DIGITAL SUSTAINABILITY IN SERVICES

A study of practices and challenges when designing sustainable digital services

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Abstract

IT companies face a growing corporate responsibility for reducing CO^2 emissions coming from digital services and related energy consumption. Many organizations, institutions, and companies have proposed various ways to reduce digital energy consumption. However, companies are still struggling to implement digital sustainability as such an implementation requires large-scale change across strategies, competences, and practices. Through a social practice theory lens, this thesis aims to examine core areas of digital sustainability and the experiences of employees within IT companies to support the design, implementation, and practice of sustainable digital services.

The study involves a literature review that identifies the prominent roles of a service designer in relation to change management and researches state-of-the-art literature within the field of Green IT. It employs design thinking and MUST methodology to study four selected IT companies' current practices and challenges with implementing digital sustainability through a qualitative and participatory approach. Through an iterative design process and co-creation methods, the study proposes a framework to implement digital sustainability successfully. The framework provides an overview of principles for IT companies to explore, use and develop more energy-efficient solutions. It suggests a plan of action for each principle and advocates the use of service design in change management processes to improve employee experiences.

This paper supports digital design teams, change managers, and service designers in implementing digital sustainability by suggesting a process for anchoring and building digital sustainable competences within an organization. In addition, it provides an in-depth understanding of the multiple contributions they can integrate to create the right conditions for new practices.

This paper identifies and examines the core elements that must be firmly integrated into the design of digital services design and system infrastructure to advance the approach to digital sustainability within the field of service design and IT practices. In contrast to related work that focuses on *what* should be done to create greener services, this thesis focuses on *how* this is done in a business-oriented organization.

Keywords: Service design • Digital sustainability • Green IT • Change management • Software development • Web development • Business strategy

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INTRODUCTION

1. Introduction

Digital services have become increasingly important for companies to compete with the rapid technological development due to digitalization, servitization, and innovation (Sunesen & Thelle 2018). Whereas digitalization embraces the ability of digital technology to collect data, establish trends and make better business decisions, servitization refers to products being sold as services rather than a one-off sale (Baines et al. 2017). Companies and public sectors are moving from physical products and pen-and-paper processes toward digitalized service systems with multiple electronic alternatives. Many companies believe that developing and implementing new and advanced technological solutions will be a necessity in future strategies (Ismiris 2019). Additionally, when discussing digitalization, sustainability is believed to be one of the many benefits of digital transformation in terms of reducing pen-and-paper processes, transforming psychical products into digital services, and making smarter and more data-driven solutions.

In 2017, the organization Climate Home published a report arguing that one major issue in the process of digitalization has been overlooked and is now causing an even bigger environmental problem (Vidal 2017). The use of software, digital touchpoints, and demand for data has increased immensely over the recent years, and as a result, energy consumption has grown exponentially (Vidal 2017). The reports show that the IT industry is responsible for 3,6% of the global CO^2 emissions (Malmodin & Lundén 2018), equivalent to the global aviation industry. The report goes on to state that global computing plays a big role in the equation of sustainable IT as modern technology is becoming more available: *"Global computing power demand from internet-connected devices, high-resolution video streaming, emails, surveillance cameras and a new generation of smart TVs is increasing 20% a year."* (Vidal 2017)

If no actions are taken, and without a dramatic decrease in energy efficiency, the IT industry could be responsible for 5,5% of the global CO2 emissions in 2025. In 2040, it is estimated that this number will be 14% (Vidal 2017).

> "We have a tsunami of data approaching. Everything which can be is being digitalized. It is a perfect storm. 5G is coming, IP [internet protocol] traffic is much higher than estimated, and all cars and machines, robots and artificial intelligence are being digitalized, producing huge amounts of data which is stored in datacenters." (Vidal 2017).

1.1 Defining Digital Sustainability in Services

Energy consumption of service systems stems from various interconnected and complex processes embedded in the service system design. Therefore, a definition of digital is required to further understand the flow of the energy and resources used to power a digital service.

According to the Australian Digital Technologies Hub, the term *digital system* refers to hardware, software, and networks and their use (Digital Technologies Hub 2021). A system consists of various components, including a central processing unit (CPU), a hard disk for storage, a keyboard, a mouse,

a screen, etc. The different components of the hardware and software transform data into a digital solution. The connection of multiple digital systems forms a network that transmits data, which is often seen in modern-day services connected to the internet. To adopt a holistic approach, this paper will define *digital services* as services embedded in a digital solution in front-stage or back-stage processes. These processes include interfaces such as digital touchpoints, channels, software, databases, and systems that, in some way or another, complement the service and use the internet to do so.

When referring to sustainability within the field of IT, common design methods focus on creating IT projects that are viable in terms of economics, strategy, and employees' capabilities. One of the principles in MUST methodology, developed by Simonsen et al. (2008), is 'having a shared vision' which includes focusing on three domains that have to be in balance for an IT project to be sustainable: 1) employees and their qualifications, 2) economics and 3) technology (Simonsen et al. 2008). The MUST method does not include an environmental domain but instead focuses on creating feasible digital solutions for the company and its users. In the field of design management and design of digital products, Sherin (2013) defines sustainability as a balanced use of social, environmental, and economic resources - also known as the triple bottom line of sustainability *"people, planet, and profit*" (Sherin 2013). By following this definition, the high volumes of emissions produced from all digital operations must be considered as a great environmental concern and therefore be included in design strategies.

In the investigations conducted within this report, the focus on sustainability targets the environmental impacts of digital services. Therefore, *digital sustainability* is defined as the orchestration of digital touchpoints, software, partners and server hosts, internal processes, and hardware to reduce CO2 emissions.

1.1.1 Contributions to digital sustainability

Reactions to the carbon footprint of IT have inspired many scientists, organizations, and companies to propose solutions that will reduce companies' energy consumption. Green IT is one of the many contributions and is often formulated as a set of 5-10 complex principles (Berry 2020; Dansk Erhverv 2021; IT Branchen 2020). These principles have been redefined, reviewed, reemployed, and rebranded various times over the years, yet they still struggle to become an integrated part of IT development. In the field of software engineering, Naumann et al. (2011) propose the Greensoft model, which is a conceptual reference model for green and sustainable software (Naumann et al. 2011). The model comprises a life cycle overview of software to support software developers, administrators, and software users in creating, maintaining, and using software more sustainably (Naumann et al. 2011). The model is highly detailed but might not be easy to understand for leaders and employees without high levels of experience in software development. In the field of service design, Sierra-Péreza et al. (2021) combine service design with eco-design through the ECO SD model, which entails a defined method structure that uses the service blueprint and specifies criteria to barriers for sustainability within the field of product and service design (Sierra-Péreza et al. 2021). The ECO SD model is highly efficient in identifying problem areas. Still, it categorizes all digital processes under 'resource consumption', which makes it challenging to navigate through what types of resources and specific elements should be targeted. Furthermore, it does not include how digital sustainability can be achieved within the system design.

Despite the long-term effort to reduce CO2 emissions through green IT, the Greensoft Model, and the SD ECO model, research seems to imply that the initiatives have not yet seen their results (Vidal 2017). Though the potential of digital sustainability has been mentioned in various literature and strategies, the actual practice is yet to be revealed.

The consequences of using digital services are impacting the environment and global warming (Malmodin & Lundén 2018) as the demand for data-driven and internet-connected services grows rapidly within the service industry. Service designers might have an important role to fulfill when it comes to designing energy-efficient services and service flows. Service design revolves around the design of services and optimizing customer and employee experiences. It explores people, activities, infrastructure, communication, and material components to improve the quality of the service and the interactions between the service provider and its customers (Interaction Design Foundation 2022). In recent years, service design has also made an impact within change management Bau 2020) as service designers have a multidisciplinary role and a broad pallet of capabilities, such as design thinking and co-creative methods (Brown 2008), to solve complex problems and support processes of change. Social practice theories have also gained impact in design strategy (Spotswood et al. 2015), as social practices are forming ways of thinking and designing services (Morelli et al. 2020).

This paper will investigate current literature and practices within the field of digital sustainability to improve the conditions for digital, sustainable services through a study of four danish IT companies and a design process in which a solution is suggested. The research question centers around how service design might support the design and implementation of digital, sustainable services in IT practices. In chapter one, a historical and comprehensive literature review is presented, and the project research scope is defined, followed by chapter two, which presents the methodological approach of this thesis. Chapter three presents the empirical study and analysis of four companies and their strategies and practices concerning the implementation of energy-efficient solutions. The discoveries from the four studies are then converted into a specific problem statement that is addressed through an iterative design process. Chapter four documents the process of ideation and co-creative activities conducted within the design process, followed by a documentation of the prototyping and testing process in chapter five. Chapter six presents the final design outcome of the project. Lastly, chapter seven will discuss and evaluate the knowledge contribution of this thesis and conclude on the overall research question and discoveries of this thesis.

