingskrav få dra nytte av universelle løsninger med høy fleksibilitet og brukskvalitet for alle, jmf. Iwarsson og Ståhl (2003). Potensielt vil en kostnadsbesparelse fra universelle løsninger også kunne tas ut i økt assistanse og veiledning fra fagmiljøer på tilrettelegging til studenter og fagansatte. Det kan for eksempel åpnes for mulighet til både bevisstgjøring og kompetanseheving for faglærere, som i dag har relativt uklare retningslinjer for hva som forventes, hvilke behov ulike studentgrupper kan ha og hvordan institusjonene ser at man legger til rette for universell utforming av læring (UDL). Vårt første tiltakspunkt for sektoren er derfor å øke fokuset på å få etablert universelt utformede normalløsninger.

5.2 Still klarere krav til universel brukskvalitet!

De to hovedleverandørene av digitale eksamensløsninger i norsk UH-sektor i dag synes å være Inspera og WISEflow. Disse tilbyderne fremstår å ha god teknisk kompetanse på universell utforming, og være i stand til å håndtere langt større kravsbyrde for å sikre tilgjengelighet og universell brukskvalitet i både kjerne- og oppgavefunksjonalitet. De er også svært positive til et slikt fokus. De er klar over eksisterende svakheter i deres nåværende løsninger, og hvordan disse kan løses. Det er altså *ikke* et teknisk kompetanseproblem hos tilbyderne å sikre universell utforming i digitale eksamensløsninger. Likevel er hovedregelen at universell utforming *ikke* defineres i kravspesifikasjoner ved anskaffelse av digital eksamensløsninger. Det fremstår også uriktig å vurdere pålegg om universell utforming i all relevant funksjonalitet som en uforholdsmessig byrde for UH-sektorens eksamensløsninger. Hovedproblemet synes rett og slett å være at få eller ingen krav til universell utforming blir stilt, og at de krav som stilles er overordnede og lite spesifikke, og nedprioriteres i forhold til funksjonalitetskrav. Dette bør endres.

UH-sektoren anbefales derfor som andre tiltakspunkt å benytte den foreslåtte kravspesifikasjonen for universell brukskvalitet i digitale eksamensløsninger fra Begnum og Foss-Pedersen (2017) som grunnlag for sine kravspesifikasjoner). Basert på en revidering av UNINETTs tentative kravsett til universell utforming. spesifiseres konkrete teknisk tilgjengelighetskrav og kvalitative vurderinger som samlet gir et svært godt grunnlag for å sikring universell brukskvalitet i digitale eksamensløsninger. Den universelle brukskvaliteten kravspesifikasjonen speiler er absolutt oppnåelig i dag, da den er utarbeidet på basis av ekspertevalueringer av nåværende kvalitet i Inspera og WISEflow sine digitale eksamensløsninger. Begrepet «universell brukskvalitet» er valgt i stedet for «universell utforming» da brukskvalitet handler om anvendbarhet, effektivitet og tilfredsstillelse for brukerne. Begrepet 'universell brukskvalitet' anses derfor mer beskrivende og dekkende for dagens digitale eksamensløsninger.

5.3 Ansvarliggjør tilbyder for teknisk tilgjengelighet

Resultatene indikerer et behov for tydeliggjøring av ansvarsroller mellom parter i anskaffelsesprosesser. Ettersom tilbyderne leverer til offentlig sektor har de, og tar de, et ansvar for å levere universelt utformede løsninger, uavhengig av kravspesifikasjoner. Det er likevel UH-sektoren som sitter med ansvaret for å påse at løsningene de anskaffer oppfyller lovverket. Det vil derfor være hensiktsmessig å innføre en todelt kvalitetssikringsprosess: 1) teknisk ekspertvurdering og 2) brukerinvolvert utprøving i praksis. Vi foreslår at gjennomgang av tilgjengelighet, inkludert kvalitative beskrivelser, gjøres av tilbyderne. Ansvaret for å sikre tilgjengelighet kan gjerne ligge hos tilbyderne, da disse har teknisk kompetanse, og det er mulig å spesifisere klare krav til teknisk tilgjengelighet innenfor lovverkets forskrift (eksempelvis WCAG 2.0 og hjelpemiddelteknologikompatibilitet). Vi anbefaler derfor som tredje tiltakspunkt å ansvarliggjøre tilbydere for teknisk tilgjengelighet ved å eksplisitt etterspørre dette i kravspesifikasjon, anbud og kontraktinngåelse.

Tilbydere tipses å se på foreslått rammeverk for ekspertevaluering av universell utformingskvalitet (UD-Q) i Begnum og Foss-Pedersen (2017) og Foss-Pedersen (2016). Slike interne kvalitetssjekker anbefales gjennomført underveis i hver utviklingsperiode på spesifikk ny funksjonalitet, i tillegg til en endelig gjennomgang av all funksjonalitet ved levering.

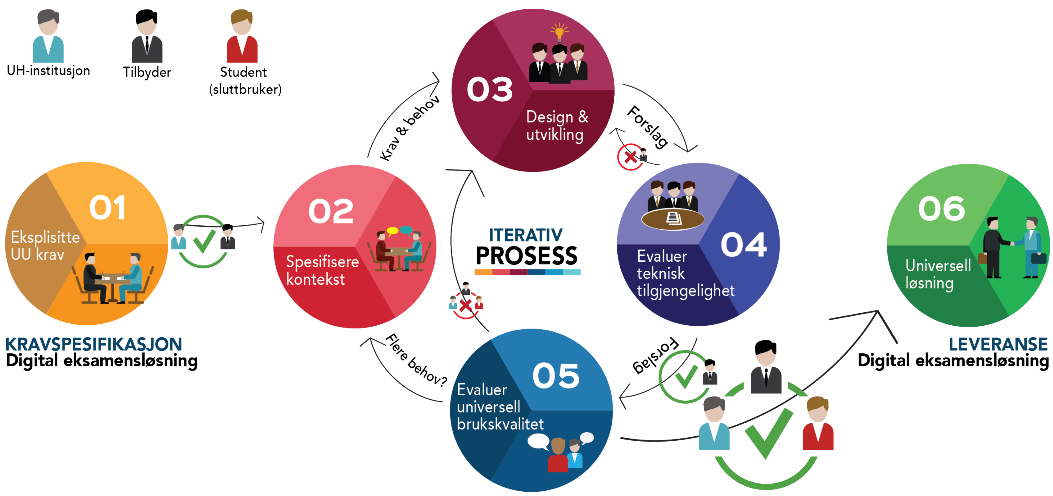
5.4 Kvalitetssikre gjennom brukertesting

Det synes videre å være lite strukturert og mangelfull kvalitetskontroll av universell utforming både i anskaffelsesprosesser (for eksempel kravspesifikasjon og kundemøter), og i overlevering av endelige løsninger (akseptansetester). Samtidig er det altså nå tydeliggjort gjennom ny forskrift til forskrift om DTL at lovverket gjelder for UH-sektoren, og at institusjonenes ledelse står ansvarlig. For å kunne sikre universell utforming i praksis, og både oppfylle lovverket og dokumentere institusjonenes arbeid for dette, anbefaler vi at praktisk utprøving gjennomføres i samarbeid mellom tilbydere og institusjoner i forbindelse med akseptansetester. Her anbefaler vi at funksjonalitet piloteres i ekte brukskontekster, med avansert hjelpemiddelteknologi og reelle sluttbrukere. Økt fokus på å sikre brukskvaliteten i løsningene vil være positivt for både ansatte og studenter. Å velge tilbydere som har et etablert brukskvalitetsfokus vil kunne være en fordel for å øke fokus på kvalitet fremfor kvantitet i funksjonalitet. Begge tilbyderne har i dette utvalget har i det siste økt sin kompetanse på brukskvalitet, men benytter seg i liten grad av brukerkontakt for å kvalitetssikre løsninger. Funksjonalitet som skal implementeres beskrives med brukerhistorier og scenarier, som indikerer at det finnes etablerte metoder for å få innsikt i hvem brukerne er, og bruke denne informasjonen i utviklingsløpet. Spesifisering av kontekstuelle brukskrav og behov baseres på informasjon fra institusjonene. Dette er ikke nødvendigvis feil, da institusjonene har tilgang til brukergruppene og erfaring med bruken av systemet, men ekte brukere bør inkluderes i kvalitetssikring og test. Vi ser fra IKT-sektoren at det er et stort overlapp mellom brukskvalitetsarbeid, brukersentrering og universell utforming, og videre at DTL gir en positiv effekt og brukes som ”brekkstang” for å øke prioriteringen av brukersentrering og brukertesting av universell utforming (bl.a. i Harder og Begnum, 2016). Vårt fjerde tiltakspunkt er derfor rettet økt kvalitetskontroll av universell brukskvalitet i praksis.

5.5 Prosessmodell for anskaffelse og utvikling foreslås

Studien har identifisert sentrale forbedringsområder fra institusjonene knyttet til anskaffelsesprosessene; manglende kompetanse om tekniske muligheter og mulig kravspesifisering, få klare krav til universell utforming, uklare ansvarsroller og manglende praktisk brukskvalitetstesting av løsninger. Derfor foreslås det en prosessmodell for anskaffelse- og utvikling. Prosessmodellen presenteres i Figur 5. Den legger opp til strukturerte kvalitetssikringsprosesser med tydelig ansvarsplassering og kravkompetanse, og. søker å ivareta dagens utviklingspraksis samtidig som den øker kvalitetssikring og brukerinvolvering, og understøtter tiltakspunktene beskrevet i 5.2- 5.4.

I den første fasen foreslås det å definere eksplisitte krav til universell utforming sett i sammenheng med den løsningen som skal anskaffes eller utvikles. Gjennom modellen foreslås at dette gjøres i samarbeid mellom UH-institusjonene og tilbyderne, før man går videre til spesifisering av konteksten. Når kravene og behovene (konteksten) er spesifisert går tilbyderne inn i en iterativ utviklingsfase, hvor løsningen skal designes, implementeres og evalueres i henhold til spesifikasjoner. Det foreslås at evalueringer av den tekniske tilgjengeligheten, som i modellen spesifiseres skal gjøres av tilbyderne som fase 4, og itererer med fase 3 design-og utvikling helt til løsningen har tilstrekkelig teknisk tilgjengelighet. Dette er altså en iterativ prosess inne i en iterativ prosess. Først etter ”bestått” intern kvalitetssjekk (antatt tilgjengelighetstest og ekspertevaluering etter WCAG 2.0 og spesifikke krav til teknisk tilgjengelighet) foreslås det at løsningen, det vil si funksjonalitet implementert så langt, gis videre til UH-institusjonen for brukerinvolvering.



Figur 5: Prosessmodell for anskaffelse av digitale eksamensløsninger

Som Figur 5 viser, legger modellen opp til at UH-institusjonen utfører evalueringen av den universelle brukskvaliteten gjennom studentinvolvering. Her kan løsningen bli godkjent, underkjent eller godkjent men flere behov gjenstår (for eksempel ytterligere funksjonalitet). Fasene 2-5 vil derfor gjentas iterativt inntil løsningen blir akseptert, og tilbydere overleverer løsningen til UH-institusjonen. Ansvaret for å gjennomføre og iterativt følge opp testresultater før løsninger går i drift foreslås å ligge hos UH-institusjonene, da det er institusjonene som vil kunne saksøkes ved brudd på lovverket, som kan innhente behov og erfaringer fra studenter, og som kan fastsette eksamensformer og brukskontekster for digital eksamen i studieplaner. Vi håper prosessmodellen vil kunne støtte kvalitetsprosesser for sikring av universell utforming i anskaffelse og utvikling av digitale læringsverktøy, visualisere faser, ansvar og roller, stimulere til økt brukerkontakt og bidra til å avdekke problemer med tilgjengeligheten i en tidlig fase. Vi foreslår derfor som vårt femte, og siste, tiltakspunkt at UH-institusjoner skjeler til dette prosessforslaget ved anskaffelse av e-læringsverktøy.

6 KONKLUSJON

Formålet med artikkelen er å gi økt kunnskap om hvordan UH-sektoren i dag forholder seg til universell utforming ved utvikling og anskaffelse av digitale eksamensløsninger. Fra spørreundersøkelser og intervjuer med ansatte i ved UH-institusjoner knyttet til forskningsspørsmålet *'Hvilken kompetanse på universell utforming finner vi i norske UH-institusjoner, og hvordan forholder de seg til dagens lovgiving (DTL)?* avdekker studien at:

- Det er god teoretisk kjennskap til universell utforming, men
- Uklart hvem som har ansvar for å sikre universell utforming i praksis, og
- Uklarhet rundt hvilke krav til tilgjengelighet og universell utforming som er realistisk å stille tilbydere.
- Individuelle tilretteleggingsprosesser er ressurskrevende for både student, administrasjon og fagmiljø.

Tilknyttet spørsmålet *'Hva er dagens praksis i norske UH-institusjoner for å ivareta universell utforming i anskaffelse og bruk av digitale eksamensløsninger?'* indikerer svarene at:

- Institusjonenes eksamensløsninger varierer, men felles er at det er få universelle normalløsninger.
- Individuell tilrettelegging benyttes fremfor målrettet arbeid for å sikre universelle normalløsninger.
- Det er lite konkret etterspørsel etter universell utforming fra UH-institusjonene, og
- Funksjonalitetsbehov er i fokus, der funksjonsrike løsninger bestilles.
- Det er svak kvalitetskontroll av universell og praktisk brukskvalitet, både fra tilbydere og institusjoner.
- Tilbydere har kompetanse på brukskvalitet og universell utforming, men prioriterer nå funksjonskrav,
- Tilbydere er klare til å levere både brukskvalitet og universell utforming ved konkretisert etterspørsel.

Til sist spør vi *'Hva er de potensielle forbedringsområdene knyttet til identifiserte praksiser i norsk UH-sektorer?'* finner vi følgende: Det viser det seg at tilbydere både er kompetente på og interesserte i å levere løsninger med høyere universell utformingskvalitet enn i dag. Informasjon både fra UH-institusjoner og tilbydere peker imidlertid på at manglende kompetanse om tekniske muligheter og egen ansvarsrolle fra institusjonene fører til få klare krav fra sektoren som en del av kravspesifikasjonen. Det kommer frem at i dagens digitaliseringsprosesser kommer universell utforming derfor først inn som en faktor etter at mulige funksjonelle løsninger har blitt identifisert. Også kvalitetssikringen av universell utforming er svak. Institusjonene ender dermed opp med funksjonalitetstette normalløsninger uten kvalitetskontroll av universell utforming, som gjør det vanskelig for studenter med en funksjonshemming å gjennomføre eksamen. Dette fører til at mulighetsrommet for kostnadsreduksjon på individuell tilrettelegging gjennom universelle digitale løsninger ikke utnyttes. På basis av denne studien kan vi oppsummert og relatert til forskningsspørsmål si at de identifiserte hovedutfordringene er knyttet til:

- manglende kunnskap om tekniske muligheter hos institusjoner i UH-sektoren,
- manglende bevissthet om juridisk ansvarsrolle hos UH-institusjoner
- uklar ansvarsfordeling for universell utforming i samarbeidet mellom institusjoner og tilbydere,
- manglende fokus på universell utforming generelt og i kravspesifikasjoner,
- manglende fokus på kvalitetssikring av universell utforming og manglende praktisk brukertesting,
- uutnyttede muligheter for kost-reduksjon tilknyttet tilretteleggingsarbeid i UH-institusjonene.

Med dette som bakgrunn foreslås følgende fem tiltakspunkter til UH-sektoren: 1) flytt fokus fra individuell tilrettelegging til universelle løsninger i institusjonene med mål om å forenkle og effektivisere tilrettelegging. Samtidig vil da flere studenter få tilgang til et universelt utformet miljø. 2) bruk eksplisitte krav til universell brukskvalitet i kravspesifikasjonen, gjerne gjennom foreslåtte kravspesifikasjon for digitale eksamensløsninger presentert i Begnum og Foss-Pedersen (2017), 3) avklar ansvar for teknisk tilgjengelighet hos tilbydere, 4) det institusjonelle ansvaret for universell brukskvalitet i praksis anbefales sikret gjennom brukerinvolvert testing og evaluering før aksept, og 5) baser anskaffelsesprosesser på artikkelens foreslåtte prosessmodell. Studien skisserer en strukturert prosessmodell for anskaffelse og utviklingspraksis tilknyttet digitale eksamensløsninger, som ivaretar presenterte tiltakspunkter og kvalitetssikrer universell utforming. Vi anbefaler en iterativ kvalitetstesting etter modellen for å unngå en situasjon der en nesten ferdig utviklet funksjonalitetstett løsning viser seg å fungere dårlig i praksis.

6.1 Videre forskning

Oppfølgingsstudier: Denne studien er ikke uten svakheter. Det vil særlig være aktuelt med uttesting og videreutvikling av foreslåtte prosessmodell. Videre har det skjedd store endringer i sektoren, men sammenslåinger av institusjoner og et endret norsk UH-landskap. Teknologiutviklingen går raskt i sektoren. Det er derfor behov for nye vurderinger av universell utformingsaspekter i endelig kravspesifikasjoner for digitale eksamener fra UNINETT (DIFI, 2015) og jevnlig re-evaluering av digitale eksamensløsninger mot målt kvalitetsnivå i dag (for eksempel under vurderingsrammeverk foreslått i Begnum og Foss-Pedersen, 2017) er også ønskede videre studier. Det er nødvendig å fortsette arbeidet med å kartlegge i hvilken grad andre e-læringsverktøy i UH-sektoren utover eksamensløsningene forholder seg til universell utforming, og kanskje spesielt etter det nå pågående arbeidet ned innføring av ”nye” LMSer i sektoren (som Blackboard og Canvas).

Det er relevant med flere case studier hos UH-institusjoner for å se på hvordan universelle eksamensløsninger kan bidra til redusert behov for individuell tilrettelegging, og med mer spesifikke intervensjoner tilknyttet dreiing fra tilrettelegging for få til universelt utformede løsninger for alle. Fra et pedagogisk perspektiv vil det også være interessant å undersøke hvilke generelle pedagogiske implikasjoner og muligheter digitalisert evaluering innebærer. Det vil være interessant å se effekten av en tydeliggjort DTL lovgiving i sektoren frem mot fristene 1.1.2018 (ikrafttredelse), 1.1.2019 (krav må være på plass i nye og oppdaterte løsninger) og 1.1.2021 (krav må være på plass i alle eksisterende løsninger).

Kompetanseheving og bevisstgjøring: Juridisk ansvar for universell brukskvalitet i praksis ligger nå tydelig plassert hos UH-institusjonene. Det kan være behov for ytterligere opplæring i dette ansvaret i sektoren, utover å lese DTL med tilhørende forskrift, og her kan UH-sektorens interne kompetanse gjerne utnyttes og samles. Informantene er positive til intern kompetansesamling og tydeligere krav. Både tilretteleggingssentrene, administrativt ansatte ved markedsføringsavdelingene og fagmiljøer innen eksempelvis spesialpedagogikk, helse, design og teknologifag være aktuelle å dra veksel på. UH-sektoren kan også be om bistand både fra Universell, DIFI, studentorganisasjoner og interesseorganisasjoner for personer med funksjonsnedsettelser, i tillegg til at det internasjonale forskningsfokuset på temaet øker. Videre studier kan med fordel se på mulige intervensjoner på flere nivåer i UH-sektoren.

Effektmål for digitale læringsverktøy: Inntrykket er bestemt at universell utforming blir nedprioritert til fordel for funksjonalitetsbehov, og at fokuset er på å sikre rik funksjonalitet for å gi mange muligheter til ulike former for faglige evalueringer. Dette er ikke nødvendigvis et gode for faglærere og studenter, som må forholde seg til komplekse systemer, som gjerne er vanskeligere å forstå og krever økt støtte fra administrasjonen. Unødig kompleksitet og funksjonalitet bør unngås, og spesielt i forhold til personer med nedsatt syn, kognisjon og konsentrasjonsevne. Det er ikke nødvendigvis slik at *alle* vurderingsformer bør digitaliseres. Imidlertid oppgis få refleksjoner rundt pedagogiske muligheter tilknyttet digital eksamen. I stedet for å digitalisere alle eksamensformer, vil det kunne være mer verdifullt å se på *når* digitalisering bidrar kostnadseffektivt. Krav om universelle løsninger – som i seg selv er kostnadsreduserende – bør da tas med som faktor. Når målet er arbeidsrelevant evaluering, kan det for eksempel tillates hjelpemidler - da vil komplekse og kostbare løsninger som SEB, med medførende universell utforming utfordringer, kunne unngås. Det ville også være interessant å følge med på om gjennomføringsgraden for studenter med funksjonsnedsettelser vil øke med innføring av universelle løsninger. Dersom flere studenter få tilgang til et universelt utformet læringsmiljø, bør dette videre minske antall tunge tilretteleggingsprosesser for studenter, faglærere og administrasjon og slik forenkle studiehverdagen til utsatte studenter (og slik gi grunnlag for å øke progresjon), og fristille ressursbruk fra administrasjon til andre tilretteleggingstiltak – for eksempel gi veiledning til faglærere. Dette kan måles, som indikatorer for at ønsket måloppnåelse med digitale læringsverktøy.

TAKK

En varm takk til alle informanter, responderende UH-institusjoner, Inspera, WISEflow og UNINETT.

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Towards Inclusive Service Design in the Digital Society: Current Practices and Future Recommendations

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Abstract

The field of service design (SD) is fast growing. SD methodology focuses on ensuring positive user experiences across types of touch-points, types of mediums used (digital, paper, TV, radio etc.), devices (mobile, web), platforms (iOS, Android, MS, Linux), browsers, usage situations, weathers (rain, sunshine, cold weather) and so forth. However, universal design (UD) related to SD is under-researched. This paper aims to increase the knowledge of UD in SD. An exploratory approach is used to gather information, including a literature study and an interview study. Our findings show that UD awareness is lacking. Processes are highly qualitative – seeking to understand the user. However, marginalized users are not included. Based on the findings, we suggest six initiatives to promote a more inclusive SD methodology: 1) Define UD in relation to services, 2) Change the legislated focus from digital touchpoints to holistic costumer journeys, 3) Make service designers accountable for UD aspects, 4) Add UD aspects in early design-up-front, 5) Promote marginalized user focus during design and 6) Integrate UD aspects in higher education on SD. Further, we propose the following definition of UD in SD: "*A service is universally designed when its costumer journeys are usable to all people, to the greatest extent possible, without the need for adaptation or specialized design apart from choosing preferred touchpoints*".

Keywords: Universal design, Inclusive design, Service design, Legislation, Education, Methodology, User involvement, Disabled user groups, Digital exclusion

1 Introduction

As products and services are becoming more integrated and complex, service designers are considered likely to heavily impact the shape and form of future eCommerce and eGovernment services (Scott, Delone & Golden, 2016). SD is as a design approach to make services user friendly, easy and intuitive (Curedale, 2013). It is a fairly new discipline, and does not yet have a clear definition, though there are many suggestions (Schneider et.al., 2012). As a general goal, UD aims to contribute to equal participation and gender equality in the population, regardless of individual assumptions (Steinfeld & Maisel, 2012). A universally designed society aims at giving more people the opportunity to work, and decrease the need for specialized adaptions. One may predict the need for universally designed services is likely to grow, as it is estimated that by 2050 approximately 21% of the world population will be over 60 years old. In 1950, the number was 8% (Keates, 2015). With higher age, many different challenges and needs can occur for the mainstream population (John Clarkson & Coleman, 2015; Keates, 2015). However, the inclusion of UD aspects in SD is unclear. Santana et al. reports UD is absent in SD literature, (2017).

This paper investigates how we can move towards inclusive SD. We ask:
1) Too what degree is there UD awareness in current SD methodology and practice?
2) In what ways can findings contribute to strengthen the awareness of UD in the field of SD?
The contribution and audience of the paper is two-fold; 1) an academic contribution to strengthen the body of knowledge on the status of UD practice within SD and 2) proposing ways this knowledge can be utilized to improve the UD quality of SD practice. The structure of the paper is as follows: In Section 2, we view the current status of the field. Section 3 outlines our research approach and Section 4 our findings. In Section 5 we discuss and answer our research questions. Finally, Section 6 concludes and suggests future work.

2 Background

SD emerged as a design profession around 2000 (Sangiorgi & Prendiville, 2014). The essence of SD is the merge of digital, intangible and physical touchpoints to form a holistic costumer journey experience, taking into account both provider, technological potentials, users behavior and attitudes towards the service (Polaine, Løvlie & Reason, 2013; Reim, Parida & Örtqvist, 2015). Nordic countries are increasingly utilizing service digitalization, and SD is as such a fast-growing design discipline (Chakravorti, 2017; Rosenzweig, 2015). Service designers are involved in private, public and business service creation, administration and digitalization (Kuk & Janssen, 2013; Steen, Manschot & Koning, 2011). Norway is a leading country when it comes to the use of SD in public sector, as well as digitalization in society (AHO, 2016). Patrício, Fisk, Falcão e Cunha and Constantine express the need for more research on SD (2011), as it is still a young disciple.

UD is the design of products and environments to be usable to all people, to the greatest extent possible (Law, Yi, Choi & Jacko, 2008). UD and inclusive design is often referred to as synonymous principles (John Clarkson & Coleman, 2015; Goodman-Deane, Langdon & Clarkson, 2010; Wilkinson & De Angeli, 2014). When designing for a wide population, one creates services and product easier to use for everyone. UD can be viewed as a necessity for someone, but an advantage for everybody (Rotvik, 2014). Currently, both public sector and private businesses that target the public offering ICT-based solutions to the Norwegian public are obligated to ensure that these are universally designed (BLD, 2016; BLD, 201). Current legislation regarding UD is focused on Web Content Accessibility Guidelines (WCAG). WCAG is a set of guidelines to help make web content available for as many users as possible, including people with disabilities such as blind, deafness, learning disabilities, cognitive limitations, speech disabilities and so on (W3C, 2008). Norwegian regulations specify WCAG 2.0 must be followed for all digital touchpoints – such as web services and app’s (KMD, 2013). However, even though technical accessibility guidelines are followed, there can still be needs and barriers that are not covered. UD thus needs to be more than a list of criteria (Johnsen, 2017). Other sets of UD legislation relevant for service designers are those related to buildings, environments, transport and self-service automats.

Service experiences have changed in recent years with new and advanced technology (Ostrom et al., 2015). Some authors claim that customer service experiences will become increasingly important to separate one provider from another, and to add costumer value (Patrício et al., 2008). Customer experience encompasses several aspect of a company, and service designers acknowledges this importance when designing services (Teixeira et al., 2012). If people feel included and well taken care of the chances that they return as costumers are high (Vandermerwe & Rada, 1988). As positive effects of inclusive services are not only limited to the individual and his/her families but extends to the society, UD may increase business for companies in terms of a wider costumer base (John Clarkson & Coleman, 2015). Users are commonly included in the SD process (Schneider et al., 2012). With technical support, services can also make a customer a co-creator in real time, and tailor the service and adapt to customer needs over time (Patrício, Fisk & Falcão e Cunha, 2008).

3 Research Approach

Our overall research approach is exploratory and qualitative (Marshall & Rossman 2011; Merriam, 2009). We explore practices currently established in SD in a literature study, including the degree of inclusive aspects, UD awareness and types of users receiving focus. As Merriam notes, qualitative research is typically focused on aspects such understanding how people interpret their experiences (Merriam, 2009, p. 5), which is the focus of our interview study (Lazar, Feng & Hochheiser, 2010, p. 181). The literature study and interviews are conducted and analyzed iteratively and in parallel to answer our research questions.

3.1 Literature Study

NTNU`s Oria library is used to search databases in the category “design”, where 15 databases are identified. Since UD emerged around 2000, the search was limited to year 2000 and forward. We combine “newness” (updated knowledge, thus relevant) with “impact” (utilized knowledge, thus relevant) by including articles cited by 45 or more. This limited us to databases that could sort by citation; ACM Digital Library, Scopus and Web of Science. 175 articles were screened for relevance, using the inclusion criteria: a) the work is within or about SD, and b) the work reports on SD practice (and not just theoretical discussions).

Table 1. Search Results and Screening Results.

Database	Search	Results	> 45 citations	Included
ACM Dig. Lib.	“service design” in proceedings (7.12.2017)	224	4	0
	“service design” in journals (7.12.2017)	7	0	0
Web of Science	“service design” in all articles (17.11.17)	718	28	3
Scopus	“service design” in all articles (21.11.17)	2466	163	13 (10 new)
Total		**3415**	**175**	**13**

As Table 1 shows, search results from the databases overlap. As Scopus returned all the included articles, and had, overall, the most citations, citation counts from Scopus become the standard count. Note that ACM returned 290 results, but could not be limited to "articles". We chose to screen "ACM proceedings" and "ACM journals" only – excluding magazines and newsletters. After screening, our included article sample consists of 13 articles (see Table 2).

Table 2. Articles Included in the Literature Study Sample.

Article	Citations
1. Service Design for Experience-Centric Services (Zomerdijk & Voss, 2009)	207
2. Key strategies for the successful involvement of customers in the co-creation of new technology-based services (Kristensson, Matthing, & Johansson, 2008)	154
3. Designing Multi-Interface Service Experiences (Patrício et al., 2008)	124
4. Multilevel Service Design: From Customer Value Constellation to Service Experience Blueprinting (Patrício et al., 2011)	110
5. Toward an integrative approach to designing service experiences Lessons learned from the theatre (Stuart & Tax, 2004)	73
6. Field trial of Tiraisu: crowd-sourcing bus arrival times to spur co-design (Zimmerman et al., 2011)	66
7. Customer experience modeling: from customer experience to service design (Teixeira et al., 2012)	61
8. Strategies for designing and developing services for manufacturing firms (Tan, Matzen, McAloone, & Evans, 2010)	60
9. A Qualitative Cross-National Study of Cultural Influences on Mobile Data Service Design (Choi, Lee, Kim, & Jeon, 2005)	54
10. Designing for Service as One Way of Designing Services (Kimbell & Kimbell, 2011)	52
11. Understanding service experience in non-profit performing arts: Implications for operations and service management (Hume, Sullivan Mort, Liesch, & Winzar, 2006)	49
12. Managing User Involvement in Service Innovation (Magnusson, Matthing, & Kristensson, 2016)	48
13. Requirements engineering for e-Government services: A citizen-centric approach and case study (van Velsen, van der Geest, ter Hedde, & Derks, 2009)	47

Included articles were read multiple times to map the following topics; 1) methods used, 2) overall design approach, 3) user groups involved and focus on marginalized users, and 4) whether inclusive design or UD is mentioned or reflected upon. All articles were searched for the words: impairment, handicap, disabled, blind, deaf, wheelchair, special need and cognitive. Further, summarized information and other relevant information was extracted, including which service areas and topics are commonly repeated through many of the articles.

3.2 Exploratory Interviews

The interviews are semi-structured (Lazar et al., 2010). Table 3 overviews the focus of the 17 questions in the interview guide and type of data collected. To identify potential biases (Lazar et al., 2010) a pilot test was conducted prior to interviews. The only inclusion criterion for informants is that they work as service designers. Convenience sampling via e-mail was used, approaching 13 companies. The companies then forwarded the email to appropriate candidates. Audio recording is used, in 60 minutes one-on-one interviews. Free and informed consent was given, and interviews were transcribed and anonymized continuously to ensure the privacy of the informants (Torp, 2016). Transcribed material was transferred to NVivo for emergent coding, as we had no established theories (Lazar et al., 2010).. An inductive approach was used to analyze, without the purpose of generalization. The texts were read several times to identify themes that emerge from the data, supported by the audio files.

Table 3. Interview Guide Overview.

	Interview focus	Question	Data
Research Question 1	Self-rated service- and UD competence.	3,4	Quantitative
	How is UD included in current practice.	5,6	Qualitative
	Methods and processes utilized in current practice.	10,11,12	Both
	Which users are involved (if any) and how.	13,14,15	Both
Research Question 2	Ideal manner to do UD in service design	7	Qualitative
	What promotes UD in service design	8	Qualitative
	What obstructs UD in service design	9	Qualitative
	Background, age, workplace, title, experience	1,2,16,17	Both

4 Results

4.1 Literature Study

The literature study paints the most positive picture of the degree of awareness on UD, with 23% mentioning catering to users with special needs: Kristensson et al. (2008), van Velsen et al. (2009) and Zimmerman et al. (2011). Still, 77 % do not mention special needs, disabled or marginalized users and none of the articles emphasize inclusive aspects or use the terms universal- or inclusive design. Process approaches are overall qualitative, and user centered, with eight of the 13 articles mentioning co-creating as a design strategy (61 %). Only Velsen et al. (2009) includes marginalized users, since their general target users have special needs.

4.2 Interview Study

We initially intended to recruit 15 informants; however few new insights were made after the initial three interviews. The main reason is assumed to be our limited understanding of the SD field to adequately define the right sub-population to sample. We thus ended the interviews after talking to five informants. None of our informants focus on UD in their daily work, and their UD self-rating is mediocre (3.1 average on scale from 1-7). They all work on projects that target the public, and focus on understanding user needs – however marginalized user focus is lacking. When questioning the service designers on their focus on marginalized users, all the informants seemed to experience discomfort. They all stress user inclusion must be determined based on the project. No one focuses on recruiting marginalized user groups for edge-case design strategies. Thus, discomfort could understandably be related to recognizing their own lack of focus on marginalized users. Still, the results on this item should be analyzed with care due to the input from the informants on relevance.

Two informants mention that UD focus sometimes comes late in the projects, and can therefore be annoying, as they need to adjust design as a result of not including it from the beginning. Methods utilized in SD project seem to be selected dependent on specific project's aims, and informants have freedom to choose the approach and methods they consider most sufficient within resource limitation. Inputs from users are highly appreciated: *"We work very much with including the end user. I usually say that they are the material of a designer - to have an end user and understand the end-user's needs."* (Informant 2).

Table 4. Informants.

Informant	Title	Age	Experience	Workplace
1	Senior Designer	30-39	6 years	Company 1: Large Consultancy
2	Senior Designer	< 30	5 years	Company 1: Large Consultancy
3	Service Designer	< 30	2 years	Company 2: Large Banking Service
4	Service Designer	< 30	< 1 year	Company 3: Large Consultancy
5	Designer	< 30	5 years	Company 4: Medium Consultancy

Our findings indicate UD is not part of current practice, however four of five express a positive attitude to guidance for inclusive services. They would appreciate a clearer definition of UD within SD, more knowledge on how to ensure inclusiveness in their work, and increased resources to do UD. Three informants state UD should be addressed in SD education. Two of the informants who work as consultants mention that their service providers (customers) also need education on the importance of UD. One informant explains that the services or results they deliver generally do not get measured with regards to *any* quality aspects, including UD, and that often they don't know if what they deliver is implemented or not, or how well it is received. All informants are explicit on the fact that UD is not a priority. Although the degree to which they thought UD is their responsibility varied, all informants had ideas about what needs to be done to increase the awareness of UD in SD.

5 Discussion

Both the interview and the literature study show service designers seek to understand users, and work hard to make useful services. However, UD awareness is lacking. Marginalized user groups, including edge-case users within the target group, do not receive focus. This is backed by Santana et.al. (2017, p. 22), who states that "Traditional service design process models are not oriented towards addressing the needs of people with disabilities (...)". As such, our hypothesis is that inclusive aspects are generally not embedded in SD methodology. We propose 6 strategies to promote UD, presented in 5.1-5.6 and visualized in Figure 3.

5.1 Define Universal Design in Service Design Methodology

All informants ask for a clear definition of UD in SD. We believe a clear definition of UD in SD would be beneficial, and propose the following: **"*A service is universally designed when its costumer journeys are usable to all people, to the greatest extent possible, without the need for adaptation or specialized design apart from choosing preferred touchpoints*"**. Not all touchpoints needs to be available to all users, but all users must be able to use the service.

5.2 Increasing Focus through Legislation

The importance of UD is clearly argued for, both from socio-economical and personal needs (BLD, 2016; NHF, 2016). However, the current focus in UD legislation is on specific ICT- or physical *touchpoints* within services. We believe focus on the *whole* costumer journey would better ensure key costumer journeys offered by service providers are accessible to all.

5.3 Service Designer Responsibility

As van Velsen et al. (2009) mention, a team need to have people that are experts in their field. Harder and Begnum (2017) discovered through their study that it is uncommon to address UD as someone's main discipline, and propose instead to regard UD expertise as added competence within the different team members skillsets. The low UD awareness among in SD is unfortunate as service designers have the holistic view, paying attention to service context, users and provider (Polaine, Løvlie & Reason, 2013). We suggest that service designers could have the overall responsibility for ensuring universally designed services, using our proposed definition. This means the service designer understands and decides the level of UD necessary in each touchpoint for the service to be inclusive overall.