1.2 Learning objectives

The learning objectives of the thesis are defined by Aalborg University's official learning objectives. The purpose of this paper is to demonstrate the knowledge, skills, and competences gained throughout the master's program in Service System Design at AAU Copenhagen. As the learning objectives set by AAU are vast, this thesis highlights the following objectives:

- Must have knowledge about design theories and methods that focus on the design of advanced and complex product-service systems
- Must be able to work independently, to identify major problem areas (analysis), and adequately address problems and opportunities (synthesis)
- Must demonstrate the ability to evaluate and address (synthesis) major organizational and business issues emerging in the design of a product-service system
- Must be able to independently initiate and implement discipline-specific and interdisciplinary cooperation and assume professional responsibility (synthesis)
- Participate in and independently carry out technological development and research, and apply scientific methods in solving complex problems.

1.3 Motivation

The motivation behind this project comes from six years of education in Informatics, Performance design, and Service design which all focus on the design and implementation of digital services, systems, and experiences. None of these educations included knowledge and skillsets in tackling the environmental impact of technology. This thesis aims to contribute to the emerging fields of green IT and service design to push the progress of more sustainable and resource-aware production of services and digital products and advocate the importance of incorporating environmental responsibility in the design of energy-consuming services.

Through the support and inspiration from the thesis supervisor, Amalia de Götzen, and the four participating companies; Green Mobility, NNIT, Clearview Trade, and AAU, the production of this thesis is motivated by finding a solution to the high levels of emissions coming from the IT industry and is an objection to greenwashing and biased progress reports. It searches to find a way for service designers to contribute and take responsibility for what is developed (along with connected stakeholders) to create the best possible starting point for a new digital sustainable revolution.

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LITERATURE REVIEW

2. Literature review

The theoretical framework of this thesis is service design and green IT to investigate current research on digital services and how they can become more sustainable. First, a historical walkthrough and definition of service design are explained. Furthermore, the multidisciplinary role of the service designer is discussed in relation to change management to create a shared understanding of the links between service design, green IT, and change management. Secondly, digital sustainability is defined through literature on green IT, sustainable front-end and back-end design, and sustainable change management. The literature review identifies the main areas of concern in digital sustainability and uses a service blueprint to summarize and visualize these areas in order to identify the people and processes responsible for these areas when improving energy efficiency. Lastly, the summary presents the overall research question of this thesis.

2.1 Service design

Service design emerged as a result of products and services intertwining (Nielsen Norman Group 2018). Traditionally, goods were seen as tangible, consumable objects, such as food, furniture, and pens, while services were intangible experiences that could not be consumed, such as a postal service or massage (Nielsen Norman Group 2018). Since then, service design has been adopted by various design disciplines, such as industrial design and interaction design (Morelli et al. 2020). Today, there is no clear distinction as services and goods have become intertwined (Nielsen Norman Group 2018).

Most digital services provide a product consisting of software and a user interface while providing a continuous service experience. Here, a distinction between designing a service and service design is needed. Designing a service is to create a customer journey based on what the user experiences from end to end. Service design is about employees understanding what they have to do in order to then produce that customer journey (Nielsen Norman Group 2018). Nielsen and Norman (2018) define service design as *"looking across an organization's resources and designing how it works in order to: 1) improve the employees' experience and then 2) indirectly improve the user's experience"* (Nielsen Norman Group 2018).

The term *service design* origins in marketing literature (Shostack 1982), which emphasizes the service encounter and customer experience when customers interact with the service's tangible evidence, such as humans, uniforms, logos, digital platforms, and other artifacts (Morelli et al. 2020). Stickdorn (2011) also highlights the employee experience as an important part of improving backstage processes:

> "Service design projects improve factors like ease of use, satisfaction, loyalty, and efficiency right across areas such as environments, communications and products – and not forgetting the people who deliver the service." (Stickdorn 2011)

Within the IT industry, the focus is on the operational processes that happen backstage of a service. This includes *"the coordination and design of facilities, servers, equipment and other resources*

needed to produce services (Ghosh et al. 2004). The newest addition to this list is the servers, as they only emerged within the last four decades, making the academic research on how the choice of servers and data affects a service very limited.

As service design revolves around structuring human and technological processes, service designers need to engage themselves through an interdisciplinary approach that draws on experts' and users' knowledge to ensure the outcome of the design process (Joly et al. 2019). Therefore, it is often described as a user-centered, iterative, and creative process to create innovative ideas (Stickdorn 2011). The definition of service design is influenced by an actor-network approach, emphasizing that the backstage processes and stakeholders are essential elements of service design when improving efficiency and customer experience (Stickdorn 2011).

2.1.1 Role of the service designer

Along with analyzing organizational structures, a service designer researches customer behavior and common customer responses to particular experiences to then create new processes to improve observed issues (Bau 2020). As service design merges actors across different fields and expertise, the role of the service designer has changed. The employed design practice of a specific project has the ability to change what we design, how we design, and who designs (Sanders & Stappers 2007). Sanders & Stappers argue that the role of the designer has been merged with the role of the researcher and facilitator. The designer, therefore, has the responsibility to facilitate different stakeholder agendas and make room for different interests and needs in the design process and within a solution (Sanders & Stappers 2007). Bau (2020) defines the role of the service designer by splitting it into seven roles.

Empathizer	Someone who explores complex problems and uses different research methods, both quantitively and qualitatively, to understand people, markets, industries, and organizations.
Sense maker	Someone who can uncover deep insights, patterns, and themes across all research sources and methods to frame or reframe hypotheses, problems, and opportunities.
Creator	Someone who systematically generates ideas and creates concepts to come up with new products, services, and processes that strengthen the value creation.
Maker	Someone who conducts experiments and builds prototypes.
Navigator	Someone who sets the overall direction of where a company or client is going and creates strategic platforms and implementation roadmaps.
Servant leader	Someone who can empower people from behind and equips people with the right skill set and mindset to perform well.
Storyteller	Someone who can craft, dramatize and tell stories about, e.g., research findings, new prototypes, test results, or new business models.

Figure 1: Seven roles of service designers (Bau 2020)

As the seven roles expand across many detailed focus areas, Bau (2020) argues that no service designer can excel in every role at once, but these roles should at least be covered by a service design team (Bau 2020). He also stresses the fact that empowerment of the employees is part of the role of a service designer, which connects service designers to internal processes and systems, as he proposes that service designers should become involved in change processes. Typically,

service designers are involved in the innovation of products and new experiences but are not as frequently in change processes as service designers are often removed from a project before large scale implementations (Bau 2020): *"By supporting implementation processes through service design, service designers can empower people and leaders to embrace not only change but also drive change"* (Bau 2020).

He supplies this vision with four different processes of change. The model to the right shows four common approaches to change and implies that a planned, top-down approach will meet higher levels of resistance than an emergent change coming from the employees and rising up to the overall strategy of a company. The strategy for driving change is chosen by top management leaders and not by service designers (Junginger & Sangiorgi 2009).

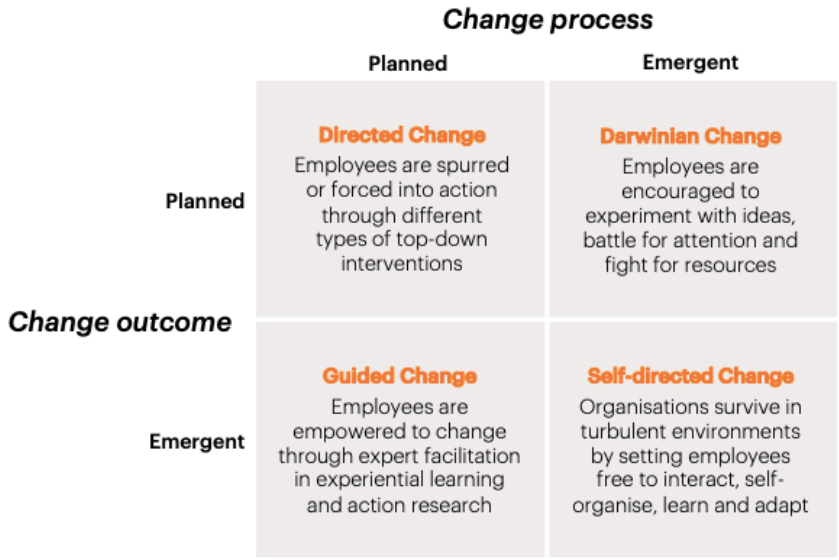


Figure 2: Approaches to change (Bau 2020)

Because service designers can play a big role in encouraging employees across the organization through co-creation and deep systematic insights (Bau 2020; Junginger & Sangiorgi 2009), research suggests using service design in change management to strengthen the employee experience that is being affected by the change and empowering the change strategy with more insights, tools, and user experiences. This suggests that the role of the service designer can be further expanded to consist of not only design and facilitation tasks but also implementation and strategy responsibilities to improve change strategies.