5.4 Inclusive Design Up-Front

If UD is included from the start, the need for redesign later, which is far more costly and time consuming, will be reduced (Sánchez-Gordón and L. Moreno, 2013 and Horton and Sloan, 2014 in Halbach and Fuglerud, 2016). All informants use some kind of "design up-front"-ish approach to map out the service with all the touchpoints, e.g. blueprint. We believe there is a need to update SD methodology to include inclusive aspects in early mapping and planning.

5.5 Marginalized Users in Focus

Methods and processes identified both from literature and industry practices have a high degree of end-user inclusion. However, all informants and all articles have used non-disabled users from their target groups. There is a lack of focus and attention on including people with special needs, and a lack of checkpoints that address different special needs. Harder and Begnum (2017) identifies focus on users with disabilities early and throughout the design process as one characterizing factor for ICT-projects successful in UD. Informants say that they often wish to get users with a greater variety of demographic, for example age and gender. We believe a change of practice towards directly involving marginalized and disabled users to a larger degree would significantly aid in creating more inclusive SD projects. Informants ask for checklist tools or similar to aid in remembering to include special needs from marginalized user groups.

5.6 Knowledge and Education

None of the informants had learned about UD in SD through their studies, or any industry training. More UD in SD education is needed.

5.7 Limitations of the Study

It is common for qualitative research to study a small sample in depth. This makes it is difficult to prove findings can be generalized (Leedy & Ormrod, 2012; Shenton, 2004). When few new insights were made, interviews were ended, as they were considered sufficient for revealing insights at this stage in time. Internal validity is strengthened through audio recordings. However, generally, one would expect a higher number of informants to secure external validity. Also, in some cases interview information might not match what is actually being done, something a case study could help reveal (Leedy & Ormrod, 2012). Further, the literature search returned 3415 results, however only 13 articles were included in the final sample. With an improved search approach, less time could have been spent on screening irrelevant articles that could instead have been utilized to read a larger literature sample. Hindsight also shows it could have been better to focus on “newness” over “impact”. As SD is an emerging field, our cut-off at 45 citations may be problematic, as new and relevant studies does not necessary have this citation count yet.

Figure 3. Proposed Strategies to Promote Inclusive Service Design Practices.

6 Conclusion

This paper investigates the degree of awareness of UD in current SD practices. Through a literature survey and an interview study we find that UD awareness is severely lacking. We identify challenges related to knowledge, responsibility and methodology. We believe updating SD methodology to better support UD should be the next steps – ensuring flexible, sensitive and inclusive services, and further that a clear definition of UD for service designers would be a major contribution to raising awareness. Based on the findings, we propose a) a course of actions in order to promote awareness of UD in the field of SD, b) a possible definition of UD in SD. First, we suggest 6 action points: 1) Create a *definition* of UD in SD, 2) Legislate inclusive service *chains*, not only accessible touchpoints, 3) Give service designers the overall *responsibility* to consider UD and inclusiveness across the service chain, 4) ensure focus on UD in early SD methodology, 5) increase involvement of *marginalized* user group, and 6) increase UD focus in SD *education*. Second, we propose the following definition of a universally designed service: *“A service is universally designed when its costumer journeys are usable to all people, to the greatest extent possible, without the need for adaptation or specialized design apart from choosing preferred touchpoints”.*

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Identifying Five Archetypes of Interaction Design Professionals and their Universal Design Expertise

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Abstract

Systems and services based on ICT (Information and Communications Technology) are now prevalent in our daily lives. Digital transformations have been, and are still being, initiated across private and public sectors. As such, the consequences of digital exclusion are severe – and may block access to key aspects of modern life, such as education, employment, consumerism, and health services. In order to combat this, regions and countries such as the US, Canada, EU, and Scandinavia have all legislated universal design in relation to ICT, in order to ensure as many citizens as possible have the opportunity to access and use digital information and services. However, there has been limited research into how higher educational programs address legislated accessibility responsibilities. This paper looks into the discipline of interaction design (IxD). IxD is the design domain focused on "how human beings relate to other human beings through the mediating influence of products" Buchanan (2001:112). The study presents an analysis of Norwegian higher educational programs within IxD. Based on document analysis, we map the skillsets the study programs state to deliver, and investigate to what degree universal design expertise is included. Our findings indicate the study programs do not deliver adequate training in universal design, in order to fulfill the professional responsibilities related to ICT accessibility. From our findings, we extrapolate five "archetypes" of interaction designers. These personas-like analytical constructs hold slightly different characteristics. For each of the five, we propose universal design expertise fitting key skillsets. We hope our contributions are useful both for the higher education sector and the industry, and will contribute to raised awareness of universal design skills so they can educate interaction designers in their different industry roles with required competences.

Highlights:

- We indicate the current content of interaction design programs in higher education, and document the lacking focus on universal design.
- We identify five different archetypes of interaction designers being educated in such programs. We describe key skillsets and strengths for each archetype.
- We propose universal design expertise for the interaction design profession, and link universal design expertise to archetype skillsets to emphasize relevance.

Keywords:

interaction design, human-computer interaction, universal design, inclusive design, accessibility, educational programs.

1. INTRODUCTION

Universal design guidelines have been continuously strengthened in national and international legislation over the last decades (Hosein, 2004; UN, 2006; US, 2008; European Commission, 2010; Access, 2010; Norwegian Ministry of Children, Equality and Social Inclusion, 2013; EU, 2016a; EU, 2016b; Norwegian Ministry of Local Government and Modernization**,** 2017). This reflects the need to ensure that as many people as possible have similar opportunities to access and use digital information and services with the increase in digitalized services delivered to the public through web and mobile interfaces, including eCommerce, eGovernment and social media (European Commission, 2017). Further, large technical companies (such as Apple) now provide accessibility and design guidelines as well as libraries of components tested for universal design compliance.

The idea of universal design (UD) is to develop products, environments and services that make usage possible for all intended users, to the largest extent possible (Difi, 2017). Technical accessibility is a key aspect in universal design of ICT regulations. Usable accessibility is to a lesser degree emphasized in legislation, though the new EU WAD directive (2018) demands accessibility statements from providers of ICT-solutions, and further the ability for end-users to give feedback.

So far, little attention has been given to studying universal design competencies needed for interaction designers. Further, there has been limited research into the skillsets provided to ICT-professionals through higher education (HE). The readiness of academic training to address universal design as part of interaction design education is thus uncertain.

This study contributes to the articulation of universal design expertise for interaction design professionals, by exploring current educational content in IxD HE programs. Three research questions are addressed:

1. *To what extent, if any, is universal design expertise included in IxD HE study programs?*
2. *What are the abstract archetypes representing interaction design professionals?*
3. *What is the universal design expertise needed by these interaction design professionals?*

The paper aims to shed light on the different skillsets currently highlighted in Norwegian HE IxD programs, including the extent to which universal design competences are included. This should be of interest to industry, students, and educators. Further, we make a theoretical contribution to the field of interaction design by proposing and discussing the needed universal design competence for IxD professionals. Although the empirical data for this study is from a Norwegian context, we believe our findings will be relevant to an international audience, as we extrapolate abstract archetypes of interaction designers from our data, and discuss the necessary universal design expertise in relation to these constructs.

The rest of this paper is organized as follows: Section 2 proves a theoretical framework for the terms "interaction design" (IxD) and "universal design" (UD). Section 3 outlines our methodological approach. Findings are presented in Section 4, followed by a discussion and concluding remarks in Sections 5 and 6. The article closes by calling for further research.

2. THEORETICAL FRAMEWORK

2.1 Interaction Design

Bill Moggridge and Bill Verplank supposedly coined the term "interaction design" in the mid-1980s. A challenge to the interaction design discipline is that an "interaction designer" is not a protected title (Fallman, 2008). Thus, professionals using this "title" may thus have various skillsets and backgrounds (Sørum and Pettersen, 2016). However, Buchanan (2001, p. 112) offers a good definition of the field of IxD, cited by many. He explains that IxD is the design of "action" – focused on how human beings relate to other human beings through the mediating influence of products.

Similarly to Buchanan, Jensen (1998 p. 189-190) describes how “interaction” in informatics mainly refers to human-machine interaction, while the concept of “interaction” in media and communication studies refers to the actions of an audience or recipients in relation to media content. This includes the communication between people mediated by a machine (computer mediated communication).. Kolko (2010) also aligns with Buchanan as he states a “simpler way of thinking about Interaction Designers is that they are the shapers of behavior” (p. 12), and views “interactions” as “experiences” (p. 5).

Buchanan (2001) explains how IxD can take on a variety of forms in order to solve how to plan an action, create a concrete form of experience, and evaluate the consequences of an action. He notes that new digital mediums are shaping the discipline, but underscores that IxD may also utilize physical objects, experiences, activities, or services. This is an apt observation. In relation to the development of ICT, the role of interaction designers is typically interpreted as constructing interface level opportunities and actions for tasks and processes that users encounter in software and information systems (Rosenfeld and Morville, 2002; Cooper, Reimann, & Cronin, 2007).

Crampton Smith summarizes IxD as “shaping our everyday life through digital artifacts—for work, for play, and for entertainment” (2007). Lowgren (2013) proposes to define IxD as “shaping digital things (including media) for people’s use”, which is likely more aligned with how IxD is viewed in industry today. These propositions limit the scope of IxD compared to the established IxD domain definitions, which specifies that IxD is not limited to digital (technological) interfaces.

As such, the academic field of IxD is well aligned in the broad view of the domain of IxD. Further, we are aware of the more limited modern use of the term in relation to the IT-industry, where digital (technological) interfaces are currently in focus. Emerging technologies creating new interactions, such as embedded and ubiquitous computing, are likely to continuously change the field of IxD. We thus believe that limiting IxD is unwise, and draw on Buchanan, Jensen, Kolko and Crampton Smith in our view of IxD as a discipline focused on how to design users’ experiences when interacting with various products, over time and in their context of use. As Buchanan (2001) noted, IxD may cover digital, emotional, and physical aspects in the dialogue between users and systems. Thus our use of the term “product” is broad, spanning digital interfaces, physical products, interactive technologies, media channels or services.

2.2 Universal Design Expertise in Interaction Design

Universal design is about designing products and environments for the broadest possible range of users (Bergman et al., 1996; Connell et al., 1997). Adaptations may complement the design, as specified in the UN Convention on the Rights of Persons with Disabilities (UN CRPD): “Universal design shall not exclude assistive devices for particular groups of persons with disabilities where this is needed” (UN, 2006, Article 2). Some regard universal design as a separate discipline, however we argue that this is not a viable approach. Instead, we see universal design needs to be interpreted and applied in the context of each field. For example, universal design is something different in the field of architecture than in the field of informatics.

This view is in line with the legislation and regulations on universal design. Universal design legislation typically demand efforts to ensure that all citizens can make use of digital services regardless of the context of use or their abilities or disabilities (UN, 2006; Hosein, 2004; US, 2008; Access, 2010; Norwegian Ministry of Children, Equality and Social Inclusion, 2017). They are however general, and extended by regulations in different areas. The Academic Network of European Disability experts (ANED, 2013) reports there is specificity of accessibility requirements for some goods and services, in some EU countries. Existing regulations typically focus on the areas of public accommodations (in particular transportation), built environments (including automats and elevators), broadcasting, telecommunications, and ICT, (in particular web-based solutions).

Accessibility is nowadays used interchangeably with universal design, though the overlap between "universal design" and related terms are still debated (including "design for all", "universal access" and "inclusive design"). Accessibility and usability are considered well-established concepts in particular for user interfaces and websites (Petrie and Kheir, 2007:387). Accessibility is defined as: the "usability of a product, service, environment or facility by people with the widest range of capabilities" (ISO, 2010). Usability can be defined as: "the extent to which a system, product or service can be used by specified users to achieve specified goals, with effectiveness, efficiency and satisfaction, in a specified context of use" (ISO, 2010), and plays an important role in designing positive experiences with digital solutions.

Universal design expertise for interaction designers has not yet been established. For the field of IxD, our view is that universal design expertise should be applied to make sure the products and the user interactions with products offer positive experiences to as many users as possible, over time and in their context of use.

Universal Design of Digital Products

Looking into the currently existing regulations, several refer to digital products. Universal design regulations for ICT-solutions typically point to technical accessibility guidelines and standards for digital solutions, such as the WCAG guidelines developed by the WAI section of the World Wide Web Consortium (W3C, 1997). Accessibility is commonly regarded as the basis for ensuring universal design of ICT: "The power of the Web is in its universality. Access by everyone regardless of disability is an essential aspect" (W3C, 1997). However, there is increasing consensus on guidelines and standards not being enough to ensure universal design (Rømen & Svanæs, 2011; Power et. al 2012). For ICT-solutions, the term "accessibility" is sometimes split into "technical accessibility" and "usable accessibility" (Paddison & Englefield, 2003; Petrie & Kheir, 2007). The split emphasizes the importance of considering usability aspects (ease of use) for a wide range of users in universal design.

Some technical strategies ensure the necessary flexibility to achieve universal design of ICT. Through dialogue independency the presentation layer of a system is separated from semantic and syntactic layers (i.e. the logic of and interaction to/from the system) (Dong, 2007). This enables the users to choose, adapt, modify, specify, or design interfaces and/or interaction styles for themselves to match their own needs (Hartson & Hix, 1989). Further, multi-modality allows different interactions forms for input and output; e.g. selecting speech recognition, computer mouse, or keyboard as input, and audio or visual output. These strategies are commonly used as best practice for usability as well as accessibility aspects.

Universal Design of Physical Products & Services

The 7 principles for universal design, developed by The Center for Universal design, is an important set of guidelines for product design (Weightman & McDonagh, 2003). They are: 1) perceptible information, 2) low physical effort, 3) size and 4) space for approach and use, 5) tolerance for error, 6) flexibility and 7) equitable, simple and intuitive use. The principles highlight physical and ergonomic aspects of accessibility.

There are no clear accessibility regulations for physical, manufactured products. For services, only digital "touchpoints" (user-service interaction points) are covered through ICT regulations. However, based on ANED (2013) report and the UN CRPD Article 9 calling for legislation, a new EU directive is proposed on accessibility of products and services (EU, 2016b). The proposal is an Annex to the European Accessibility Act (EAA) by the European Commission (2015). A set of accessibility guidelines for the design and production of products and services is proposed. Compared to the universal design principles, they appear measurable and tailored to specific types of products and services. They extend user interface and functionality design, e.g. including packaging and instructions for use where relevant. Accessibility is described as achieved by the removal and prevention of barriers, preferably through a universal design or "design for all" approaches (§25).

Combining Guidelines & User-Centered Approaches

The use of guidelines is recognized as a good, cheap basis for integrating the needs of people with varying abilities into design at an early phase, and both the principles for universal design and WCAG guidelines are extensively used. Still, guidelines are as critiqued for not being able to cover all case-specific possible usage issues. To increase the capability of professionals to detect usage problems beyond guidelines (and determine if guideline is counterproductive), recommendations are adding awareness of user diversity, knowledge of user needs and increasing designer (or developer) empathy for users. For example, Ferri, Bardzell, and Bardzell (2017) make a case for complementing assistive technology focus with an empathic design approach for anti-ageist design.

Most design approaches suggested for ensuring universal design are user-centered; extending the notion of the "user" to encompass disabled, "edge-case" (representing a challenge or situation that occurs at an extreme setting or condition) and other marginalized user groups. User Centered Design (UCD) – also called Human Centered Design (HCD) – is commonly used in IxD, and defined as an "approach to systems design and development that aims to make interactive systems more usable by focusing on the use of the system and applying human factors/ergonomics and usability knowledge and techniques" (ISO, 2010 p. 2). The starting point for universal design initiatives is typically to recognize human diversity, with the aim of creating solutions that stretch to the edges in the scatterplot of human needs.

In order to ensure universal design of an end-result, universal design expertise must be embedded into discipline-specific approaches. Efforts in this regard are being made. Newell, Gregor, Morgan, Pullin & Macaulay (2011) suggests an edge-case inclusive and sensitive user-centered design strategy, fostering relationship between designers and users. Santana et al. (2017) notes how traditional service design is not oriented towards addressing the needs of people with disabilities. By considering "edge-case" users in the design and evaluation of touchpoints and user experience journeys, one move towards ensuring universal design of services (Bue & Begnum, 2018).

One can also reflect on universal design of products by separating 1) basic material (digital or physical, also spatial), 2) user-product interactions, and 3) product content (or end-aim). When all "layers" are accessible and usable for all users (or as many as possible), universal design is achieved. This way of approaching universal design is in use in the IT-industry (e.g. by Funka Nu Inc.) to ensure universal design of web solutions. Here, layer 1 covers technical accessibility (including compliance with assistive technologies, in addition to following current coding and accessibility standards). Level 2 refers to the usability and accessibility of the user interactions and the user interface design (including understandability, navigational structure, digital ergonomics, and visual design), and level 3 audits the digitalized content (text, video, images, audio and multimedia content). Standards and guidelines are important for ensuring good universal design on some of the aspects reflected by these product layers, while utilizing inclusive user-centered design approaches (including user testing with disabled users and assistive technologies) is recommended to ensure universal design overall.

Knowledge of User Needs

On the topic of user knowledge, users to be included in universal design strategies are often those representing main bodily disabilities, such as visual, motor, hearing, and cognitive impairments. On visual impairments, one must separate between blind users and users with reduced vision. In addition, those suffering from color-blindness are often considered; usually focused on the main types of green/red and blue/yellow distinction. For blind users, guide dog needs must also be considered. In order to facilitate empathy, persons with motor impairments are often split into those with permanent disabilities and those with injuries. Wheel-chair users receive a lot of attention, and their needs largely cover what is need by persons with strollers or walking aids. Further, persons with reading- and writing difficulties (including dyslexia) is a large user group. Finally, elderly are typically considered.

Sometimes, we see that quite “young” elderly users are receiving focus in digital design. However, Slettemeås (2014) points to the fact that based on statistics, it typically the older elderly users (e.g. above 80 years) that are in danger of digital exclusion. He also identifies that non-western first-immigration non-native speakers and persons outside of the job marked (e.g. unemployed or on disability leave) are in danger of digital exclusion. Depending on the type of product designed, one needs to consider additional user groups, apart from disabled users. Further, the context of use and likely emotional states should be considered. For example, anxiety aspects may be important to consider if designing products used in stressful or high-pressure situation. We also see designers becoming more aware of usage aspects related to fatigue.

In current universal design legislation, the “right-based” and “social-gap” views on disabilities are evident. The right-based model, states disabilities should not affect a person's opportunities for participating in the society, nor the access to products, goods, and services. The social disability model focuses on the societal responsibility to remove attitudes, physical and social barriers that exclude from participation. The stance is disabilities are mainly socially created, rising from the gap between user capabilities and the product or contextual demands. This is called the “gap-model” on disability. The gap-model also fit the social-adapted model, which acknowledges individual disabilities as somewhat limiting in themselves, but holds that socially created disabilities is the main issue, and the bio-psychosocial model used by WHO (ICF 2002, p. 10), which also defines a disability by the interaction between bodily functions and specific social contexts. Note that many more disability models exist, however the gap-model is particularly useful for (interaction) designers, as it integrates user capabilities, product aspects, emotions, actions and contexts of use.

Continuous Expansions on UD Regulations

Universal design legislations and regulations are continuously updated. On the area of ICT, the EU Web Accessibility Directive (WAD) went into force September 23rd 2018 (EU 2016a). WAD regulates universal design criteria for websites and mobile applications in public sectors. WAD refers to the EN 301 549 standard, which was recently updated to include the new version 2.1 of the Web Content Accessibility Guidelines (WCAG) from the Web Accessibility Initiative (WAI). As such, EU now adheres to a newer WCAG version than comparable regulations. In addition, WAD legislates user feedback opportunities and inclusion specifications (explaining which user groups are excluded from usage, if any, and providing reasons why) from solution providers. We now await local updates from non-EU countries. For example, the Norwegian universal design of ICT regulations are currently being re-written in accordance with WAD, and we do not yet know if both public and private sectors will be covered by stricter WCAG criteria, user inclusion specification and user feedback options.

Regarding the proposed EAA Annex directive on products and services, in addition to design and development criteria, the current version suggests that all “economic operators” should be responsible for the accessibility compliance of products and services, in relation to their respective roles in the supply chain (EU, 2016b, at 9). “Economic operators” cover, in addition to procurers, distributors, and service providers, “any natural or legal person who manufactures a product or has a product designed, or manufactured” — which includes interaction designers. In line with this, there is an increased need to determine relevant universal design expertise for interaction designers, and make sure we include these competences in our educational programs and teach students how to apply universal design expertise to IxD work.

2.3 Summary of Theoretical Framework

Based on related research, universal design is seen as a professional add-on expertise that should be integrated into professional activities. IxD is a discipline focused on how to design users’ experiences when interacting with various products, over time and in their context of use. As such, universal design in the context of IxD is viewed as focused on how to make sure user interactions with various products offer positive experiences to as many users as possible, over time and in their context of use.

We treat the terms "universal design" and "accessibility" as overlapping; however both accessibility aspects related to spatial, physical, and technical issues, and aspects related to understandability, operability and visibility (sometimes referred to as "usable accessibility" in the case of digital products) must be ensured. It can be useful to separate products into different layers for ensuring universal design, separating basic material, user interaction, and content accessibility. Depending on the professional role of the interaction designer, he or she must understand the universal design aspects relevant for the design of users' experiences on either of these product layers, over time and in their context of use.

Depending on the professional role of the interaction designer, he or she must thusly be prepared to know relevant standards and guidelines for technological as well as physical design aspects, and know fitting methodological universal design approaches. The shift from "traditional" to "universal" approaches typically lies in broadening the view of the users, considering extreme users or context-of-use (edge-case design). The interaction designer thus needs end-user knowledge on relevant user groups (including disabilities), and when and how to include marginalized users in user-centered processes, design to fit these user needs, foster user empathy, and triangulate knowledge of situated user needs with established guidelines.

3. METHODOLOGY

While quantitative research concerns the systematic investigation of phenomena via statistical and mathematical logic, qualitative methodology provides an understanding of why and how elements are interrelated via analytical logic (George & Bennett, 2005; Yin, 2012). When we want to study phenomena in-depth and in their respective context, we need to use a qualitative research strategy. Thus, to articulate which competences and skillsets, and universal design expertise in particular, educational institutions offer achieved through their study programs, a qualitative multiple case study design is the most appropriate. A multiple case study enables the researcher to explore differences both within and between cases, and to draw comparisons (Yin, 2003, cited in Baxter & Jack, 2008).

Moreover, document analysis is our main tool to gain an in-depth, rich understanding of HE IxD educational programs and their universal design focus, as it provides a highly complex textual dataset to analyze inductively (Andersen, 2013; Yin, 2012). Our aim is not to generalize our findings statistically, but analytically (Yin, 2012). This is illustrated in the personas-based "archetypes" created based on key tendencies revealed in the analysis, which is presented later in this article.

The archetypes are abstract and analytical representations of how the study programs are represented online, and not based on a case study of "real people". Note that we make the assumption that Norwegian HE IxD study programs deliver according to the online descriptions, as in Norway program course tables, course description, learning outcomes and pedagogical approaches presented to students are legally binding. From the key tendencies in these empirical data, we build abstract and theoretical constructs.

In our approach, the archetypes are utilized similarly to the way "personas" are used in the design (Cooper, 2004). Unlike personas, archetypes are not necessarily focused on representing users or evoking empathy, but rather on describing a high-level "types" for an understanding of traits and characteristics (Mebuke, 2016). By theorizing archetypes and envisioning their skillsets from the empirical findings, we investigate not only the universal design focus of the programs, but also the connection between IxD competencies and universal design expertise. Using this approach, we address our stated research questions:

1. *To what extent, if any, is universal design expertise included in IxD HE study programs?*
2. *What are the abstract archetypes representing interaction design professionals?*
3. *What is the universal design expertise needed by these interaction design professionals?*

As stated in the introduction, the empirical data for this study is from a Norwegian context. However, we believe our findings will be valid outside a Norwegian context, as the archetypes are abstract representations of analytical constructs, and therefore valid regardless the context they derive from (such as the specific educational institution). Analytical constructs are important for theory development and might assist other researchers in reflecting on appropriate universal design expertise for interaction design professionals – regardless of their geographical location. As such, our findings should be of interest to scholars and practitioners internationally, due to the fields' global relevance in a time where the technological development moves fast regardless geographical borders, and where universal design legislation is continuously broadened, specified, and more strongly enforced.

3.1 Step 1: Case Sampling

Since comparisons are drawn between multiple cases, it is imperative that the case sampling process allows for a careful case selection (Yin, 2003, cited in Baxter & Jack, 2008). For case sampling, we used our view of IxD as our main selection criteria. As already stated, we consider IxD as focused on "*how to design users' experiences when interacting with various products, over time and in their context of use*". Any study programs identified as having this focus were included in our sample, regardless of whether the content was focused on digital interfaces, physical products, interactive technologies, media channels or on services, regardless of focus on experiences or products, and regardless of focus on their design or their development.

Our first step was to get an overview of IxD study programs offered in Norway. The search for IxD programs was initiated by entering the websites of all HE institutions in Norway and screen the programs at all departments in media studies, design and informatics/computer science. Then, in-site search features with the search strings "interaction design", and "design" was used for each institution to make sure we did not overlook any relevant programs. Next, we checked the Wikipedia[1] listings of IxD educations available in Norway. We also searched for IxD programs at utdanning.no, which is the official Norwegian national education and career portal, and includes an overview of education in Norway and about 600 career descriptions.[2] Between March 1st and April 18th, 2017, all existing BA and MA programs were mapped, including those that would be run for the first time from the autumn of 2017. Further, we searched the Norwegian Universities and Colleges Admission Service (NUCAS[3]) overview on May 2nd, 2017. NUCAS coordinates the admission to ordinary undergraduate study programs at all public HE institutions in Norway, and to some of the private university colleges. There is no "IxD" classification available for Norwegian HE, so we searched the labels "Design", "Media" and "Technology" (NUCAS, 2017).

Our second step was to screen the programs against our IxD definition, using the program's name and online descriptions. For HE institutions offering several studies within IxD, the decision was made to select the study track with the strongest IxD component. One-year study programs that can be extended into a BA or master's MA degree were omitted, and viewed as parts of the other programs. Combined BA+MA tracks, with recruitment to an MA with an identical name and shared research groups, are analyzed as a single study program.

From this screening and sampling process, ten study programs were identified from ten different HE institutions (see Table 1). The sample includes one college graduate (CG) program, five BA and four MA (of which two 3+2 year tracks, one 2-year track and one 5-year track) degrees. Three of the programs are named "interaction design", while the rest have other name constructs including the term "design" (e.g. "multimedia", "digital" or "ICT"). Four of the HE institutions are Universities and six

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[1] Please refer to https://no.wikipedia.org/wiki/Interaksjonsdesign
[2] Please refer to https://utdanning.no/tema/om_utdanning.no/about_utdanning.no
[3] Please refer to https://www.samordnaopptak.no/info/english/

are University Colleges. Five of the HE institutions are located in the capital of Norway, Oslo. Of the remaining five, one is in Halden, one in Grimstad, one in Gjøvik, one in Bergen, and one in Volda. We anonymize institutions and pseudonymize study programs to "detach" overall findings from specific study programs.

3.2 Step 2: Data Collection and Analysis

In a qualitative study, the sample is typically small, which makes it possible to first study each program in-depth, and then them comparatively in order to identify key tendencies. After the case sampling, data collection and analysis was started with a close reading of program and course descriptions, study aims, and other content details.

The analysis process took place iteratively. The researchers gained an overview of the study programs by a close reading of their profiles, course descriptions, study aims, and other details about the program. For three programs, content or course descriptions were not stated online. The institutions offering these study tracks were contacted by email and the requested descriptions were sent to us via email (HE Institution 2, HE Institution 9, and HE Institution 10in Table 1). These three had not yet finalized all course descriptions. Even so, the content that was available online together with the descriptions received were considered sufficient for the study in relation to the intent, main content and focus of the programs. Against this background, we revealed interesting themes that we wanted to explore systematically and in depth in accordance with our research questions.

On April 18, 2017, the authors met for a full-day workshop, moving from independent impressions to a collaborative analysis. Several half-day or shorter discussions and meetings followed this.

As part of the workshop, each program was first analyzed internally against initial themes. Each program's online presentation was considered through a close analysis of what was stated in the overall description and other official texts posted online by the HE institutions. Each program's content was considered through a systematic thematic analysis of information gathered from course tables, course descriptions and listed topics in mandatory courses (including courses mandatory for IxD specialization tracks), information on approaches to teaching, assessment and learning outcomes (what students are expected to achieve in knowledge, skills and general competences) for each course, and for the program overall..

A known weakness with document analysis concerns epistemological issues. Documents are produced by the respective educational institutions, and we need to be aware that texts are written as "sales documents" (Atkinson & Coffey, 2004) to attract students. Thus, online presentations (what they state) were compared to the content themes (what they provide) for each study program, to check whether these match and gain a more reliable program profile. Thus, as already mentioned, what we study is how institutions represent IxD study programs, not if these institutions deliver what they promise (e.g. through interviews) nor the graduated students (e.g. assessing students competencies).

Next, the study programs were compared to get an overview of their similarities and differences. During the internal and comparative analysis, we continuously coded findings into themes and key characteristics. Thus, our coding of the data emerged as we moved back and forth between the data and our conceptualization of it, and we needed to deconstruct our categories and create new several times as the analysis proceeded. We organized the content analysis by iteratively constructing and deconstructing thematic categories, as suggested by Labuschagne (2003), in order to control validity, and internal and external reliability (Shadish, Cook, & Campbell 2002). Further, this made it possible to compare the study programs with one another thematically, which was essential for developing the archetypes, along with forming an in-depth sense of each study program's characteristics.

The analysis revealed that the programs could be sorted on overall contribution orientation (**societal** or **user** oriented), targeted industry (**media** or **IT**), and the didactic emphasis (on **theoretical** knowledge or **practical** experience). Societal needs are emphasized in some program descriptions, for example highlighting an industry need for the competence taught or for discipline-specific societal opportunities or challenges. These are classified as having a **societal** orientation. Other programs emphasize human aspects more, e.g., highlighting the need to stay user centered and motivating students to make innovations to meet the needs of end-users. These are classified as having a **user** orientation. The orientations may be combined—and thus the categories are not considered mutually exclusive. The analysis further revealed that the study programs reach out to different industries. Only two programs target both **media** and **IT** industries. The didactic approach axis looks at the way the content is taught. **Theoretical** teaching refers to a focus on traditional academic training, with oral and written skills—for example, writing academic essays and discussing fictional cases. **Practical** emphasis, on the other hand, points to teaching in realistic settings, such as through internships or utilizing real-life scenarios. The teaching thus often involves the industry, which typically provides real cases, supervises work, or evaluates student results.

As we delved into the details, we also sorted the programs based on their overall content focus (emphasis on **technology** competence or **design** competence), and their underlying motivation (driven by ethical **values** or by fulfilling **industry** needs). Technology focused programs typically emphasize ability to code and provide front-end or full-stack expertise, providing strong technological and IT competences to the interaction designers. Other programs are more design focused, for example emphasizing creative skillsets and design process knowledge. Studies focusing on utilizing IxD for communication are classified as more design than technology oriented. Industry focus refers to program content emphasizing industry-relevant skills. Value focus refers to exercising ethical considerations, such as an emphasis on user-centered, socio-technical, or societal aspects. Some programs are clearly more **values** or **industry** focused, and clearly emphasize **technology** versus **design**, while others highlight both. We mapped the study programs along the dimensions in a coordinate grid. We identified programs in all four "corners" of the grid, as well as some that fall more towards the center of the grid. At this stage, we started to draft the archetypes from the data set. Finally, we mapped from the content which types of universal design expertise the programs signaled they would teach, and sorted the programs based on their overall degree of universal design focus.

From the comparative analysis, we thus identified key patterns. We used these to identify and describe five "archetype" representations (or abstract personas) of interaction designers. The five archetypes represents key characteristics (or stereotypes of interaction designers), given that the study programs deliver what they state textually in their online study program presentations, and as such indicate what high-level skillset and strengths interaction designers types from this programs would hold.

4. FINDINGS

Table 1[4] is an overview of the ten IxD study programs. All BA programs are full time tracks, while MAs can be taken either full time or part time. Regarding admission requirements, all HE studies have general study competency requirements (GSC). GSC is usually acquired via high school, but may also be obtained via test scores in combination with work experience by older students. The only exception for GSC requirements is one of the private university colleges offering a CG degree, which accepts vocational skills combined with a partly completed GSC upon consideration.

4.1 Universal Design Focus

Although we found a heterogeneous universal design focus across the IxD programs, the main finding is that most programs have a weak or absent focus. There are no distinct differences between Universities and University Colleges. The programs were rated along a continuous scale from "high" to "low" based on their degree of universal design content, including web accessibility and general

[4] (GSC = general study competency, CS = Computer Science, eqv. = equivalent).

focus on inclusiveness across user abilities and contexts of use. Programs in design and IT have a spread in their focus. Media degrees, however, all have a low or absent focus on universal design.

Three IxD study programs are completely **lacking** in any focus on universal design and its related topics (as outlined in the literature section). These studies do not mention any ethical considerations, regulations and laws, or any other related knowledge, skills or general competences related to universal design, design for the elderly, disabled or marginalized users, whether at a course level or at a program level. This is disheartening, as all these programs include courses where universal design competence is needed in order to educate professionals able to fulfill current legislations. For example, these programs educate IxD professionals in web development and visual design, without ensuring they will be able to deliver legal solutions to the market with regards to web accessibility.

Table 1: *Overview of the IxD Study Program Sample (GSC = general study competency, CS = Computer Science, eqv. = equivalent).*

Pseudonym	**Study program characteristics**	**Institution**	**Admission Requirements**
HE Institution 1	Informatics Degree: 3 year BA, full time.	University College, Private	GSC
HE Institution 2	Informatics Degree: 3+2 year BA, full time + MA full/part time.	University, Public	GSC (BA), C+ average BA with 80+ ECTS in CS (MA)
HE Institution 3	Informatics Degree: 2 year MA, full/part time.	University College, Public	BA in Engineering or eqv. BA with 80+ ECTS in CS
HE Institution 4	Design Degree: 5 year MA, full time.	University College, Public	GSC + Passed admission test
HE Institution 5	Media Degree: 3 year BA, full time.	University College, Public	GSC
HE Institution 6	Media Degree: 3 year BA, full time.	University, Public	GSC
HE Institution 7	Media Degree: 3 year BA, full time.	University College, Public	GSC
HE Institution 8	Technology/Media Degree: 3 year BA, full time.	University, Public	GSC
HE Institution 9	Design Degree: 3+2 year BA, full time + MA, full/part time.	University, Public	GSC (BA), BA with 80+ ECTS in CS/design/media (MA)
HE Institution 10	Design Degree: 2 year CG, Full time.	University College, Private	GSC or vocational skills

Four programs are categorized as having a **low** universal design focus. In addition to displaying very limited attention (typically, one single-sentence competence goal within one of the courses), the goals included are focused on theoretical knowledge only. None of the programs with a low universal design focus mention WCAG, other WAI criteria, or universal design principles.

One program is regarded as having a **medium** focus on universal design. This study program includes an expectancy of the ability to apply universal design, and not only a theoretical awareness. WCAG is explicitly mentioned (as an example of universal design guidelines). Still, the universal design focus is limited to two courses relating to web design and web development, with three competence goals on the subject.

Finally, two study programs have a **high** level of universal design focus. These programs have universal design perspectives included in many of their courses where they are relevant to the topic at hand, and are related to actual skillsets as well as to theoretical knowledge. Examples of universal design aspects are: the including of marginalized users in the user research, principles of universal design in user-centered design, adding mobility aspects and emotional aspects to user-experience design, web accessibility topics in courses on web development, color and contrast needs in user-interface design (including color blindness), universal design as innovation strategy (extreme users), teaching inclusive approaches in design methodology, assistive technologies and interaction styles in human-computer interaction courses, etc. Other topics on universal design are more academic, such as defining disability, understanding trends and demographics, and knowledge of universal design terminology, standards, and regulations.

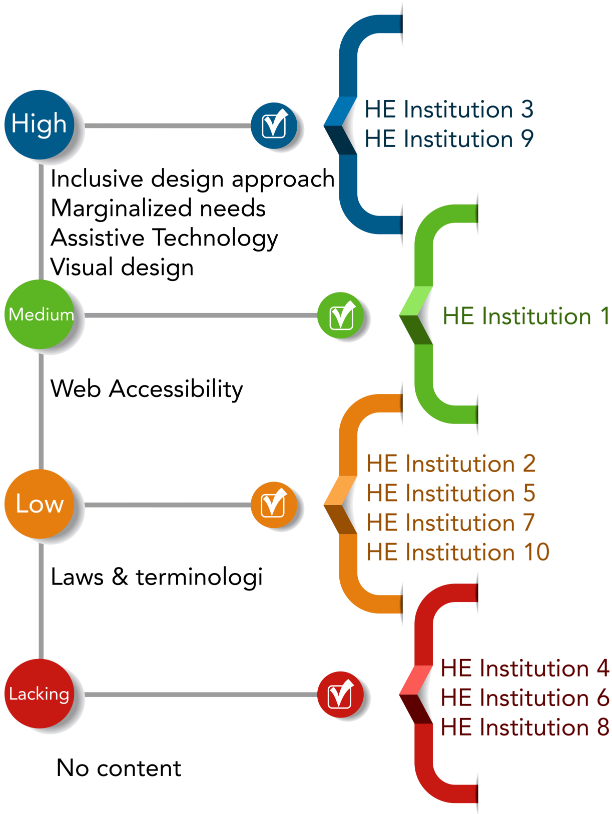

Figure 1: *Universal Design Focus of HE IxD Programs*

Figure 1 presents the program ratings, using their pseudonymized names. In the following sub-section, we briefly present each of the ten study programs, synthesizing the findings per program.