Figure 3: Service design roles in supporting change management (Bau 2020)

2.2 Green IT

Green IT has gained momentum since the discovery of the environmental impact of the IT industry (Vidal 2017). Berry (2022) sees the business case for green IT to be stronger than it has ever been as *"sustainability will be a Top 5 priority for 60% of executives at major Western European and North American companies by 2015"*. Back in 2008, the Danish Ministry of Science, Technology, and Development published a plan of action for implementing green IT in Denmark (Ministry of Science, Technology and Development 2008). The initiative was to support the danish IT industry in adapting to the growing corporate responsibility. The Danish government has recently taken part in this action by enrolling a new strategy toward reducing the public sector's CO2 emissions by 70% in 2030 (Buch 2021).

> "Initially, it will affect the purchase of hardware, but as soon as there is a methodological tool ready for it, one also expects a demand for climate-friendly IT services and software" (Buch 2021).

This methodological tool is currently being created by IT-Branchen, Infinit, DTU, and the Alexandra Institute (Buch 2020), who explores how to commonly measure energy consumption across different digital solutions and how to eventually be able to create an energy certification for it-services and software (Buch 2020). Even though official regulations are not yet formulated, Berry (2020) highlights development in the IT industry.

> "It's not just a feel-good idea – practical business considerations – not peoples' personal beliefs about the environment – are driving corporate sustainability programs. Companies now understand that green IT saves them money and increases their value in the marketplace." (Berry 2020)

If this were to be true, implementing principles from green, IT would be a preferred business model for most companies. The discoveries within this paper suggest that these motivation factors, money, and market value, might not be as known and desirable as proposed by Berry (2020).

2.2.1 Defining Green IT

Considering the overall scale of business processes performed by web services and applications, researchers of green IT has discovered a significant opportunity to promote energy-efficient, green processing (Bartalos et al. 2010). Bartalos et al. (2010) define green IT as the investigation of:

> "the environmental aspects related to the design, manufacturing, usage, and disposal of IT-associated equipment and infrastructure. The goal is to minimize the overall impact of information and communication technologies (ICT) on the environment." (Bartalos et al. 2010).

Similar definitions are shared by large IT organizations (Berry 2020; IT-Branchen 2020; Dansk Erhverv 2022), and all stress the need to use sustainably aware equipment and infrastructures such as hardware, servers, and electricity. These definitions come with a list of actions that can be followed to create more sustainable IT infrastructures. The actions include:

- Adopt a policy for the lifecycle of IT equipment and make a circular procurement agreement.
- Encourage employees to change their work habits by using telecommuting, teleconferencing, and video conferencing technology.
- Use power management software to manage devices across networks.
- Implement server and storage virtualization and use cloud computing services.
- Make sure server rooms and data centers are energy efficient, that cooling systems are running at maximum efficiency, and that leaks are plugged
- Map the energy consumption, including the bills that are hidden in the storage of external cloud solutions, in uploading and downloading data, as well as in network installations.
- Use power efficient coding (sustainable code)

(Berry 2022; IT-branchen 2020, Dansk Erhverv 2022)

This list highlights many opportunities for improving the backstage processes of an IT company. At first glance, the lists of actions seem reasonable and implementational but taking a further look at the later bullets, it is clear that not all of these actions are realistic. As mentioned by Buch (2021), scientists are still researching how to map out electricity consumption across different digital solutions. Furthermore, using power efficient coding can relate to a number of various disciplines within software engineering, UX, and service design that requires are more detailed implementation approach. The next sections will present the most prominent disciplines to be aware of when designing for digital sustainability.

2.2.2 Sustainable front-end design

Roberson et al. (2002) disclose some effective areas of improvement in front-end design through an analysis of the energy consumption on computer screens. Their research shows that the colors, size, graphics, refresh rate, and resolution settings of a web application affect the amount of power a computer or digital device uses while on.

> “Image displayed is primarily a function of the user's color settings and desktop graphics, as well as the color and size of open application windows; a given monitor requires more power to display a white (or light) screen than a black (or dark) screen.” (Roberson et al. 2002)

The discoveries of their analysis indicate that the design of a website, app, or any given screen design will impact the overall power consumption of the user journey, including the service system energy consumption and the users’ device energy consumption. Roberson et al. test results show that a monitor uses 69 watts while displaying a black screen and 97 watts while displaying a white screen (Roberson et al. 2002). On this particular monitor, a website with a black background could use up to 28 fewer watts than on a white website, suggesting a potential for energy-saving UX and UI design. One example of this type of design is the online search engine, Blackle.com, developed by the Australian company Heap Media. By using a black background on an online search engine, their mission was to give people a more sustainable alternative to Google’s classical white screen background (Heapmedia 2022). In 2007, Google reacted by adding a black background option available for their users. Ontkush (2007) proposed a theory stating that with Google’s daily 200 million queries, each displayed for 10 seconds, Google would save 8.3 Megawatt-hours per day, or

about 3000 Megawatt-hours a year on a global scale (Ontkush 2007). This estimate is based on the assumption that a white screen on a CRT (cathode-ray tube) monitor consumes 74 watts, and a black screen consumes 59 watts.

Since then, monitors and desktop screens have become increasingly more power efficient and less sensitive to bright designs. Nowadays, almost all laptops, monitors, tablets, and smartphones use LCD (Liquid Crystal Display). The LCD screen is not as affected by the colors, sizes, graphics, refresh rate, and resolution settings as the older CRT models because of the digital advancement of backlighting (Roberson et al. 2002). When tested by Roberson et al. (2002), LCD screens showed a 1-3 watt variation while displaying a black and a white screen. Therefore, the results of changing the design and look of a website may not be as effective nowadays but will still affect the overall energy consumption.

In the field of user experience, Greenwood (2021) suggests that sustainability in digital services is achieved through cooperation between teams such as UX designers, developers, engineers, and external server-hosts and less use of motion graphics and auto-play videos (Greenwood 2021). A website also consists of multiple files and underlying code that is transferred through the internet from a server to various users. The smaller the files are, the less energy it will take to send, load, and use the digital service (Greenwood 2021). Moreover, less time spends on the internet (both users and admins) and on digital devices also reduces energy consumption. Through sustainable web design, Greenwood suggests various methods to minimize the size of a website or app, such as downsizing files, optimizing the use of CSS, and reducing JavaScript.

Another method to reduce the energy consumption of a website is to set a page weight budget (Frick 2022). A page weight budget is a budget of how much a webpage is allowed to weigh in kilobytes or megabytes of files: *“it is the size of files transferred over the internet when a web page is loaded”* (Frick 2022). Setting a page weight budget, the team’s goal is to ensure all pages and files within the webpage are no more or less than the agreed budget. The budget acts as a benchmark for all team members to focus on in planning and design activities through to development.

2.2.3 Sustainable back-end design

Software and web developers play an important role when creating energy-effective services. After confirming UX design specifications, the responsibility of creating smaller websites or software is put on the developers. Here, developers have to follow rules of optimization, such as reduction of code and JavaScript, while also making sure that all images and files are as small as possible (Dick et al. 2010). By tracking the CPU usage (also referred to as ‘compute’), developers are able to identify where in the code and website or software data there is potential for optimization (Dick et al. 2010).

Another considerable opportunity for sustainable back-end development and operation is choosing a network of renewable energy sources. This includes server hosts and the configuration of added services. Shifting to renewable energy does not affect the service in terms of UX, design, technology, or economy. Greenwood suggests using hosting servers that have a commitment to renewable energy (Greenwood 2021). He also suggests using CDN (Content Delivery Network) servers for caching HTML pages, JavaScript files, stylesheets, images, and videos to reduce the amount of data transferred, downloaded, and stored on a server (Greenwood 2021). To further explain the

opportunities for which service designers can have an impact on the digital sustainability level of a service, a service blueprint is shown below.

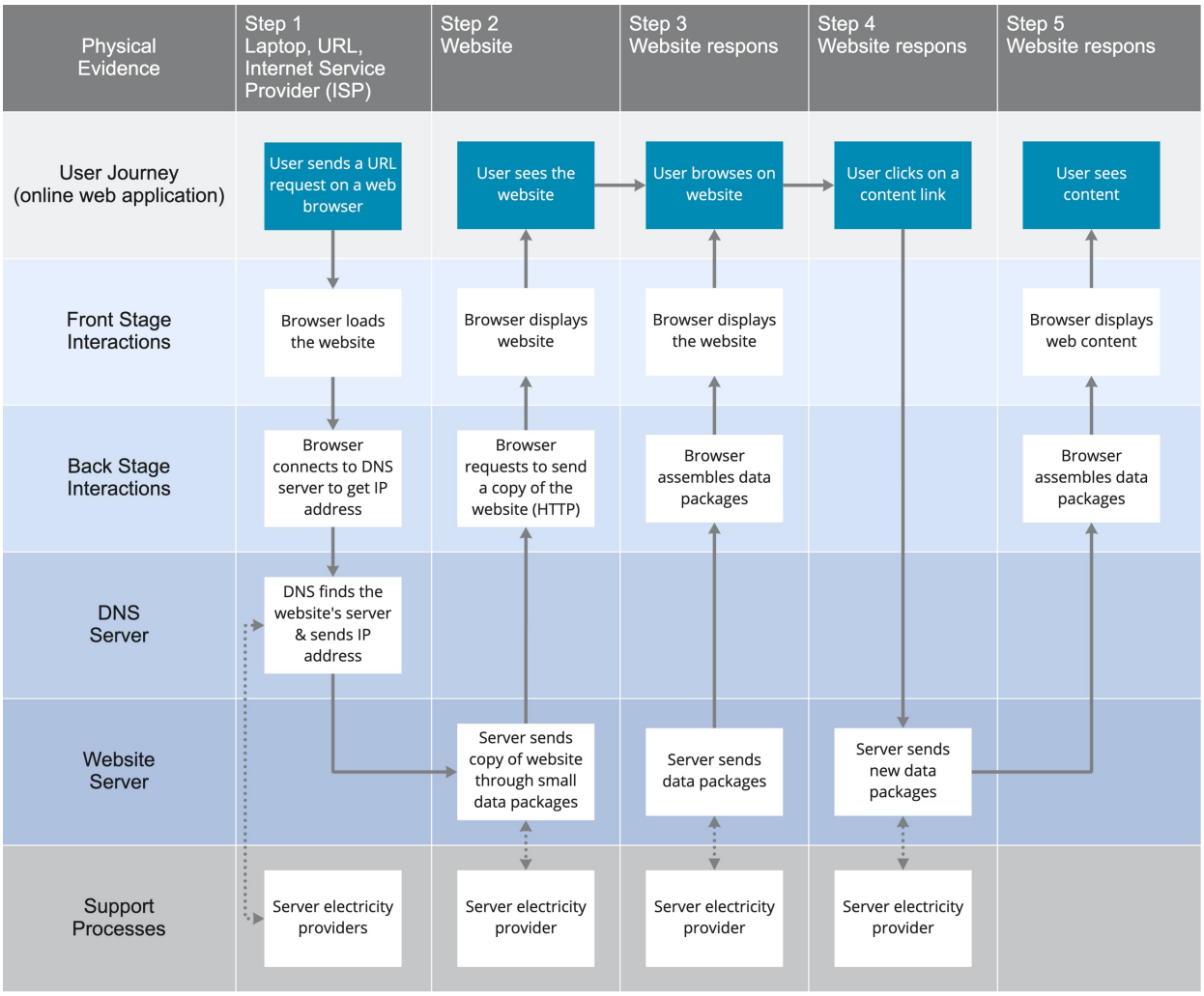


Figure 4: Service blueprint of a user using an online web application (example)

In the early 1980s, Shostack introduced the term blueprinting, which since then has become an essential service design tool in order to *"describe the activity of designing and codifying the sequence of actions that are included in a service performance"* (Shostack 1982). The service blueprint makes it possible for designers to overlook each user action, evidence, and process needed to produce the service experience both in frontstage and backstage operations (Shostack 1982). By having this overview, the designer and stakeholders can extract how each step in the service performance affects the next. This blueprint outlines potential focus areas for service designers to tackle with lies within the data packages requested and sent throughout the user journey. The user will use less power on their personal computer if the packages are small, and the same goes for the network of routers and servers, as smaller packages require fewer data and compute power. The number of steps within the digital user journey can therefore affect the energy efficiency.

The underlying code that drives the service system is accessible through software and web developers. Most data centers that store service systems are already focused on energy efficiency and optimization of the server's hardware (Berry 2020). Service designers can thereby improve

energy efficiency by facilitating decision-making processes that focus on sustainable energy providers, data packages, and user journeys.

2.3 Research question

The following will summarize the insights gained through the literature review that led to the research question of this thesis. Digital sustainability has been defined as the orchestration of digital touchpoints, software, partners and server hosts, internal processes, and hardware towards eliminating CO2 emissions. The below points of action synthesize the outcome of the research conducted within the literature review and will be used as guidelines for the later investigation.

- User journeys (e.g., length and activities)
- Touchpoints (e.g., aesthetics and graphical expressions, storage, size, and data administration)
- Software (e.g., application software and internal software systems)
- Hardware and physical evidence (all physical aspects of digital services)
- Sustainable partners (e.g., server hosts, energy providers)
- Internal processes (e.g., garbage sorting, water, and energy consumption)

The main principles in service design highlight that value is created through a variety of stakeholders and people, who, together with the service designer, has the capability to impact the carbon footprint of a digital service. Using service design in the field of change management can potentially reduce resistance from the employees within an organization when implementing sustainable digital strategies. This thesis explores the research question of '*how might service design support the design and implementation of digital, sustainable services in IT practices'*. The research question finds itself in the gap between social practices, service design, and change management in relation to digital services as it aims to provide a supportive contribution to succeeding in implementing green and sustainable IT processes.

03

METHODOLOGY

3. Methodology

The project's overall methodological approach combines the human-centered design thinking methodology with the IT-oriented MUST method developed by Simonsen et al. (2008). This chapter presents the methodological approach employed in this project to explore the research question.

First, it introduces the design thinking methodology, which provides the framework to structure the overall design process of four studies that together creates a qualitative empirical foundation for the design process. Thereafter, the MUST methodology is presented, which is integrated into the design thinking model to explore the research question within an IT-focused framework. In addition, social practice theory will be used to structure the analysis and findings in three main areas of inspection. Lastly, the chapter provides an overview of the overall research process along with theoretical descriptions of the methods used within the methodological framework, as the methodological structure provides the project with specific guidelines and tools.

3.1 Design thinking

Design thinking is an iterative process that involves strategic and user-centered processes from which designers can develop new ideas (Brown 2008). It is a tool for problem-solving and innovation that shifts between a divergent and convergent approach (Boakye et al. 2021; Dam & Siang 2018). There are many variations of the design thinking model, which usually consists of three to seven stages (Boakye et al. 2021). This thesis will use the IDEO design thinking model, which entails the five stages: *empathize, define, ideate, prototype, and test* (Dam 2021).

The first stage is focusing on ‘empathizing’ with the people involved in or impacted by the project's research purpose. It aims to get a holistic perspective of the situation to ensure all interests and problematic areas are considered in the design process (Boakye et al. 2021). By gaining an empathic understanding of the problems concerning the problem area, designers can gain insights into what experiences and motivations impact the problem area. In this project, four in-depth interviews with current danish service providers were conducted to understand the users, their needs, and underlying problems related to the prevalence of digital sustainability in IT practices.

As the first stage is about diverging, the second ‘define’ stage uses converging methods to analyze and synthesize the insights discovered through empathizing (Boakye et al. 2021). To be able to progress into a phase of ideation, a clear definition of the problem is needed. This can be done by defining the core user struggles or beginning to formulate questions such as *“how might we”* (Dam 2021). The defined process enables designers to reflect upon the problems and insights to indirectly create a plan for finding a solution (Brown 2008).