4.2 Presenting the Programs

Table 2 presents a summary of the comparative content analysis sorting, which draws on online program profiling (typically expressing overall intentions with the program, including values, orientations, industry collaboration and motivations), as well as legally binding program learning outcome, legally binding course tables, legally binding course descriptions, legally binding course-level learning outcomes, and to some extent the proposed curriculum (may be subject to change). The legally binding documents provide the basis for assessment of program content, and didactic styles. In some cases the online program profile descriptions did not fully lined up with the legally binding presented content. For example, the profiling may be advertising an intent that is not fully reflected in the formulated learning outcomes. If so, we describe this in the following study program presentations.

Further, study programs could not always be sorted as "either-or" on our analytical dimensions of **societal** or **user oriented** orientation, ethical **values** or **industry** needs as driving motivation, **media** or **IT** industry targeted, emphasis on **technology** or **design** competence, and **theoretical** or **practical** didactical emphasis. The dimension categories are not necessarily mutually exclusive, and program descriptions reflect any ambiguities or dual sorting along the dimensions. However, we are overall able to identify the differences between the programs using these analytical dimensions. Based on comparisons of these extrapolated program traits and of the program content, we are able to create analytical constructs for our abstract archetypes of educated interaction design professionals.

Table 2: *Summary of Comparative Study Program Sorting*

	Key Content Categorization				**Orientation**		**Industry**		**Didactics**	
	Industry	Values	Technology	Design	User	Society	IT	Media	Theory	Realism
HE Institution 1	•		•		•		•			•
HE Institution 2		•	•			•	•		•	
HE Institution 3		•	•			•	•		•	
HE Institution 4		•		•		•	•	•	(•)	•
HE Institution 5	•			•	•			•	•	(•)
HE Institution 6	•			•	•			•		•
HE Institution 7	•			•		•		•	(•)	•
HE Institution 8	•		•	•	•	•		•	•	(•)
HE Institution 9	•	•	•	•	•	•	•	•	(•)	•
HE Institution 10	•	•		•	•		•		(•)	•

4.2.1 HE Institution 1

"You become a technical designer who will master web development and interaction design."

This program results in an IT BA degree and it lacks a clear design focus, but includes several IxD topics. The study is user oriented and front-end focused, and includes web and mobile development and user testing. A medium level universal design focus is provided through the web design and web development courses, focused on web accessibility. The program has an applied focus, incorporates practical casework and portfolio-based evaluation, and many cases are assigned by external clients. Industry collaboration is emphasized, and specifically with the IT-industry.

4.2.2 HE Institution 2

"You understand how IT influences individuals, organizations, and society and vice versa."

This track is also an IT degree with a strong IxD component. Descriptions focus on informatics skills, such as the ability to "explain how computers are built and function" and refer to apps, websites, and programming. User research and design processes are mentioned. The study targets the IT-industry. Both MA and BA offer opportunities for an increased focus on IxD, information design, software engineering, mobile or web technologies etc. Societal value ideals are promoted by an emphasis on awareness of legal obligations, technology as an influencer of organizations and social systems, and the ability "to reflect on key ethical, societal and academic issues related to own and others' work". Courses teaching practical skills and case-based reflection are more prominent in the BA, while theoretical reflection is emphasized at the master's level. Only a low, theoretical focus on universal design is provided. Overall, the emphasis is on analytical reflection and theoretical insights. No industry collaboration is mentioned.

4.2.3 HE Institution 3

"...suited for you who want to be a specialist in universal design of ICT-systems."

This program is also technological and is based on an IT-degree. It is value focused around the topic of universal design, with a societal orientation. There is a strong focus on universal design and accessibility, with social gap and equal rights-based disability model perspectives. Environments can create disability barriers, thus our societal responsibility is to reduce these. The program draws on user-centered design principles, but is otherwise not focused on design. The study program educates candidates for the IT-industry. Emphasis is on analytical reflection and evaluation of existing ICT-solutions, mainly using expert evaluations and technical accessibility checks. Assessments are done through traditional written and oral exams and written hand-ins. There is no apparent industry collaboration or business-related courses.

4.2.4 HE Institution 4

"...educate specialized students with a common grounding in design thinking."

The first three years of this design degree five-year MA may be replaced by a design-discipline BA. The online profile emphasizes design driven processes and design thinking, it highlights the creative aspects and is design oriented. The program presentation does not clearly match the learning outcome descriptions. The industrial design background of the program is evident through courses related to physical production, production technology, and methods. Although the profile states that teaching utilizes external enterprises and industry work environments, it is unclear to what extent industry collaboration and an industry focus are included in the education. A societal orientation with a value focus seems far more prevalent. The students are taught design reflection, design theory, and design methodology; however, universal design perspectives are missing. Portfolio-based evaluations are extensively utilized, but multiple-choice school exams and design reflection hand-in assignments are also included. Students are mainly educated to work within the IT-industry.

4.2.5 HE Institution 5

"...provides you digital competence closely related to creative disciplines."

The online profile describes a study that is closely associated with the media industry. It is however difficult to determine how much practical collaboration with the industry the program offers. No internships, real-life casework, or external project assignments are highlighted, instead, the program seems to value academic writing skills. Thus, the assumption is that the program has more fictional casework and project evaluation. The program has a well-balanced mix of individual portfolio assessments, written and oral school exams, and project reports. The program seems user oriented. The online profile emphasizes creative processes, thus appears design focused. When considering the content of the study program, learning goals are however more focused on technological skills. The study program description is somewhat vague, with quite general learning outcomes, making it hard to pinpoint the true focus. The universal design focus is low and limited to web development.

4.2.6 HE Institution 6

"Teaching takes place in close cooperation with media businesses ..."

This online study program mentions topics such as front-end development, web programming, games, and mobile solutions. It thus seems technological. However, the study content does not clearly fit the online presentation. Based on the specified learning outcomes, it appears that design receives more focus than technology. Both design practice and design theory (ethical and analytical) is covered. Technological competences seem aimed toward utilizing existing digital tools within a media context. Production of media content is included. The program targets the media industry and stresses close industry collaboration. The program is user oriented, but without a strong ideological or value-loaded focus on user-centeredness. Universal design is completely lacking from the program. The study program has an overall assessment style based on fictional casework, with hand-ins of textual reports for grading based on practical assignments, in addition to portfolio-based assessments.

4.2.7 HE Institution 7

"...you design and create content for today's and tomorrow's platforms."

The study is presented as focusing on technology as a mediating platform in society, and has a societal orientation. The program does not have a clear IxD component, but design perspectives are highlighted in designing interactive digital solutions and concepts. The presentation emphasizes web and multimedia, the producing of media content and visual communication. Students are mainly educated to work within the media industry**.** There is not a strong technology focus, instead humanistic perspectives seem to be the influencing factors in the study program. Universal design is given very little focus. The study mentions collaboration with industry, but though teaching and assessment methods are similar to those at HE Institution 6, a close connection to industry seems lacking. An applied focus is present in the program content description, although academic reflections are also taught. Exams are a mix of individual and project work, and include written assignments, case reports, produced work, portfolios, oral exams, and home exams.

4.2.8 HE Institution 8

"...foundation in technology so you can develop complete multimedia products."

This study profile is clearly targeting the media industry. Content wise, it includes graphic design, and 3D visualization, in addition to animation, video-, and audio-production. The IxD component appears weaker than its focus on digital media production. The study is viewed as somewhat society and user oriented, and theoretical reflections as well as design and development skills related to user-friendly solutions are expected. However, no ethical or methodological stances or values are highlighted. Universal design is lacking. Extensive self-study is combined with problem-based learning and workshops. The students are evaluated partly through written hand-ins and partly through practical design and development projects. Portfolio assessment is emphasized. No industry collaboration is mentioned.

4.2.9 HE Institution 9

"... making the world better through designing and building great user interfaces..."

A strong value focus is conveyed in the BA+MA track, together with societal engagement, idealizing contributions to a better world through design, as well as a strong user orientation. User-centered methodology is emphasized. Online profiles fit contents with respect to the emphasis on design skills, including user experience (UX), human factors, service design, information architecture, visual design, and a strong universal design focus. However, in-depth content information reveals that the track also includes technological and industry focuses—e.g. offering web-technology and front-end skills. As such, the education merges the design, technological, industry and value focuses. Reflection and analytical skills are stressed, both as related to practical case experiences and theoretical knowledge. The track focuses on cross-disciplinary teamwork, methodology, and uses case-based learning. Some industry-related practice and collaboration is included, especially at the BA level. Students are mainly educated for the IT-industry.

4.2.10 HE Institution 10

"The job of an interaction designer is to make technology functional and user friendly."

This program is profiled as technology and value focused: understanding human needs and designing and developing websites and apps to bring value to users. When the learning outcomes and program contents are considered, this picture changes slightly. Here, the technological focus is downplayed, whereas the user orientation and value focus remain present. Like the HE Institution 9 program, the study provides a cross-disciplinary introduction to IxD spanning from front-end to service design, but it has a low focus on universal design. The program expects their students to be able to make ethical and methodological reflections. The study appears hands-on and practice-oriented, emphasizing processes in industry and IxD-related teamwork. The study program mainly aims to educate students for the IT-industry, covering design, values, and industry focus.

4.3 Archetypes of Interaction Designer being Educated

In the following section, the five identified archetypes are presented. Based on the data analysis, we find universal design aspects are largely weak or absent in IxD education. Table 3 summarizes key findings on archetypes and universal design, showing the overall weak and lacking focus on universal design in current IxD education.

Table 3: *Summary of Universal Design Focus and Archetype Representations*

	Universal Design Focus	**Archetype Representation**
HE Institution 1	Medium	Front-ender
HE Institution 2	Low	Full-stacker
HE Institution 3	High	Full-stacker
HE Institution 4	Lacking	Design Tinker
HE Institution 5	Low	Communicator
HE Institution 6	Lacking	Communicator
HE Institution 7	Low	Communicator
HE Institution 8	Lacking	Communicator
HE Institution 9	High	User Empath
HE Institution 10	Low	User Empath

4.3.1 The Front-ender

The first theorized type of interaction designer is the Front-ender. The HE Institution 1 program (presented in 4.2.1) is informing the abstract creation of this archetype, as this program is more technology focused than design focused, utilizing a didactic approach focused on realistic teaching over theoretical, and tailoring the program content to the skillsets needed by the industry.

The main characteristic of this abstract archetype is defined as proficiency in web development and web design, hence the name Front-ender. A Front-ender candidate fresh out of school is hypothesized to have up-to-date industry relevant skills in web and mobile programming. In addition, basic knowledge and skillsets within human-computer interaction, user-interface (UI) design, user-centered design (UCD), mobile development, responsive design, and web accessibility competences are envisioned. Front-ender types of interaction designer are theorized to have limited full-stack abilities and limited user research and design skills.

4.3.2 The Full-stacker

The programs from HE Institution 2 (presented in 4.2.2) and HE Institution 3 (presented in 4.2.3) form the basis for our construction of the Full-stacker. These associated study programs are focused on technology, focusing on analytic and evaluator abilities and exercising reflection on theoretical insights.

The “Full-stacker” interaction designer thus inferred as having a classic informatics (or Computer Science) background. The Full-stack interaction designer is theorized as having received basic knowledge of typical back-end skills, such as programming, databases, networks and operation systems, and computer hardware knowledge. This archetype is constructed to have full-stack development capabilities (thus the name), be well versed in software engineering, and we imagine interaction designers resembling this abstract archetype may potentially help bridge the gap between designers and developers (for example in agile settings). In addition to proficiencies in mobile and web technologies, we picture a candidate fresh out of school is knowledgeable of cutting-edge technology. However, this archetype may lack extensive training in design methodology, user research and user empathy. The IxD training of the Full-stacker is hypothesized based on the corresponding study programs as having been mostly HCI and UI focused, such as considering input/output modalities and information design.

4.3.3 The Design Tinker

The third archetype represents an interaction designer with a design degree. We have one study track forming the basis for this archetype: from HE Institution 4 (presented in 4.2.4). Overall, the HE Institution 4 program is considered to particularly emphasize design and values, which fit an abstract "tinkering" archetype.

The name "Design Tinker" refers to the creative process of "tinkering" – experimenting with ideas and materials to explore, improve, or create something. This bottom-up and hands-on experimentation of moving between theory, experimentation, and reflection is viewed as a different approach to innovation than the traditional top-down analytics of computer scientists and engineers.

In contrast to interaction designers with informatics degrees, represented by e.g. the Full-stacker and Front-ender archetypes, the Design Tinker is envisioned as having a disciplinary core in design thinking, design theory and design reflection. Based on our analytical constructs, the Design Tinker is viewed as an interaction designer well versed in problem solving through design thinking and using creativity triggers. He or she is assumed to hold broad design skills, in addition to interaction design competence. We thus hypothesize interaction designers reflected by the Design Tinker archetype may label themself as belonging to a design-discipline that overlaps with IxD, such as information designers, graphic designers, industrial designers, product designers, service designers etc.

Design Tinkers are assumed to have limited development and programming capabilities. However, the Design Tinker is expected to be familiar with physical prototyping, and thus hold capabilities for problem solving by tinkering and prototyping with technological artifacts (utilizing sensors, IoT, etc.). Overall, this type of interaction designer is envisioned suited for tasks where a broader design skillset is needed, and predicted capable of designing more than technological contact points and interfaces.

4.3.4 The Communicator

Students graduating from HE Institution 5 (presented in 4.2.5), HE Institution 6 (presented in 4.2.6), HE Institution 7 (presented in 4.2.7), and HE Institution 8 (presented in 4.2.8) are likely to reflect the Communicator archetype construct. The level of technological focus somewhat vary between these programs, but the focus is overall on applying, rather than developing, technology; using technology as a mediating platform and utilizing interactive digital solutions within the media context. All the programs are user oriented, but lack a strong value-based focus. Although design aspects are given some emphasis, IxD is not a primary focus in these programs. All the four programs represented by this archetype are primarily educating candidates for the media industry. As such, this interaction designer archetype is extrapolated from the interaction designer programs providing a media degree.

The Communicator represents an interaction designer schooled in how to use technology to develop media services and to communicate with users, trained in content production and visual communication. The Communicator is theorized as skilled in media design and in media production (such as animation, video- and audio-). We also envision this type of interaction designer has some skills relating to front-end development, games, and web and mobile solutions. A Communicator archetype is further anticipated as skilled in reflecting on ethical and societal implications related to applied solutions, including universal design. It is also assumed that Communicators probably hold some basic skills in visual design, UI, and creative processes

4.3.5 The User Empath

Finally, we find study programs that provide in-depth IxD training. Studies from HE Institution 9 (presented in 4.2.9) and HE Institution 10 (presented in 4.2.10) fit this category (representing two tracks and three programs; a two-year CG, three-year BA and an optional two-year MA add-on). These programs have a strong focus on training students in user-centered IxD skills, and universal design perspectives are included in all programs. They are of very different length (two to five years) and offer different degrees (CG, BA, or MA). Although the level of in-depth reflection skills varies, all communicate value-based design choices and focus on user needs. They are also quite interdisciplinary, and include topics related media-studies, cognitive psychology, management perspectives, technology, and design.

From the empirical base of these studies, we build our final archetype: The User Empath. We envision this type of interaction designer has received an interdisciplinary training, and draws on both design and IT topics, including UI and visual design, and web and app development. Due to the interdisciplinary programs inspiring this analytical construct, we believe a User Empath type of interaction designer is likely to hold basic competence in IxD-related disciplines, such as service design, information architecture (IA), HCI, and human factors. A User Empath will thus have an education that covers several topics within the UX-field and as related to IxD, including reflection on universal design, ethics, and design methodology.

We imagine this archetype would be trained in user research and user testing, and view it as the most likely IxD archetype to be skilled at user-involved, participatory, user-sensitive and empathic design techniques, such as workshops, ethnography, empathic design, in-situ interviews, shadowing, and participatory observation strategies. Further, that this type of interaction designer is likely well versed in design methodology. We hypothesize based on the empirical data that the mainly focus is on user-centered design and cross-disciplinary teamwork, but it could also include e.g. creativity and innovation training. In addition to strong user-centered design competences, we envision the User Empath holds some visual design skills. Finally, we theorize this archetype skillsets covers basic front-end design and development skills, mainly as related to websites and apps

5. DISCUSSION

First, regarding the question, **To what extent, if any, is universal design expertise included in IxD HE study programs?**, the analysis revealed that many of the IxD programs lack a focus on universal design, including the teaching of web accessibility. This is worrying and somewhat surprising, as usability and accessibility are concepts well integrated into IxD and UI design (Petrie & Kheir, 2007), and both national and international legislation is in place to ensure a minimum level of accessibility in our societies. The low presence of universal design in study programs in IxD in Norway is an important finding, and one that is highly critical for educational institutions to address in order to decrease and not increase the digital gaps in a society where the digital development moves fast.

Universal design perspectives are vital when designing products for a wide variety of users (Bergman et al., 1996; Connell et al., 1997), and therefore they were expected to play a more central role in the study programs that cover design and product development. Innovative companies, for example Apple, have learnt that designing devices and systems that are easy for everyone to use is a business opportunity. From a business perspective, it should be equally important for future entrepreneurs and start-ups that their designers have skills in universal design if they are to target a large audience.

Further, web accessibility is regarded as a key component if all users (citizens) in our digital society are to be included, and it is legislated in Norway as a mandatory part of all new IT-solutions targeting to the general public (Norwegian Ministry of Government Administration, 2013). From 2021, accessibility will also become mandatory for existing IT-solutions in Norway, both public and private (Norwegian Ministry of Government Administration, 2013). Accepting the fact that inclusion of universal design is also manifest in worldwide guidelines and standards (Hosein, 2004; UN, 2006; Access, 2010; US, 2008), we could expect that educational institutions serving the media and IT industries would pay more attention to this in their study programs and course plans. At the very least, one would expect HE institutions to make sure that newly educated interaction designers possess the necessary competence to adhere to current Norwegian and international legislation.