The third stage is about starting to ideate and bring new possibilities to the table (Kelley & Littman 2001). Ideation is about coming up with ways to tackle the discovered needs and, thus, transform the design process perspective from problem identification to solution discovery (Boakye et al. 2021). This project uses a co-creative approach to support the ideation and viability of the design outcome (Sanders & Stappers 2008).

The fourth stage is ‘prototyping’. Prototyping is important not only for the realization of an idea but also for sparking new ideas (Brown 2008). By starting with creating low-fidelity prototypes and mock-ups, designers can quickly test and see if ideas work or should be altered (Dam 2021). This is an experimental stage that aims to come up with a fit solution on the basis of the users’ experiences.

The last stage of the design thinking process is ‘testing’ and is closely related to prototyping. By moving back and forth between stages of prototyping and testing, designers or evaluators can rightfully identify the best solution. As highlighted by Dam (2021), results and insights gained through building and testing prototypes are *“often used to redefine one or more problems and inform the understanding of the users, the conditions of use, how people think, behave, and feel, and to empathize”* (Dam 2021).

3.2 MUST

The MUST methodology was created by Simonsen et al. in 1998 and has since then been continuously updated to fit current IT practices (Simonsen et al. 2008). The method is rooted in change management and proposes a way to support the design of sustainable IT applications. The method proposes designers follow four grounding principles:

- A shared vision – a solution of the project must foresee a collective vision for the available technology, the work organization, and qualifications of employees
- Real user involvement – employees (users) have to be part of the project
- Practices must be experienced through first-hand experiences
- Anchoring – creating understanding and motivation for change and implementation of new solutions, all stakeholders who are affected by the change must be informed (in on the shared vision) to eliminate resistance

As the principles highlight, the MUST method takes a participatory approach as it practices collective creativity (Sanders & Stappers 2008). It aims to develop feasible solutions based on available technology, the work organization, and the qualifications of employees (Simonsen et al. 2008).

In the MUST methodology, co-development should include the three domains shown in figure 5 to ensure the viability and sustainability of an IT project. Therefore will, this thesis draws inspiration from the four principles and three domains throughout the design process. Furthermore, will the ‘affinity diagram’ method used to analyze user experiences in the MUST methodology also be deployed in the define stage.

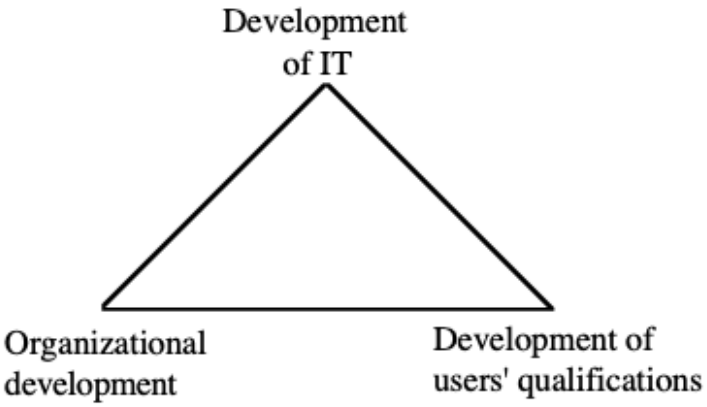


Figure 5: Co-development in related domains (Simonsen et al. 2008).

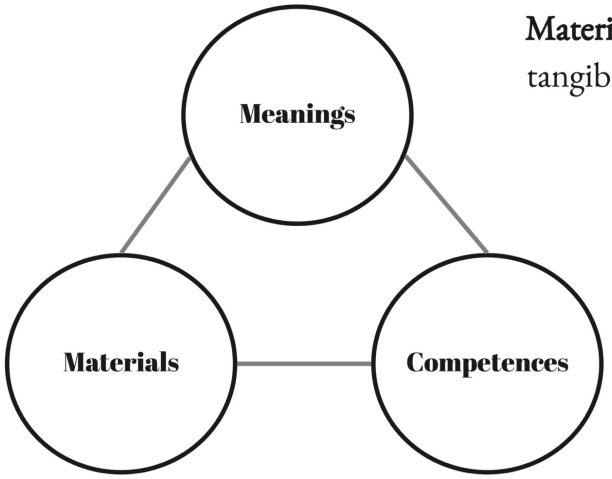
3.3 Social practice theory

In the definitions of service design, other characteristics related to the negotiation of values between a customer and service provider see services as *"socially constructed activity"* (Morelli and Loi 2001) and suggests using *"methodological approaches of social theories to help designers understand and manage the social and cultural aspects of service design* (Morelli et al. 2020).

The implementation of green IT has been on the rise for more than 15 years, and yet, the IT industry is still struggling with lowering its carbon footprint. One hypothesis is that many companies do not find the savings and increase in market competitiveness valuable enough. Another is that the employees do not have the right skillsets or desires to practice digital sustainability. To help discover what challenges IT companies are facing, this project will approach empirical findings through the social practice (SP) framework proposed by Shove et al. (2012).

Social practice theory defines and deconstructs how practices are formed by materials, meanings, and competences, suggesting that the reason why green IT is yet to be implemented might hide within the complex relationships of these elements. The methodological approach within this thesis will therefore use the Social Practice framework to help deconstruct the complexity of employee experiences.

The social practice framework consists of three elements that together create a practice: *materials, meanings,* and *competences* (Spotswood et al. 2015), whereas an individual is at the crossing points of these practices.



Materials: including things, technologies, tangible physical entities, and the stuff of which objects are made.

Meanings: symbolic meanings, ideas and aspirations.

Competences: which encompass skill, know-how and technique.

Figure 6: Three-element Social Practice Framework (Shove et al. 2012)

The three elements cannot exist solely, as they are interconnected and combined through complex relationships (Spotswood et al. 2015). The framework provides an overview of what causes certain behavior to exist (Shove et al. 2012). The thesis draws on Reckwitz's definition of practice as:

> "a routinized type of behavior which consists of several elements, interconnected to one other: forms of bodily activities, forms of mental activities, 'things' and their use, a background knowledge in the form of understanding, know-how, states of emotion and motivational knowledge" (Reckwitz 2002).

As service designers are interested in using user-specific knowledge in design projects, the deconstruction of a practice help enlighten possible problem areas and convert them into specific problem statements when analyzing a problem.

3.4 Overall design process

The project methodology gains inspiration from the MUST methodology and seeks to implement the four grounding principles within a design thinking process. Below, an overall structure of the design process is shown. The model includes the design thinking process combined with principles from the MUST method and presents the theoretical foundations and perspectives this thesis draws on to investigate the research question.

The four studies of the project were conducted in the spring of 2022. In addition to the two methodological approaches, toolkits from service design and MUST methodology includes in-depth interviews, stakeholder and customer value constellation mapping, creation of an affinity diagram and personas, and co-creation workshop activities.