Currently, the general manager of a private or public company, or other organization, is legally responsible for adhering to the law. This makes sense as this person is in control of the budget. However, it is reasonable to expect that procurers will be advised of current legislation by service providers so that plans and offerings from the media- or IT-industry will comply with current legislation—just as an architect must comply with building regulations. The prioritization and focus on universal design in the design and development processes of IT projects is a critical success factor if inclusive ICT-solutions are to be achieved (Harder & Begnum, 2016). Knowing that procurers often lack the necessary expertise in universal design, we argue that it is an ethical matter to ensure that professionals are adequately educated so that they can advise providers regarding their legal responsibilities. We urge the HE sector to take responsibility for ensuring that there is an adequate universal design focus in IxD education. This is supported by §47 of the 2016 EU regulation on the accessibility of websites and mobile applications, which states that members should: “take the necessary measures to raise awareness of, and promote web training programs relating to, the accessibility of websites and mobile applications, for relevant stakeholders and in particular staff responsible for the accessibility of websites or mobile applications” (EU, 2016a).

The EAA Annex directive proposition suggests placing the responsibility for ensuring universal design across stakeholders in the supplier chain. The aim is to complete the EAA work before the end of 2017. There is therefore reason to believe that interaction designers may soon be held legally responsible if they disregard universal design legislation in their professional work. This adds to the importance of Norwegian HE institutions ensuring that their IxD students receive the necessary competence and knowledge, and understand both their current and potential future legal responsibilities.

On our second research question, **What are the abstract archetypes representing interaction design professionals?**, we have identified five different archetypes of interaction design being educated in Norway. We find that among Norwegian IxD programs there is tremendous heterogeneity as regards type of institution, study program length, degree achieved, academic focus, content and overall aim, didactics, and level of industry collaboration. The five constructed archetypes each emphasize various key characteristics from the programs, ranging from the highly technical to the more user-oriented with softer skills.

Although there is a common agreement as to the importance of user-oriented development, e.g. through activities such as usability testing (as consistent with e.g. Hornbæk, 2006 and Nørgaard & Hornbæk, 2006), we find a scattered focus on user inclusion and user empathy across the various study programs. The large variation in the IxD archetypes being educated raises some challenges, both for the industry as well as for the individuals. Currently, this seems critical in four instances: 1) when failing to recruit or recognize the correct type of interaction designer to adequately match a positions competence needs; 2) when failing to recognize and utilize the competence available, e.g. on project teams; 3) when failing to educate professionals with the necessary expertise, as needed by society and required from the industry; and 4). when failing to recruit students into IxD programs, thereby e.g. maintaining an industry shortage.

For example, recruiting interaction designers with the right expertise is a challenge for industries in Norway. Several previous studies (e.g. Fallman, 2008; Sørum & Pettersen, 2016) discuss the many aspects considered important within IxD. By presenting these archetypes, we aim to make it easier for organizations to better address the skills they need when recruiting, and to ensure a better match between their business needs, the job descriptions, and the new employees. We visualize a scenario where organizations are able to review the archetype descriptions, and on this basis improve their communication regarding the type of skillsets they are looking for. Likewise, interaction designers will have an easier way of communicating their competences, e.g. that that they are a mix between two of the archetypes.

Another challenge relates to the hiring of new employees: namely, whether to utilize in-house or to hire new IxD expertise. Thus, the archetypes may contribute to make available skillsets amongst applicants as well as those currently held by organizations be more apparent. Further, industry might benefit from the archetypes when staffing and planning their internal resources, as the archetypes could enable them to map the range of skillsets at hand or needed for a particular project. Increasing the visibility of available skillsets may not only aid management, but also communicate the capabilities of interaction designers. As such, a recognition of available competences may facilitate more established professional IxD roles, e.g. in cross-disciplinary teams. A more explicit way of communicating IxD skillsets may combat the tendency to reduce UX skills to interface design as is often reported in agile settings (Kuusined, 2015; Constantine, 2001; Begnum & Furuheim, 2016).

Further, the archetypes may reveal to educational institutions the competence gaps that need to be filled in the IxD education they currently offer, and also contribute to ensuring that tacit knowledge of the program is made explicit in the external presentations, thereby ensuring a better match between program profiles and actual content. It is unlikely, and frankly not desirable, that the same type of interaction designers should be educated across all institutions. Even though the industry currently reports that it is not the quality of the education, but rather the quantity of candidates that is the issue, having a way in which to communicate what IxD skills are needed presents an increased opportunity to ensure a match between what the industries need and what is taught. Previous studies (Sørum & Pettersen, 2016) have also indicated that IxD skills and topics as taught in various educational programs are often inadequate to match the competence needs of the design industry. Consequently, we can speculate that there is a mismatch between the topics considered significant in an educational context versus the knowledge that is needed in the industry. Such a mismatch between theory and practice has also been highlighted by Goodman, Stolterman, and Wakkary (2011), who also emphasize the importance of minimizing this gap.

In addition to within-programs improvements, improved articulation not only of the IxD field but also regarding specific educational programs has the potential to ensure that political and managerial strategies in the HE sector understand the overlap between, or the uniqueness of, IxD programs, and whether institutions are competing with or complementing each other. This might aid strategic adjustments, future mergers, student exchange opportunities, and collaboration between study programs.

Finally, in Norway, the HE sector is currently striving to meet the industry's need for more interaction designers. Thus, the sector has strengthened and collectively built up its IxD education programs during the last decade, and especially in the last five years. The first program named "Interaction design" was launched in 2013. However, low application numbers remain a challenge; both in terms of filling all available programs with motivated students and being able to select the students that best fit specific programs from among several candidates. As there is no standard or homogeneous skillset required to become an "interaction designer", and because IxD is in many ways an umbrella term, the HE sector perceives challenges related to communication the content of the profession to students and high school career advisors. We propose the archetypes can be used to better reach potential students, as they communicate more easily to young people what the IxD profession is about, which roles they are likely to fill, and what abilities are needed. This may lead both to increased recruitment, and a better match between potential students and the HE study programs they select.

Our view is that the IxD field is not static or definite, but is constantly changing in relation to technological and societal developments. Thus, to attempt to specify one "correct" interaction designer archetype would not be a relevant aim. Rather, we argue that articulating IxD archetypes could combat the four challenges identified above, without limiting the field in time or content. As the field changes, new archetypes may be added and existing archetypes may be updated with new skillsets.

With regard to our third question: **What is the universal design expertise needed by these interaction design professionals?**, the findings show that the level of universal design competence currently being taught is low. As such, what universal design competence is needed is largely undefined from the empirical data. Our study revealed that three out of the ten programs are completely lacking in attention paid to universal design, while a further four study programs have only a low focus on this topic. One program has a medium focus, and only two were found to include extensive universal design aspects. In this regard, we express our concerns regarding future solutions created by students of the IxD programs. Currently, Norwegian IxD studies do not appear to be contributing to the intended shift toward a more inclusive society as set in motion by national and international legislation. If students are not taught the importance of adhering to existing regulations as part of their education, and are not even informed that these regulations exist, we perceive that it is unlikely that they will discover them on their own — and they may even be resistant to taking these regulations seriously in their professional work. However, if universal design standards, regulations, best practices, and quality control are taught as part of an IxD education, we consider it likely that newly educated interaction designers will suggest and share these in their places of work.To make a contribution towards aiding the HE sector in rectifying the lack of universal design focus, the decision was made to include a proposal on universal design expertise perceived as key for each of the five archetypes. Thus, in addition to discussing the implications of a shortage in universal design skills in the study programs, the paper and the archetypes makes an explicit contribution to ensuring that the necessary additional expertise in universal design is implemented in the field. Through advocating for universal design competences, we hope to open up a debate on the necessity of such skills in IxD and the responsibility of educators to arrive at agreement on what level of universal design competence is relevant for interaction designers.

As universal design expertise must be embedded into the interaction design profession, the abstract archetypes provide a foundation for discussing which universal design expertise is relevant for interaction designers. Our first assumption, based on the data, is that many professionals working as interaction designers in the IT-industry have a cross-disciplinary background in informatics and front-end and UI-design. A few programs offering in-depth IxD content, focus more on user-centered values and skills, while also attempting to balance design and technology content. In the media industry, our findings indicate that professionals holding IxD responsibilities are likely to have a cross-disciplinary background in media technologies, media design and media production.

Second, those who enter IxD positions in the IT-industry are usually expected to do either front-end coding or user-interface design. For both these tasks, we suggest they need **web accessibility** competence to achieve the minimum universal design standards as determined by current legislation. Currently, web accessibility competence needed is mainly WAI WCAG, responsive design, app accessibility, and following coding standards. IxD professionals also need to now how to check accessibility, including the UI. The basic methods for doing this are automatic validation, expert inspections, and user tests with disabled users. A basic understanding of assistive technologies such as screen readers, screen magnifiers, and switch-systems is highly beneficial.

Third, interaction designers utilizing user-centered approaches should understand key **needs** of major user groups in danger of exclusion. In particular, we believe users with severe visual impairments should be prioritized. Other highly relevant user groups for digital product design are in our view persons with dyslexia (or reading- and writing difficulties), first-generation non-western speakers (and tourist), persons with severe motor disabilities, and persons with cognitive challenges (such as dementia, fatigue, context-, or emotion-related challenges). For physical product design, we would argue persons with dexterity challenges, persons with impaired hearing, and persons with non-typical sensory experiences (including many with autism-spectrum disorders, ADHD) should be considered. Further, for service design, we believe non-digital users (such as many elderly over 80 years of age) needs to be emphasized, in line with UN recommendations. Forth, those interacting directly with users in user research and design phases should know how to apply **inclusive design methodology** into user-centered approaches, including empathic design techniques, direct user contact with disabled and marginalized user groups, end-user involvement, and contextual disability awareness (such as in the social "gap" model). Further, anyone

Finally, anyone producing multimedia content should know how to make this inclusive and multi-modal; e.g. using captions, tagged pdf-reading order, alt-texts, subtitles, or audio description. Both content design and information design touches upon visual, cognitive, and audile aspects, including readability and understandability. In other words, **content accessibility** expertise is needed. From these assumptions, we propose the following universal design expertise for the five archetypes.

5.1 The Front-ender

Based on the identified professional role of the Front-ender, we propose universal design expertise focused on ensuring technical accessibility. However, we also suggest the Front-ender types of professionals should hold universal design expertise connected to user-interface design tasks, e.g. accessible navigational structures, colors, and contrasts. We propose Front-enders are taught the following universal design expertise:

- Knowledge of WAI accessibility guidelines and expertise in adhering to the WCAG criteria;
- Ability to code according to best-practice standards, including mobile (app) accessibility;
- Ability to do automatic accessibility assessments using online or downloaded tools;
- Understanding of the needs of disabled user groups that can be accommodated through accessible coding, especially visual impairments, including color blindness. Awareness of users with dyslexia, reduced cognition and motor control is beneficial, although not expected;
- Ability to do formative user testing with disabled users;
- Knowledge of assistive technologies, including switch-systems, screen readers and magnifiers, and the need to ensure compatibility with these;
- Ability to do expert accessibility evaluations of user interface and front-end code according to accessibility best practices and guidelines and simulated assistive technologies (e.g., keyboard to simulate switches). Ability to do basic expert testing with assistive technologies is beneficial, though not expected;
- Awareness of current international and national legislations and responsibilities.

5.2 The Full-stacker

We propose interaction designers reflecting this archetype include universal design expertise focused on technical accessibility:

- Ability to code according to best-practice standards, including mobile (app) accessibility and WAI accessibility guidelines;
- Ability to do automatic accessibility assessments using online or downloaded tools;
- Knowledge of assistive technologies such as switch-systems, screen readers and magnifiers and how these assistive technologies function in relation to complex and server-based systems. Ability to consider assistive technology in relation to IoT, health technology and other technological innovations is beneficial, although not expected;

- Ability to do expert accessibility evaluation of systems to ensure accessibility and assistive technology compatibility, including basic user-interface accessibility evaluations. Ability to do a more thorough expert evaluation of user interfaces and front-end code and the ability to do basic expert testing with assistive technologies are beneficial, although not expected;
- Awareness of the needs of disabled users groups;
- Ability to do formative user testing with disabled users;
- Awareness of current international and national legislations and responsibilities.

5.3 The Design Tinker
Proposed universal design expertise for the Design Tinker relates to user-involved and empathic design techniques that increase the inclusiveness of ergonomics and interactions, e.g., as related to service design (contexts of use, digital and physical touch points) and product design (tangible artifacts). The following universal design expertise is proposed as fitting for the Design Tinker:

- Understanding the needs of user groups with specific needs, such as the effects of reduced motor control, dexterity, fine motor skills, and cognitive abilities, through illness, age, low vision, and blindness as related to the use and ergonomics of digital and non-digital solutions;
- Understanding the effects of dyslexia and visual impairment on information design;
- Awareness of users in danger of exclusion, including the elderly over 80 years and first-generation non-western immigrants;
- Ability to do user involvement with marginalized user groups, including user testing, interviews and observation;
- Knowledge of the social “gap model” on disability as related to different contexts of use;
- Knowledge on how to simulate the needs of marginalized users for empathic design strategies as well as for expert testing, e.g., by using assistive technologies such as wheelchairs and crutches, or by applying limitations to their vision, dexterity etc.;
- Awareness of current international and national legislations and responsibilities.

5.4 The Communicator
For the Communicator, we thus suggest universal design expertise emphasizing abilities that ensure accessible and inclusive content (text, video and images) in user interfaces and media services:

- Understanding the needs of disabled user groups related to user-interface design and content design, especially hearing impaired and visually impaired users;
- Knowledge of audio description for the visually impaired and closed captions for deaf and hard of hearing audiences of video content, in addition to subtitles for non-native speakers;
- Understanding the implications of dyslexia and visual impairment for textual and visual information design;
- Ability to do user-centered design involving disabled users, including user testing;
- Knowledge of WAI accessibility guidelines and expertise in adhering to WCAG criteria;
- Ability to do automatic accessibility assessments using online or downloaded tools;
- Awareness of current international and national legislation and consequent responsibilities.

5.5 The User Empath
For the User Empath, we suggest universal design expertise related to edge-case and inclusive user-centered design approaches, as these are viewed as its key professional competencies compared to the other IxD archetypes:

- Understanding the needs of marginalized users and the effects of reduced motor control, dexterity, fine motor skills, and cognitive abilities, together with illness, age, low vision and blindness as they relate to the use and ergonomics of digital solutions. Awareness of users in danger of exclusion, including the elderly over 80 years and first-generation non-western immigrants is beneficial, although not expected;

- Ability to do user involvement with marginalized and disabled users, including user testing, interviews and observations;
- Ability to simulate the needs of marginalized users for empathic design strategies as well as for expert testing and evaluation;
- Understanding the social "gap model" on disability as related to different contexts of use;
- Understanding the needs of disabled user groups as related to user-interface and visual design, navigational structure, and digital ergonomics—especially the effects of dyslexia and visual impairment on textual and visual information design, and the effects of reduced cognition, fine motor skills, and vision on interactions. Knowledge of audio description and closed captions is beneficial, but not expected;
- Knowledge of assistive technologies, including switch-systems, screen readers, and magnifiers, and how these influence human-computer interaction. Understanding the needs of disabled user groups that can be accommodated through accessible coding is beneficial, although not expected;
- Ability to do automatic WCAG accessibility assessments using online or downloaded tools;
- Awareness of current international and national legislation and consequent responsibilities

Table 4 summarizes the universal design expertise proposed in relation to the constructed archetypes. It should be noted that the proposed universal design expertise is based on a relevance assessment for each archetype, founded on our theoretical framework for universal design in IxD. As such, proposed universal design expertise depends on the identified skillsets within each archetype. The summary of our proposed expertise highlight our stance that all professionals contributing to the digitalization of services (including media services) are likely to be covered by accessibility regulations, and therefore they need to know at least the current national and international **legislation**.

Table 4: *Summary of Proposed Universal Design Expertise*

Expertise:	**Front-ender**	**Full-stacker**	**Design Tinker**	**Communicator**	**User Empath**
Legislative responsibilities.	•	•	•	•	•
WAI/WCAG/ mobile (app) accessibility/code standards	•	•		•	•
Assistive technologies	•	•	•		•
Accessible code impact for visual & motor impairments	•	•			(•)
Accessibility assessment, Expert inspection code/UI	•	•		•	•
User testing with disabled	•	•			•
Inclusive user involvement			•		•
Empathic design techniques			•		•
User-need knowledge; dyslexia, vision	(•)	(•)	•	•	•
User-need knowledge; motor skills, cognition, age			•	•	•
User-need knowledge; illness, dexterity, other			•	(•)	•
Contextual "gap" awareness			•		•
Inclusive information design			•	•	•
Inclusive multimedia				•	(•)

In summary, this study reveals an unfortunate absence of a universal design focus, which should be consistently present in all IxD education. Our findings suggest that Norwegian HE institutions are not staying updated on relevant universal design skills as required by national and international law, and as such, are in danger of not equipping their students, as future professional interaction designers, to adhere to current and anticipated legislation. Proposed universal design expertise for interaction designers is tied to the constructed archetypes, and based on matching the professional activities of these abstract IxD representations. To this end, we demonstrate that an increased awareness and articulation of current educational content may contribute to addressing possible competence gaps.

5.5 Limitations of Our Study

This study is not without its limitations. First, it articulates abstract archetypes as based on educational programs only, and does not articulate any other types that may exist in the industry. Second, only Norwegian study programs were included in our study. We do believe that we have captured key characteristics that are likely to be present outside of the Norwegian context, as discussed in Section 3. However, a key characteristic of the Norwegian educational system is that programs offered at universities and public colleges are free of charge. Private institutions do have enrollment fees, which are typical of many schools and universities elsewhere. This could result in differences between educational programs, for example related to the context of teaching, didactic styles and resources at hand. Further, though similar, the legislation in EU and US somewhat differs from Norwegian laws. This could also influence the universal design focus in IxD study programs. Finally, we make the assumption that Norwegian HE IxD study programs deliver according to the (legally binding) description represented by institutions, and not made further investigations into whether institutions deliver what they promise (e.g. through interviews and observation with students and teaching staff.

6. CONCLUSION

As the use of digital channels increases, the role of the interaction designer plays a vital component in facilitating satisfactory and accessible user experiences and interactions. Legislation linked to universal design is becoming increasingly important, while there is no clear perception of the content of interactions design (IxD) programs. Consequently, this study presents a qualitative multiple case study of relevant higher education programs in Norway, aiming to investigate the level of universal design focus by articulating the expertise currently being taught in such study programs.