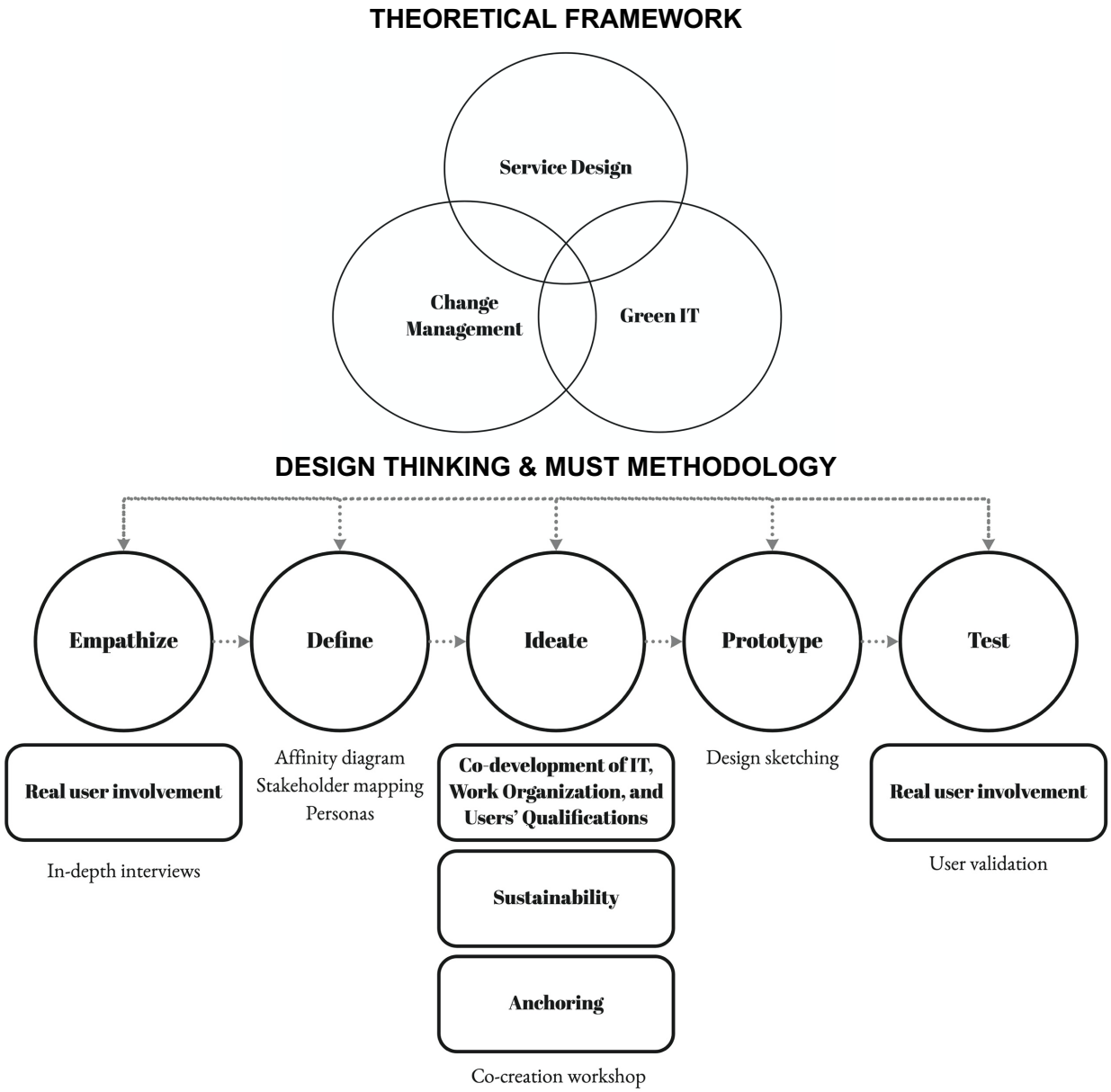


Figure 7: Theoretical and methodological framework

3.5 Reflections of methods

The project methodology is highly concerned and partially dependent on real user insight, with often calls for a comprehensive amount of observations, interviews, and context experience (Simonsen et al. 2008). Interviews have the ability to bias the investigation through what is referred to by Simonsen et al. (2008) as the say/do problem. The say/do problem stresses the fact that informants reply based on memory, self-identification, and underlying motivation or control factors which may affect the oral descriptions of their work practices. This can often be prevented by observing the informants in real work settings and through in-situ interviews or by 'looking over the shoulder' (Sanders & Stappers 2008).

When finding participants for this project, a total of 18 companies were invited to participate. Out of the 18, four companies replied yes, and 16 replied that they were 1) too busy to participate, 2) overwhelmed by student interests, 3) not believing that they would be able to make a positive environmental effect because of their size, or 4) simply not interested in digital sustainability. Furthermore, the companies that accepted only agreed to do one interview with the possibility of doing one more if needed. During the project, the participating companies had trouble finding time to participate in additional co-creational activities. This limited the project's empirical resources, but to compromise for lack of participation in the design process, the interviews used an in-situ inspired approach by interviewing and letting the informants present documents, processes, and systems used in the companies' real-life practices. This strengthened the reliability of the insights collected throughout the empirical study. This issue might have been avoided if the alignment of expectations for participants had been conducted during the recruitment process. This could have ensured a higher level of user participation throughout the project.

Another issue with having limited people collectively participating in the design process is 1) not having many people to come up with ideas and 2) comparing ideas and practices collectively. As the scientific foundation for this project's solution is mainly rooted in software and web development and change management, having more participants and experts within their own field contributing to the knowledge created could have supported the sensemaking and decision-making processes throughout the design process. Only interviewing one or two employees from each company provides an insightful but subjective view of the organization and its practices. It can be discussed if choosing one particular case study would be preferable to go in-depth with multiple employee practices in comparison to investigating four different companies to gain a general and more objective perspective on the problem area.

04

EMPIRICAL STUDY

4. Empirical study

This chapter presents the process and outcome of the main empirical investigation conducted during the project. The investigation includes four studies of four danish companies. It explores and analyzes the challenges and possibilities that current IT companies experience in relation to digital sustainability through in-depth interviews. Furthermore, additional methods and tools were used to synthesize the insights and knowledge gained from the analysis. The four studies include collaborations with the four following companies:

- Green Mobility (private company)
- Clearview Trade (private company)
- Novo Nordisk IT (NNIT)
- Alborg University IT department (public institution)

4.1 Methods

The following sections present the methods used to conduct and further analyze the data collected within the empirical study.

4.1.1 In-depth interviews

The study conducted four in-depth interviews (Bjørner 2015) with one informant from each company. In-depth interviews are particularly appropriate in situations where *"complex issues need to be clarified or where the topic is sensitive, taboo or controversial"* (Bjørner 2015). In this case, employees are asked to talk about their practices, challenges, and aversions in their daily work, making the topic sensitive to their position within the organization. The in-depth interview often results in very detailed information and usually produces rich data and new insights (Bjørner 2015). The interviews conducted within this thesis take a semi-structured approach to enable flexibility within the conversations with the informants. The semi-structured interview made it possible to reorder questions during the interviews and created room for exploration and undiscovered areas within the informants' statements. An interview guide was created for each of the interviews and acted as an interview guideline. The interview guide and recordings of interviews can be found in appendix 1,2,3 and 4.

4.1.2 Affinity diagram

After conducting all four interviews, data and insights were gathered in an affinity diagram. The affinity diagram is a method proposed within the MUST methodology to process large collections of data from interviews (Simonsen et al. 2008). The results of an affinity diagram create structure and overview of qualitative insights and are created by writing down important, significant, or questionable keywords and statements from interviews or observations on post-its, which thereafter are organized in groups (Simonsen et al. 2008). Groups of data that seem to go well together are given a suitable headline. For this project, excel was used as a digital tool to write down collected statements and to group and name the identified themes, categories, and data structures within the affinity diagram. Thereby, the affinity diagram is characterized by using a bottom-up approach as the

empirical data creates its own structure. The process of affinity diagramming within this project discovered the following themes: stakeholders, sustainable strategy, sustainable initiatives, service features and characteristics, problem areas, data and servers, design process and development. The affinity diagram is shown in appendix 5.

4.1.3 Stakeholder mapping

As one of the themes discovered within the affinity diagram was stakeholders, a stakeholder map is used to visualize and provide an overview of the various stakeholders that should be involved when creating digital sustainable services. This is done through a Customer Value Constellation map. Between all actors, there is an exchange of value, which drives the entire value constellation (Patricio et al. 2011). The CVC places the main customer goal in the center of the service system network and surrounds this activity with the services that enable the value constellation experience. It concerns implicit beliefs that guide behavior in the organization and involves investigating why actors are part of the network (Patricio et al. 2011). In this study, the analysis of each company highlighted similar stakeholders, and therefore a CVC is created based on all four companies despite their different value constellation experiences. The objective is to capture the value exchange of the different stakeholders that are a part of the service network. The CVC will also provide an understanding of where in the value constellation, resources and costs can be optimized in a sustainable perspective and affect the value creation positively.

4.1.4 Personas

At the end of the analysis, four personas are created and used as a medium for communicating the different roles, attitudes and their underlying motivations, challenges, and current practices (Pruitt & Grudin 2003). The persona descriptions provoke empathy towards different kinds of users (Nielsen 2022) and create a necessary understanding of why some companies and the roles of employees struggle with sustainable practices more than others. By using personas, the design process will be able to implement controversial opinions toward green IT in the design evaluation, which will strengthen the viability of the project outcome. The personas were furthermore created to make sure all different levels of sustainable practices were included in the design process. The personas are based on the data collected within the analysis and will support the design process by maintaining a user-centered perspective (Nielsen 2022). They also support the participation process by making data and insights from earlier stages in this project available for outsiders, such as the participant during the co-creation workshop. The personas create an overview of the different strategies, roles, and organizational cultures that are affecting the implementation of digital sustainability. As they are based on the data collected through the empirical investigation, they do not represent a specific company but a general role and attitude that can be seen within an organizational culture.

4.2 Structure of analysis

The following analysis investigates how service design can be used to discover the challenges related to developing digital sustainable services and how can service design tools help IT companies overcome these challenges. More importantly, it explores why digital sustainability is difficult to implement in practice and, furthermore, what current practices exist and need to change. As the interviews involved sensitive and employee-personal criticism of current practices, the four

informants' names and personal identifications are left out. Instead, their job titles are used to identify what their roles are within the organizations and reflects important roles within the personas. The analysis is divided into four sections presenting each company and analyzing the insights gained throughout the study. The discoveries from each study are followed by a synthesis of the collected insights.

- Presentation of companies and their relevance to the project
- Sustainable strategy
- Sustainable initiatives
- Design process and development
- Problem areas

4.3 Green Mobility

Green Mobility is a danish company offering a car-sharing service originally known as Din Bybil (Your Town Car). The company was founded in 2013 by Henrik Isaksen, who in 2015 started to develop the concept behind Green Mobility and their digital platform and processes. The company grew quickly, and by 2016, they had 400 electrical vehicles operating in Copenhagen, Denmark. Users find and reserve cars via the Green Mobility app, which also serves as a car key. They also provide a website where visitors can sign up can read more about their service.

4.3.1 Relevance to the project

As the name indicates, Green Mobility is an eco-friendly initiative for the service transportation sector. Their cars are connected to various IT systems, which require various digital systems to perform well and create value for the users and the company. Their strategy, standards, and design processes will contribute to the exploration of if and how common IT practices focuses on digital sustainability. Furthermore, the study focuses on finding problem areas that might be hindering a sustainable practice. The study was conducted through a semi-structured interview (Bjørner 2015) with the Tech Lead of the IT department situated in Green Mobility's headquarters in central Copenhagen. The first response received after contacting them about this project was that they had to decline due to overwhelming student interest in their work. A few days later, their Tech Lead reached out and agreed to an interview at their headquarters.

Figure 8: Green Mobility press photo

4.3.2 Sustainable strategy

When discussing Green Mobility's sustainable strategy, the following topics were raised. Firstly, the Tech Lead empathized the goal of Green Mobility is to have 10.000 electric cars to share in 35 cities by 2025. He mentions that this goal is typically the first priority in the company's agendas and that in a smaller organization like theirs, they often tend to focus on that one goal than setting others.

> "We often try to do the right thing, but in a busy schedule, we often have to say 'Making sure these cars are operating is our most important contribution to sustainability', which means we do not focus on that many other initiatives" (Tech Lead, Green Mobility, appendix 1)

He follows up by stating that because the organization is still small, they do not have a very high in-house supply of hardware, electricity, and other expenses. As a frontrunner within the danish car-sharing community, they publish a yearly ESG report (European Commission 2022). The Tech Lead supports the need to address the ESG goals but highlights that constructing these reports requires energy and money.

> "Even though it is a small thing to do, it takes energy and money to conduct. But even so, we believe that if we, as a company working for sustainability, did not do it, who else would?" (Tech Lead, Green Mobility, appendix 1)

Despite the acknowledgment of priorities focusing on scaling, the Tech Lead acknowledges his own role and potential for change. He expresses concern about how the company can gain this knowledge and the need to be able to compare with other companies:

> "I think it would be nice to have a way to compare yourself with other companies and share knowledge and tricks. Sometimes I wonder if it is my own fault we do not know more about this or if the information simply does not exist" (Tech Lead, Green Mobility, appendix 1).

4.3.3 Sustainable initiatives

The following presents the sustainable initiatives applied in Green Mobility.

- Cars were recently updated to a new model that has a more efficient battery. The old cars were sold off to another company.
- Partnering with an electricity supplier that produces renewable energy when possible
- Using cloud-based services and limiting the number of servers needed for reporting and operating the service
- Data compression to strengthen the performance of systems
- Trash sorting and recycle systems at the headquarter
- ESG report

During the interview, the Tech Lead expresses concern about not making drastic changes. He states: *"Sometimes I feel people take too small steps to get where they want to go"* (Tech Lead, Green Mobility, appendix 1). The many perspectives and reflections Green Mobility has on the topics of

digital sustainability express a growing interest in the field, and they see the potential in learning more about this to strengthen their company profile.

In relation to databases, the Tech Lead shows a great appreciation for their serverless system approach. By switching to serverless and cloud-based software, they use very little energy to develop new software and implement additions to the service (e.g., Bluetooth registration). Another perk with serverless is that they *"do not use any servers when the users are not using the cars"* (Tech Lead, Green Mobility, appendix 1). This reduces the costs and CO2 related to their operations. They also try to split the service up independently, enabling them to switch servers on and off. Here, a problem of remembering to turn off servers has caused high bills from their platform developer. The Tech Lead highlights this as a downside of using a serverless approach, as it is very easy to turn on servers through cloud platforms, but it is hard to remember to turn them off: *"If you forget to turn off one server, you easily spend 5000 DKK"* (Tech Lead, Green Mobility, appendix 1).

The interview did also show one problem area related to the use of JavaScript. The Tech Lead chose to use JavaScript even though he knew it runs a bit slower than other programming languages and takes up more CPU. This decision was made based on the evaluation of the employees' capabilities and expertise.

> "If we were to learn a completely new language, it would take too much time and resources to get all the employees to learn how to code with it. The cost of spending that many additional hours was the reason we chose to keep using JavaScript. I chose JavaScript because it is the easiest for us and not because it is the smartest" (Tech Lead, Green Mobility, appendix 1).

4.3.4 Design process and development

The interview also addressed the design and development process within the IT department of Green Mobility. Here, they use SCRUM as a methodology to structure their development processes. They use diagrams to visually communicate design requirements internally, and they are highly focused on sharing knowledge between team members to ensure the overall capabilities of each employee. The Tech Lead also prioritizes reaching out and learning from various digital communities at conferences, blogs, and debates. This works most of the time, but in relation to digital sustainability, the Tech Lead states: *"Sometimes it is just too complex to know what you don't know"* (Tech Lead, Green Mobility, appendix 1), suggesting there is a gap in implementing a sustainable practice and the employees' knowledge.

4.3.5 Problem areas

One of the most dominating problem areas addressed in the interview was the lack of data about the service systems' power consumption. This makes it difficult to provide accurate estimations to the ESG report. The Tech Lead explains that it is not possible for them to figure out how much energy they use because it fluctuates every minute. Therefore, they are very interested in working with this to be able to perform better in the ESG report and improve their tracking of CO2 emissions, as this could potentially be a competitive advantage.

There is also a wish to be able to compare themselves with other companies to know what and how they should incorporate changes. This is also affected by internal agendas and the economy, as all sustainable initiatives have to be approved by the board and backed up financially for a profitable business model. Even though the serverless approach brings many advantages in centralizing servers and databases, another problem area is the lack of influence they have on their stakeholders' energy suppliers. By using cloud services, they cannot control the energy sources used to provide power for their service.

Within the design process, there is a potential problem in gaining new knowledge as the department simply does not have the time and guidance needed to achieve this knowledge. These problem areas suggest that Green Mobility has had considerations about implementing a digital sustainable mindset and procedures but has not yet made it a reality. As the company prioritizes scaling their service and they do not have the expert knowledge to create sustainable optimizations, it suggests that the potential for making changes to their work practices is within the shared meanings and opinions across the organization and the development of employee competences.

4.4 ClearView Trade

Clearview Trade is a complete digital solution that connects all partners in international trade. They help digitize international trade, minimize the time and resources companies use to book transportation, and complete and manage export documents and certificates. They work together with the ISO standardization committee, Peppol, and EU e-Delivery working groups to develop new open standards for transport and logistics (Clearview Trade 2022). They support organizations dealing with waste from paper and environmental packaging. Their export portal is web-based and contains all the features with a ‘pay for what you need’ business model. The main user touchpoint is the website portal, where all user actions take place.

Figure 9: Clearview Trade press photo

4.4.1 Relevance to the project

With over 3.500 companies using their service, Clearview Trade is an example of how digitalization can reduce the need for papers and psychical documents, reducing the resources related to an existing practice. As their service is web-based, the digital infrastructure plays a big part in their overall environmental impact. Therefore, by studying their strategy, work practices, and infrastructure, the project will gain insights into how companies use similar ‘software as a software’ models. The study was conducted through a semi-structured online interview with the IT Manager of Infrastructure and Operations.