In our study, we identify five archetype constructs of interaction designers: 1) Front-ender, 2) Full-stacker, 3) Design Tinker, 4) Communicator, and 5) User Empath. These archetypes communicate the interdisciplinary nature of the field with each differing in its characteristics and skills, ranging from the highly technical to the more user-oriented with softer skills. Through these, we indicate the current content of interaction design programs in higher education. Knowledge of the key characteristics of IxD study programs is interesting, both as a theoretical contribution to the field and for the industry recruiting these workers, and for the students considering their options for IxD studies. We discuss how the archetypes may we valuable as strong IxD communication tools for a wide range of audiences, and further demonstrate in our research how an increased awareness and articulation of current educational content may contribute to addressing possible competence gaps.

By articulating the field, we did not aim to statically define a “correct” type of interaction designer, but rather to make visible the dynamic and plural nature of the field, while at the same time supporting competence awareness, and particularly contribute to address possible competence gaps such as that related to universal design.

That few programs include adequate universal design expertise is worrying. Norwegian HE IxD students are not necessarily conversant with their legal and ethical accessibility responsibilities. We argue universal design expertise should be a key element in current IxD educational programs. Since universal design expertise must be linked to professional activities, we propose which universal design skillsets are necessary for each of the five archetypes. By linking universal design expertise to archetype skillsets, we emphasize the importance of considering professional relevance. By adding universal design competences to the archetypes, we hope to support both educational institutions and individual professionals in identifying the need for universal design expertise, and thereby open a discussion about universal design skillsets that would need to be included in the IxD discipline.

6.1 Future Work

We invite future research to investigate how our archetypes may be further developed; including how they as abstract representations fit IxD as a discipline with global characteristics. Further, the archetypes could be validated empirically against graduates from the included study programs, for example through self-categorization, or descriptions from employers. It is our hope that other scholars will conduct similar studies in their respective contexts, so we can observe if there are any differences internationally in how the studies are organized, compare archetypes constructs and discuss relevant expertise. We believe we have captured all the relevant study programs in Norway, and future research could advantageously focus on exploring whether the identified archetypes of IxD professionals' skillsets are evident elsewhere and over time, or if they need to be expanded on.

Further, we believe it is important to not only compare archetypes of interaction designers, but also whether the national challenges on lacking universal design focus in IxD HE study programs as described in this paper are found internationally. Universal design competence fitting for IxD professionals should be researched and discussed internationally. Perhaps international IxD study programs are better at ensuring universal design competence for their students. If so, these experiences may contribute to improve upon proposed universal design competence for our identified archetypes.

Future studies could also study the link between legislation and degree of placing universal design on the study program agenda. We encourage follow-up research on the consequences of a lack of universal design awareness in the IxD discipline, both for users in danger of exclusion, and in relation to the legal implications for interaction designers as the European Accessibility Act (EAA) move toward completion.

Finally, investigating opportunities for raising awareness of universal design within the IxD profession is important future work, and we particularly welcome investigations into how the archetypes could be utilized to aid organizations, students, and educators in universal design skillset training.

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Figure & Table legends

Figure 1: Universal Design Focus of HE IxD Programs

Table 1: *Overview of the IxD Study Program Sample*

(GSC = general study competency, CS = Computer Science, eqv. = equivalent).

Table 2: *Summary of Comparative Study Program Sorting*

Table 3: *Summary of Universal Design Focus and Archetype Representations*

Table 4: *Summary of Proposed Universal Design Expertise*

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Ensuring Universal Design of ICT: Triggering the Triggers!

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Abstract. Some ICT projects manage to create award winning, inclusive solutions, while others fail. Previous research has gathered data from 34 informants across 23 ICT-projects that have achieved universal design (UD). Their reasons for success are complex, but 15 Critical Success Criteria (CSC) can be identified. This article asks: How can we utilize these insights to promote UD efforts in the ICT-industry? The article proposes a way to model the empirical data for societal utilization; supporting future efforts to promote UD. First, we analyze the relationships between personal, processual, organizational and societal factors, and how the different critical success criteria work together to positively influence the projects in our sample. Next, we apply Hertzberg and Fogg's theories to classify the CSC as triggers, facilitators, motivators or hygiene factors. Based on this deeper understanding, we model the data and propose 3 trigger factors for UD of ICT. Using our model, we propose the following three strategies, which have a high effect potential for "triggering the triggers": 1) Legal interventions, 2) Awareness interventions, and 3) Training interventions. The contribution of the article is theoretical: a) providing richer insights into empirical data, by modeling their relationships, and b) predicting the impact of future interventions on the ICT-industry based on our modeled findings.

Keywords. Universal design, ICT, success criteria, high-impact interventions

1. Introduction

Universal design (UD) contributes to societal, ethical and commercial benefits. A political stance on the importance of UD has already been made by international stakeholders such as the UN, US, Japan, China and EU [1]. Despite legal efforts to secure UD of ICT, numerous inaccessible websites still exist [2-4]. There seems to be a gap between the societal intent of UD, and real-life industry practices and results. In order to help bridge the gap, research proposes best practices for achieving UD of ICT. One such study has interviewed 34 informants across 23 UD award-winning ICT-projects [5, 6]. Here, 84 characterizing factors for UD success in ICT-projects are identified. 15 of them are considered Critical Success Criteria (CSC). There is a need to make these empirical insights more applicable in order to facilitate that CSC are met in future ICT-projects. We re-examine the interview data to identify the dynamics in play in the sample – how factors affect each other. Hertzberg (1964) and Fogg (2009) both have theories relevant for describing and modeling the data [7, 8]. Based on improved insights, the article proposes interventions with the potential to trigger chain-reactions to efficiently promote UD of ICT. We ask the following research questions:

1. What is the relationship between the Critical Success Criteria (CSC)?
2. Using Herzberg's theory, are the CSC motivators or hygiene factors?
3. Using Fogg's model, are the CSC motivators, facilitators or triggers?
4. What are likely high-impact strategies for UD of ICT?

2. Heading

In our previous work, interviews from 34 informants are transcribed and analyzed, and 84 characterizing factors are identified from 23 ICT-projects that have successfully delivered universally designed ICT-solutions (see Figure 1). The characterizing factors were identified through emergent coding of full textual transcribed in-depth interviews, supported by audio recordings. We separate between obstructive and promoting factors, classified as Societal, Organizational, Processual or Personal.

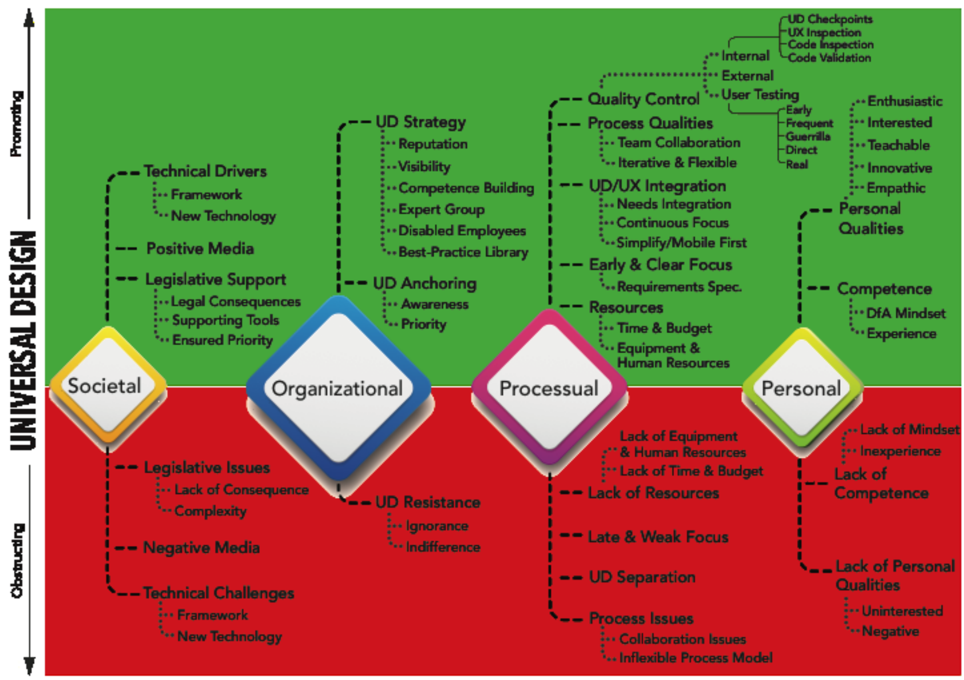

Figure 1. Overview of identified characterizing factors.

Based on the frequency of factors mentioned in the interviews, the following 15 factors are considered CSC:

1. Legislative Support (Societal)
2. UD Awareness, (Organizational)
3. UD Priority (Organizational)
4. Strategic UD Competence Building (Organizational)
5. Requirement Specification of UD (Processual)
6. UD/UX Needs Integration (Processual)
7. Continuous Focus (preferably iterative, Processual)

8. Cross-disciplinary Team Collaboration (Processual)
9. User Testing (preferably with real and disabled users, Processual)
10. Internal quality control (code validation, inspections etc.) (Processual)
11. Enough Time & Budget (Processual)
12. Enough Equipment & Human Resources
13. Design for All (DfA) Mindset (Personal)
14. Interest in UD (Personal)
15. Enthusiam about UD (Personal)

Our findings seem to fit well with related studies, for example Lazar, Goldstein and Taylor [9] on organizational aspects and process guidelines; Khang and Moe [10] on the competence of the team as well as motivational and awareness barriers (such as the importance of project management being dedicated to success); and inclusive development principles as outlined by Fuglerud and Sloan [11] and Røssvoll and Fuglerud [12].

3. Research Approach

The overall research approach is qualitative, using an exploratory interview study to map empirical factors for UD success. This is appropriate for eliciting subjective views on informal and complex practices [13:5, 14:91]. The study gains knowledge of project members' perceptions of a situation, and is as such interpretive with phenomenological traits [15]. The data is analyzed through thematic content analysis, which is iterated to deepen insights. Thus, the study has hermeneutic traits; incrementally deepening our (post-) understanding. Narrative evidence is used in order to describe relationships between the CSC factors and applying theoretical perspectives.

Hertzberg's dual-factor theory revolves around employee motivation [7]. Herzberg identified how someone being satisfied or dissatisfied at work might arise from different factors, and that what motivates people may be different from, and not simply the opposite of, factors causing dissatisfaction (hygiene factors). While hygiene factors must be *sufficiently* present to *avoid* dissatisfaction, motivational factors increase satisfaction when increased. Hertzberg dual-factor theory is used to investigate if CSC are motivators or hygiene factors.

Fogg's theoretical model for human behavior [8] is focused on how factors influence human behavior. According to Fogg, behavior (B) can be triggered (T) if adequate motivations (M) and abilities (A) are present (B=MAT). The theory has been successfully applied to persuasive design. Its strength and weakness is the simplified and static view on behavior and motivation, and the lack of individual (project) difference. Nonetheless, Fogg provides a starting point for understanding the dynamics of what is (not) working in our sample, and is applied to theorize which CSC are the triggers for UD. Based on insights into the type and nature of the factors, we model the empirical data, and use insights to propose actions that could "trigger the triggers".

4. Findings and Discussions

4.1. CSC Relationships

On the Societal CSC "Legislative Support", informants express how the Anti-Discrimination and Accessibility Act [16] boosts mandates to create inclusive solutions, while the threat of fines ensures a minimum priority from stakeholders. Informant 23 states: *"It's a shame to say it, but it's the law and regulation that promotes it here (state agency)"*. A “pointing fingers” approach of critizising others for doing things wrongly is however not always motivating, as informant 22 indicates when talking about using legislation to push UD priority; *"Then you have no choice, but that's not to say that it is the main driver to do the job well"*. An alternative approach is influencing Personal CSC: “Enthusiasm”, “Interest” and “DfA Mindset”. Informant 29 explains, *“Because if you understand why you do something, then you have the motivation to do it. But if you only see it as a checklist that you have to read through and comply to, it’ll be, like, substantially harder”*, and Informant 2 says: *“But if they don’t care if the contrasts are good enough or not, it (designers or developers skillsets) doesn’t matter. Then it (the solution) won’t be (universally designed).”*

Personal attitudes are not formed in a vacuum. Indifference to UD on management levels is described as detrimental to the enthusiasm and focus on UD in a project. This coincides well with [10]. Three Organizational factors are CSC: "Awareness" and "Priority" which are both within the "UD Anchoring" factor, and UD “Competence Building”. Quite a few of the success projects in our sample have established "Expert Groups" as part of the organizational competence development. Some have persons with a special UD responsibility within sections, while others have dedicated UD sections. The common denominator is that someone within the organization has been assigned a mandate to ensure or promote UD. These persons are often described as “UD beacons”, and are as such persons with a high degree of enthusiasm. They typically try to promote UD awareness and knowledge among colleagues, management and clients. Another interesting strategy is hiring people with disabilities, such as developers with severely reduced vision. Disabled employees provide organizations with in-depth assistive technologies competence, access to real-life marginalized users for testing and experts for quality reviews and design guidance. Having disabled colleagues seems to make the issue of inclusion more real, and promote organizational awareness.

The majority of factors influencing UD success in our sample are Processual factors. Here we find the last 8 CSC. Two are related to Resources, which all informants mention. “Time and Money” are the primary concerns, with “Equipment and Human resources” a close second. Having an UD focus from the start is expressed in the CSC specifying “Requirements for UD”. Informant 1 says: *“So, I think it's very important to have it from the very beginning. It applies to almost everything (...) it will be abandoned if you wait to implement it.”* Finding the time to do thorough quality control of technical and usable accessibility needs is also critical. Wide ranges of assessment methods are used, with two CSC; early, direct, informal and frequent “User Testing” (preferably with real and disabled users), and frequent “Internal quality control” (code validation, peer review inspections etc.). The CSC cross-disciplinary collaboration is needed for optimal results. Informant 21 states: *“I think if I'm to be completely honest, I think the customer had decided to do it. And they ordered it from us – they wanted to be good at it. I think that was absolutely crucial. That means we could, and in some way had to, spend a lot of time on it, on universal design. But if it hadn’t been part of their order, we would probably* *not have done it, so .. that the customer was a good procurer, I think was absolutely crucial."*

Our data suggest there are large overlaps between UX and UD work. Informant 10 explains; "*As I see it, it's part of the quality of use, user experience like the big umbrella, then it's usability, and then you have accessibility, universal design for everyone*". In fact, based on our data, UD could be interpreted as "UX for all", expressed in the CSC "UD/UX Needs Integration". The successful projects see UD as an extension of UX, with a DfA mindset pointing to user focus: *"When we say 'design for all' - then we think basically 'good for everyone'"* (Informant 26). A "Continuous Focus" on user needs – not separating between UX and UD work – is another CSC.

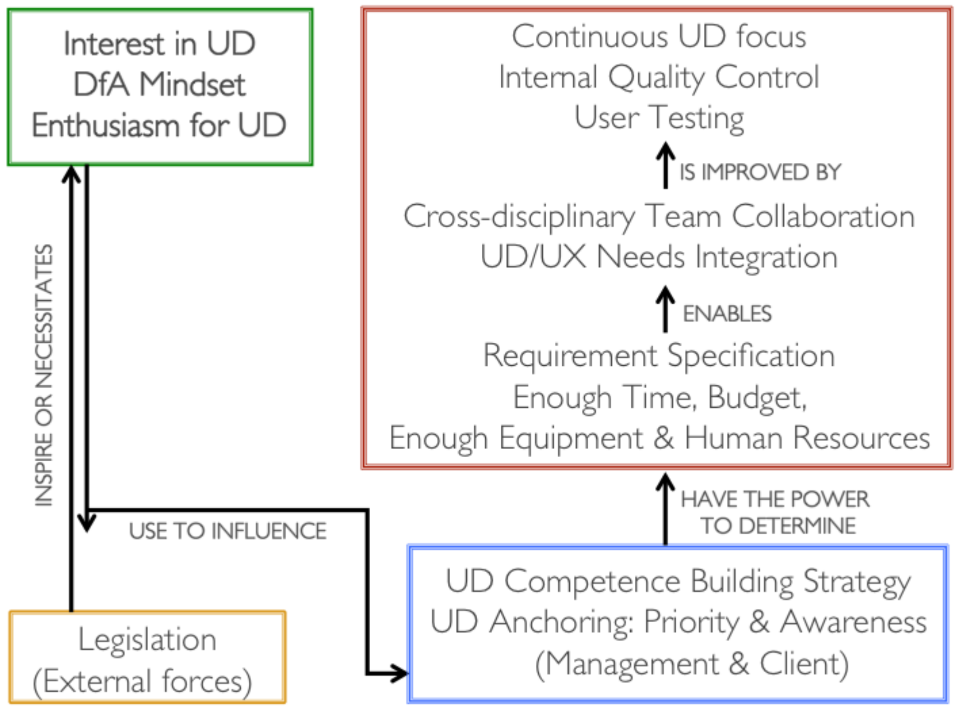

Figure 2. Critical Success Critera (CSC) relationships.

4.2. Applying Hertzberg's Dual-Factor Theory

As Figure 1 shows, many obstructing and promoting factors correspond to each other. For example, "Technical Drivers" on the promoting side holds the sub-category "Framework", which commends companies for providing inclusive guidelines, platforms and libraries. The same "Framework" sub-category is found in the category "Technical Challenges" on the obstructing side, referring to e.g. how Content Management Systems generate inaccessible code. Thus, frameworks may both aid or hinder UD. Likewise, media attention can be either "Positive Media" or "Negative Media". Organizational "Resistance" is the opposite of "Anchoring", and sub-categories "Ignorance" and "Indifference" is basically lack of "Awareness" and "Priority". While "Awareness" refers to management and project stakeholders on all levels holding a positive understanding of UD, "Ignorance" points to viewing UD as something irrelevant, often paired with a lacking focus on user needs in general. "Priority" is taking UD seriously, investing in real-life practice, while "Indifference" points to a weak or missing focus in the organization or from the client. Further, on Personal level; “Lack of Personal Qualities” is divided into the sub-factors “Uninterested” and Negative”, where the former is in opposition to “Interest”, and “Enthusiasm” is viewed as the opposite of “Negative”.

These examples illustrate that many factors could be viewed as on a gliding scale from negative to positive. One could envision Tech frameworks, Media attention, Organizational cultures and Personal attitudes that are “neutral” – neither facilitating nor hindering UD. The question then is whether there is a *sufficient presence* cut-off to avoid *hindering* UD for these factors – e.g. if they should be considered *hygiene* factors.

Hygiene factors do not necessarily promote UD if increased beyond sufficient presence. For some factors, this fits very well. Resource is an obvious candidate, as lacking resources to do UD work are clearly detrimental. However, unlimited access to users, time, equipment and staff is not necessary. What you need is *sufficient* resources in order to choose appropriate approaches.

We argue it is beneficial to distinguish between *hygiene* factors that are obstructive when (too) absent, and *motivators* hypothesize to always increase the likelihood of UD when increased. Investigating the data, we find that all factors categorized in “UD Strategy” are likely motivators, as are the UD/UX Integration sub-factors “Needs Integration” and “Simplicity/Mobile First”, all factors under “Quality Control” and the Personal Qualities sub-factors “Teachable”, “Innovative” and “Empathic”. Applying Hertzberg to the 15 CSC, we find;

10 hygiene factors:

1. Legislative Support (Societal)
2. UD Awareness, (Organizational)
3. UD Priority (Organizational)
4. Continuous Focus (preferably iterative, Processual)
5. Cross-disciplinary Team Collaboration (Processual)
6. Enough Time & Budget (Processual)
7. Enough Equipment & Human Resources
8. Design for All (DfA) Mindset (Personal)
9. Interest in UD (Personal)
10. Enthusiam about UD (Personal)

and 5 motivators:

1. Strategic UD Competence Building (Organizational)
2. Requirement Specification of UD (Processual)
3. UD/UX Needs Integration (Processual)
4. User Testing (preferably with real and disabled users, Processual)
5. Internal quality control (code validation, inspections etc.) (Processual)

4.3. Applying Fogg’s B=MAT Theory

In Fogg’s model, hygiene factors can be translated into *abilities.* But which, if any, CSC are *trigger* factors in Fogg’d B=MAT model? We find that the *legislation* is sometimes the only thing forcing UD in ICT projects. Informant 12, a consultant, says: *"We try not to use the law more than necessary, but we can resort to it if nothing else works"*. Even though the current legislation is vital to enforce resources and protect against budget cuts, it is not always the key to UD dedication*; "Then you have no choice, but that's not to say* *that it is the main driver to do the job well"* says informant 22. Instead, informants try to spread a positive attitude – e.g. targeting Personal factors.

This brings us to *enthusiam* about UD as the second trigger. The law is often used as leverage to secure a mandate for taking on UD responsibilities. Sometimes, this empowers individuals to call for increased prioritization and competence. In parallel with the leverage approach, several funnel their professional enthusiasm and knowledge of UD to colleagues, clients and management. In some cases, UD awareness seems to slowly be internalized in the organizations originally *not* interested. Grass-root movements also use external factors apart from legislation to influence; e.g. if media attention and awards create a positive external UD image, management can be inspired to keep up the good reputation.

An organizational UD culture provides focus and priority beyond what the legislation is able to ensure on it's own. When a project owner orders UD requirements, the resources for meeting these requirements are also allocated. Informant 7 summarizes: *"Cause if they have the awareness, they will probably find money."* Thus, *specified UD requirements* is the third trigger identified. Informant 17's explains: *"we had a client – Project 16 – who was willing to pay for this, for them this was important. And that's what made it possible. And that's the problem today. It isn't that we can't do universal design well enough. One can surely never be good enough, but we can do it quite well. The reason why we don't do it in many apps today is because the customer isn't interested in buying it."*

Applying Foggs to the CSC, we find;

8 hygiene factors:

1. UD Awareness, (Organizational)
2. UD Priority (Organizational)
3. Continuous Focus (preferably iterative, Processual)
4. Cross-disciplinary Team Collaboration (Processual)
5. Enough Time & Budget (Processual)
6. Enough Equipment & Human Resources
7. Design for All (DfA) Mindset (Personal)
8. Interest in UD (Personal)

4 motivators:

1. Strategic UD Competence Building (Organizational)
2. UD/UX Needs Integration (Processual)
3. User Testing (preferably with real and disabled users, Processual)
4. Internal quality control (code validation, inspections etc.) (Processual)

and 3 triggers:

1. Legislative Support (Societal)
2. Enthusiam about UD (Personal)
3. Requirement Specification of UD (Processual)

Figure 3 shows how increasing *abilities* decreases the needed *motivation* – and vice versa – in order for a *trigger* to be successful (green area).

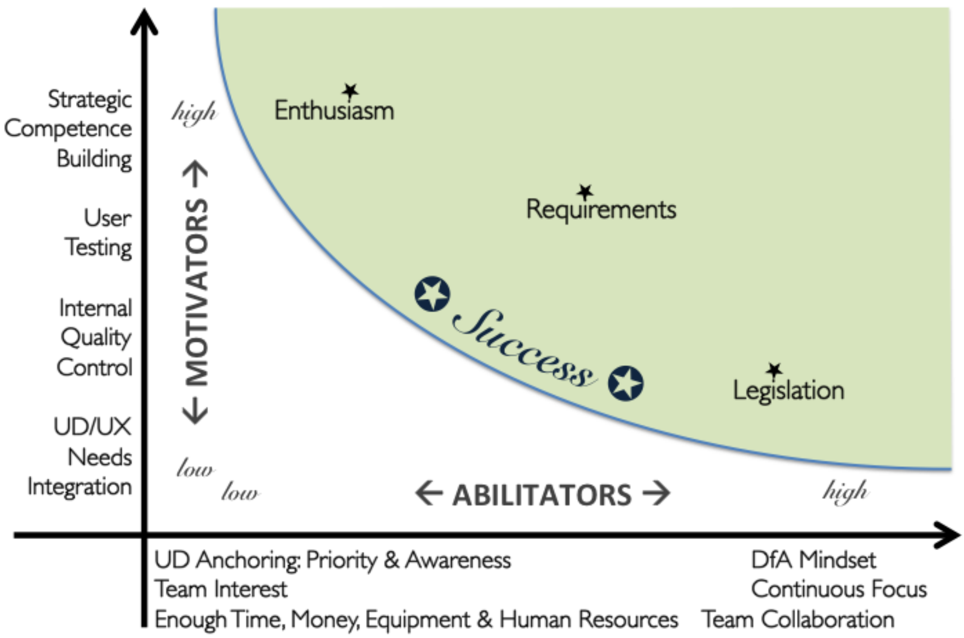

Figure 3. Mapping CSC *triggers*, *motivators* and *abilities* into Fogg's B=MAT model.

4.4. Theorizing High-Impact Interventions

What interventions are likely to have the largest effect on promoting and ensure best practice CSC in place from the start of ICT development? We first explore impact perspectives related to *legislation*. Legislation seems effective to *trigger a minimum of UD quality*. However, several informants worry that the focus on technical accessibility (the minimum legislated in Norway) derails from the DfA mindset. One could consider adding to the regulation to promote DfA perspectives, e.g. demanding process documentation. Further, some mention lack of real-life consequences for breaking the law. Any UD efforts in projects with a high degree of UD resistance are likely to depend on legislative enforcement. UD focus could end if possible negative consequences can be avoided. Larger organizations seem to view the threat of fines as more real than small businesses, which point to the ICT provider as the one responsible. Thus, current legislation may not work for "less serious" actors. EUs proposal of placing responsibilities for ensuring UD across all links in the development process is interesting [17].

Requirements effectively trigger priority and resources. In order to encourage more projects to specify UD requirements, one needs to trigger top-down strategies derived from management levels. Creating tools to support UD discussions with the project owner at the start of a project is considered a potential tool to anchor UD values among the project stakeholders. Creating checklist-based integrations to project management tools is also an interesting approach to highlight UD best practice at a management level – e.g. propose quality assurance and DfA activities at certain intervals or in certain phases. Anchoring *UD values* among project owners is a powerful approach to *inspire a maximum of UD quality* within the available limitations of a project. We propose increased attention on raising awareness among procurers of ICT-solutions, especially in public sector.

Finally, we ask how to trigger *grass-root movements*. Some informants complain that developers are not skilled in legislated UD requirements from their education. If engineering and design students are not being adequately trained in accessibility responsibilities, they might be resistant to regulations in their professional work. However, if best practice and quality control are ingrained as part of their education, they are considered likely to apply and share this competence in their workplaces. For industry practitioners, we propose in-situ training interventions targeted at ICT designers and developers. Informant 24 describes the WCAG guidelines as a *"wall of text"*. Focusing on *"hundreds of thousand of requirements"* is demotivating and makes it hard to create enthusiasm among peers who do not (yet) have a UD interest. Thus, simplifying regulations seems an appropriate strategy. The Norwegian Agency for Public Management and E-Government (DIFI) have started to take action in this respect, by offering advise through seminars and online guidelines [18]. This work should be continued, especially "how-to" guides minimizing complexity.

We argue that action plans for promoting UD in the field of ICT should focus on triggering the identified CSC triggers to have the highest impact potential. We discuss a handful of possible interventions for triggering positive change. Early findings are presented at a national "Universal ICT" expert network [19]. The results received a warm reception and exceedingly positive feedback, providing some tentative external validity. Future research will focus on increasing validity, investigate characterizing factors not considered CSC and investigate "low effort, but effective" interventions.

5. Conclusion

This article re-analyzes interview data from 34 informants across 23 ICT-projects awarded for universal design (UD), in order to a) deepen insights on critical success criteria (CSC) and start modeling empirical data; b) assess the likely impact effects of future interventions. We find CSC must to be present at Societal, Organizational, Processual and Personal levels in order for a single ICT-project to succeed. By applying Hertzberg and Fogg's theoretical models, we model the relationships between CSC, identifying eight *hygiene* CSC that only needs to be sufficiently present, four *motivators* its always beneficial to increase, and three *triggers* creating positive CSC chain-reactions. We propose that future steps to promote UD of ICT focus on triggering these triggers; 1) Legal interventions to enforce a minimum level of UD, 2) Awareness interventions to inspire maximized UD priority and 3) Training interventions to facilitate UD grass-root movements.

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Triggering Universal Design in HE Digitalization

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Summary: *Some digital developments produce "universally designed" solutions, allowing utilization by a wide range of users in a wide range of situations. Norwegian Higher Education (HE) institutions are becoming increasingly digitalized, but universal design (UD) has so far not received priority, and disabled students still face excluding mainstream solutions. New legislation seeks to rectify this by placing stronger accessibility responsibilities on ICT used by the educational sector. But is this updated law sufficient to trigger UD focus in Norwegian HE digitalization efforts? This paper hypothesizes an answer, by drawing on insights from HE case studies and Fogg's theory of persuasive design. We propose factor relationships needed to successfully ensure UD in HE digitalization.*

1. Introduction

The Norwegian Discrimination and Accessibility Act (DTL) of June 2008 emphasized UD as a human rights issue [1]. It went into force 1.1.2009, and specifies the duty to ensure public physical and digital environments are usable by all. Ensuring UD of ICT became increasingly pressing as our society underwent digital transformations. In 2013 the regulations for UD of ICT were written [2], taking effect July 1st 2014. Focus is on ensuring technical accessibility and compatibility with assistive technologies that disabled user groups need. The Act relating to Universities and University Colleges of 2005 states learning environments should be based on the principle of UD [3], but sector legislation explicitly covering UD in digitalized educational environments was never updated as expected.

The effect of higher education (HE) is significant, with likelihood for employment increasing 4,5 times with a HE diploma for disabled professionals [4]. The HE sector is increasingly digitalized, both for pedagogical purposes and as part of institutional service digitalization. In these efforts, our impression is UD perspectives are lacking – at best only partly considered or regarded as less important than aspects such as cost or functionality. Several studies report accessibility issues in current LMSs. Our case study into institutions converting to digital assessments revealed a lacking attention to safeguard UD [5]. The consequences of not being able to use a LMS or take an digital HE exam easily and effectively is of great consequence to students with disabilities – who are already at a disadvantage. Politicians proposed in October 2015 to explicitly include the educational sector in DTL. This was agreed on in September 2017 [6]. The updated legislation appears intended to ensure the digitalization of HE will take UD into account – including improving the UD requirement specification in digital procurements. As of 1.1.2018, digital teaching aids (eLearning systems and tools, learning materials and digitalized services) must follow the UD of ICT regulations. The aim is for eLearning tools and digitalized HE services to be used by as many students (and staff) as possible - without the need for adaptations - in a wide range of situations and across different devices and platforms. As a legal minimum they must adhere to the WCAG AA-level and be able to be used in combination with assistive technologies. However, drawing on our impressions from the case-based knowledge, do we believe the legislation sufficient to reach its intended effect?

2. Methodological Approach

According to Fogg [7], human behavior (B) can be triggered (T) if adequate motivations (M) and abilities (A) are present. According to Fogg's theory, a trigger factor is only successful if there is a sufficient combination of motivations and abilities. High motivation can overcome constraints, and high abilities can overcame low motivation. In other words, the formula of "B=MAT" can be applied to model a simplified and static overview on the relationship of factors influencing human behavior.

Based on insights into empirical data, we see several challenges related to UD in HE. These factors are summarized, categorized as *abilitators*, *motivators* and *triggers*, and mapped into the model.

3. Impressions

From the case study on digital assessment procurement, we interviewed 21 informants; two solution providers and 19 from HE administrations [5]. We detected several challenges, which seems fairly consistent with other research findings. Our impression is negative mechanisms may be in place on the following factors: Lacking UD Awareness, Knowledge of Technical Possibilities, Knowledge of Legal Responsibilities, UD Capacity Building, End-User Participation, UD Quality Assurance, Real User Testing, Discussion of Digital Transformation and Value Effect, Underutilized Technical Accessibility Competence and Contextual Usability Competence, Weak UD Responsibility Assignment and UD Requirements, Staff and Change Fatigue. On the positive side, budget constraints are not emphasized. Our assumption is that clarified requirements, legal responsibilities and bottom-up UD enthusiasm are triggers. This is consistent with data gathered from UD success cases from ICT-industry [8]. A starting point for understanding the dynamics of what is (not) working in our sample is proposed in Figure 1.

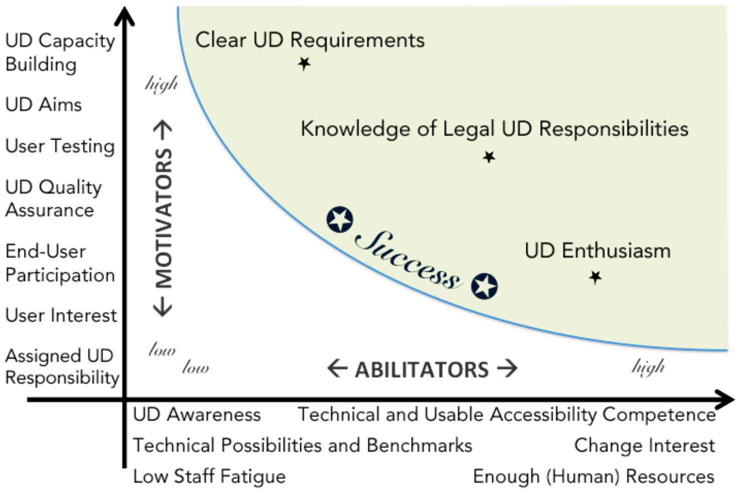

Table 1: Mapping identified challenges into Fogg's B=MAT model.

4. Discussion

Our data shows heterogenous solutions are selected among HE institutions. As each HE institutions select and pay for their solutions, combined efforts such as that of UNINETT seems important to support procurement processes. However, UNINETT proposed UD requirements are not considered satisfying. For example, in 2016, UNINETT proposed mandatory requirements for UD in procurement of digital assessment solutions as the following: "documentation must be submitted in both Norwegian and English", "the user interface must be available in English and Norwegian Bokmål" and "should be available in Norwegian Nynorsk" [9]. Though providers are asked to further describe strategies for usability aspects, only half of these relate to accessibility and no accessibility requirements are set. In later UNINETT recommendations on LMSs, detailed reasonings and ratings (such as accessibility assessments, providers' replies and final priorities) are not open to the public. In order to ensure UD, each institution must thus rely on in-house organized UD quality assessments. An improvement would be to increase the open sharing of any assessments made by one HE institutions to others.

Though the institutions overall hold competence in UD, it is spread throughout the organization and not necessarily linked to digitalization processes. For example, staff working with institutional websites have followed the UD of ICT regulations since 2014, and should have in-depth knowledge of technical accessibility. Further, staff working with individual adaptation to individual students have experience with UD in real-life contexts. Design, ICT and Health departments have students and staff with relevant knowledge. We have no examples of how these resources are utilized. Some fatigue is indicated among staff. Though legal demands are clarified in the updated law, there has been little work done yet to "spread the word" and inform the HE sector of their institutional responsibilities related to UD. We hope that the law clearly defines minimum criteria for technical accessibility, and propose improved versions of UD requirements specification [9]. However, usable accessibility must still be specified related to the context and aim of the digitalization.

Connected to the lack of necessary hands-on UD competence is lack of student and staff participation, user testing and in-context quality control. There is little or no user involvement and no real-life testing with disabled students prior to delivery. For example, we learned individual exam adaptation is costly and strenuous for the student as well as HE staff. Still, the new mainstream digital assessment solutions are not suitable to solve these issues. Instead, they pose new issues by demanding the use of systems with low accessibility and e.g. by replicating closed-book exams on campus computers and thus hindering access to assistive technology needed by disabled students. Further, the pedagogical value or cost-effectiveness of the new solutions in practice seems neither planned nor quality assured. It does not seem pedagogical strategies are discussed –in the case of digital assessment improving facilitation of more advanced open-book exams, such as simulations, formative feedback sessions, portfolio assessment and collaborative grading. Overall, it can be argued that real-life utilization receives too little attention, with focus on *digitization* rather than exploring opportunities for *digital transformation*. Instead of exploring digital transformation values, focus seems to be on digitizing existing solutions through top-down adminstrative efforts. End-results seem to end up as feature-dense in order to cover any possible usage situations and needs, without a clear increase in real-life utility for students and staff, and without the necessary level of usable and accessible main solutions.

5. Conclusion

Through our own and other researcher's exploration, an impression has been formed as to the reasons for why UD up until now has received insufficient attention, priority or quality assurance. The intitutions lack knowledge of the UD qualities in external solutions, legal demands and their practical implications and technological possibilities and reasonable accesibility requirements to ask of digital providers. Further, appropriate user participation and in-practice quality assurance is lacking. Figure 1 visualize triggers, motivators and abilitators necessary to either fail or succeed with triggering UD, based on our insights. Drawing on more HE cases and experiences, the proposed model can be updated to better reflect factors and mechanisms needed. The model could also be expanded to better ensure e.g. user participation, social cost-reduction and transformational value.

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