4.4.2 Sustainable strategy

The IT Manager of Clearview Trade makes it clear that he believes the best way to lower their CO2 emissions of through the reduction of costs. For him, CO2 emissions quals less power usage, which

means fewer servers and less server activity. Therefore, Clearview Trade has implemented a server infrastructure that divides their processes and data into separate building modules, which can be turned on and off independently: *"There are two reasons why we chose this infrastructure. One is the economic savings and the other is the CO2 savings."* (IT Manager, Clearview Trade, appendix 2). This indicates that the company is willing to work with digital sustainability as long as the effort is creating financial advantages.

Although they are aware of lowering their power usage, the IT Manager admits that safety and, thereby, the redundancy of their servers are their highest priority. To ensure the platform works 24/7 on-demand, they require lots of backup servers to run simultaneously. They constantly evaluate the necessity of adding more servers as they prefer to save costs if possible. He thinks that many companies choose to be safe and secure rather than green and server-saving, which results in multiple servers being used for backups only. By viewing cost savings as the same as reducing CO2, the IT manager emphasizes that they do not concern themselves with digital sustainability in their day-to-day work practices. *"We focus on reducing our own costs and thereby also our CO2 emissions. Therefore it is not something we spend much time on in our daily tasks."* (IT Manager, Clearview Trade, appendix 2). When asked about the competitive branding value that comes with having a sustainable strategy, the IT Manager replies:

> "We do not brand our infrastructure as sustainable. We do it kind of implicitly through our service that digitalizes the processes. Let us say 100 papers a month pr. Customer. This might add up to one tree each year. It is interesting to know what kind of environmental damage the digitalization of this causes" (IT Manager, Clearview Trade, appendix 2).

This indicates that Clearview Trade has an interest in resolving the question of where in their value constellation they are causing CO2 emissions. One of the reasons they do not brand themselves as sustainable is because it is not a need they hear from their customers. Therefore, the IT Manager does not believe that Clearview Trade's digital infrastructure can create CO2 reductions great enough to affect the environment.

4.4.3 Sustainable initiatives

Based on the interview, Clearview Trade has implemented the following initiatives for a more sustainable practice.

- Optimizing the compute time and performance level of all service touchpoints
- Reducing costs on servers and thereby reducing power usage
- Remote working practices to reduce the need for transportation
- Reduction of databases to speed up work processes (from 140 to 50 gigabytes of data)
- Reducing unused code to enhance performance levels
- Reducing CPU cycles

Their initiatives on optimizing their code and server infrastructure can have a big impact on their carbon footprint, as presented in the literature review. In contrast, they do not use a recycling system to purchase new hardware for their employees as they believe that: *"It is more important than a*

computer can be used for many years and satisfy the needs of the employee for them to be able to fulfill their tasks fasts" (IT Manager, Clearview Trade, appendix 2).

Furthermore, they do not believe that sustainable web design can make significant changes and that the principles within do not comply with real practices: *"It would be too boring and difficult to stand out if we all should have a black website with small pictures"* (IT Manager, Clearview Trade, appendix 2).

4.4.4 Design process and development

In relation to the overall design processes, Clearview Trade also utilizes SCRUM as their project management methodology. They have an agile framework that focuses on testing new implementations multiple times to ensure high-quality outcomes. This is also described as a *"Why, What, and How approach"* (IT Manager, Clearview Trade, appendix 2).

During a SCRUM project, a design document is created to establish a shared vision for the project. At the interview, an example of a newly made design document was shown to represent their way of working with visual models. The design document contained a use case diagram, a swim lane diagram, and a sequence diagram. Through an iterative process, the design document gets updated each time a developer or UX designer has made new changes to it (IT Manager, Clearview Trade, appendix 2). To create the visual models, the employees use a Miro Board and Draw.io as platforms for creating mock-ups of their design and design requirements.

4.4.5 Problem areas

Clearview Trade is already working on optimizing their power usage and compute time. This relates directly to their CO2 emissions, indicating that Clearview Trade might already have a relatively sustainable platform. As the requirements for a 'sustainable platform' is still undefined, the term relatively covers a platform that uses as little power and CPU as possible for the existing service system.

Their cost-saving approach is positive towards the development of digital sustainable services, but the lack of acknowledgment and focus on sustainability suggests that they do not have a shared vision for the meaning and importance of sustainable IT methods, e.g., sustainable web design and sustainable procurement agreements. Their work practices also highlight the need to create value when starting new IT projects. Digital sustainability does not seem important enough that costs and resources expand, but it is an added bonus if the method can reduce costs.

Furthermore, the company does not use any service design tools but uses many models and diagrams from the field of software engineering. As a majority of their employees are software engineers and programmers, they have certain models explaining complex requirements, which is needed in order to ensure a high level of communication. Just as Green Mobility, Clearview Trade would have to incorporate new capabilities within their employees if they were to use different tools than they already use.

The analysis of Clearview Trade advocates that the company has strong competences in creating energy-efficient solutions but does not acknowledge and use digital sustainability as a method to

achieve this, as their motivation lies within the financial gain. As they prioritize and evaluate their compute levels and power consumption often, they have the technology and means to start implementing a greener strategy but might lack specific competencies about what methods and tools they can use to reduce their energy consumption further.

4.5 Novo Nordisk IT

Novo Nordisk IT is a danish company also known as NNIT. The NNIT Group provides IT and consulting services across industries in 12 countries worldwide. They develop, implement, operate, and advise on IT solutions using the newest technology, such as AI and cloud services. As they create IT systems for other companies, their work practices, and infrastructure affects multiple digital services and their CO2 emissions. They have a headquarter in Denmark and employ more than 3000 people across the world.

4.5.1 Relevance to the project

By studying NNIT, the project gains insights into how one of Denmark's biggest IT companies works with sustainability. This will help uncover what is possible for companies to take on when reaching a certain size and contribute to the investigation of work practices within a large organization. The interview was conducted at NNIT's headquarters in Søborg, Copenhagen. Their Senior Communications Consultant is responsible for implementing new sustainable practices within the entire organization. She agreed to meet and discuss their work regarding sustainability.

Figure 10: NNIT press photo

4.5.2 Sustainable strategy

As mentioned above, NNIT's sustainable strategy is framed by ESG goals. Each year, the report conducted by Sustainalytics provides NNIT with an overview of their performance which gives them an incentive to improve certain aspects of their organization.

The communication and marketing department is responsible for sustainable change, and sustainability has therefore been anchored as a project within this department. Compared to the other studies conducted in this thesis, the communication and marketing department seemed as a

strange place to focus on creating changes in ongoing practices, but as the consultant highlights, communication is a big part of implementing change.

> "It is something that you typically see that the work with responsibility ends up in the communication department also because it is very much about communicating. After all, it is a process of change when larger companies want to start working more sustainably." (Communication consultant, NNIT, appendix 3)

NNIT follows the 'three p's', which include *"people, planet, profit"* (Communication consultant, NNIT, appendix 3). They focus on social and environmental change and often experience how these two are related and will make the organization appear more attractive to their customers. They have noticed a change in their customers' demands, focusing more and more on NNIT's sustainable profile. *"It is great when customers ask for sustainable solutions. It makes it so much easier to get initiatives approved by the directors"* (Communication consultant, NNIT, appendix 3). The customers' tendencies to require greener partners seem to show that the need to work more with sustainability goes both ways – from customers to service providers. And with companies like EcoVadis, the transparency is improving across the danish market, suggesting that this tendency will spread in the years to come.

The strategy involves collecting data from the ESG rapport and gathering the sustainability committee to review and decide what initiatives to take on next. They decide based on what is the most strategic initiative for them, including what is achievable within the next year. This suggests that the committee chooses initiatives that are manageable to implement and will give them a better score in the next report. Thereafter, the chosen initiatives are put into an excel spreadsheet and delegated to relevant departments. A problem with this strategy was raised by the consultant:

> "If you take a look at our current CO2 footprint, it does not include water, daily waste, and travel. If we include this data, next year's report will grade us worse, even though we have become better in certain areas and better at collecting adequate data" (Communication consultant, NNIT, appendix 3)

In this quote, it becomes clear that the profit gained from having a strong, sustainable profile is the most important factor when implementing sustainable initiatives. If certain initiatives do not improve the overall profile of the organization within one year, the initiative is withheld and saved for later, when the organization is more prepared to complete the task. This might cause problems in sustainable acceleration, as companies deliberately choose to slow down their implementations of new initiatives to receive better ESG gradings. Despite these issues, NNIT has set a goal to include water, waste, and travel in their next report to create a realistic foundation for future initiatives.

NNIT does not yet have a written agreement on how much sustainability should be included in a business proposal. The sustainability committee is working on creating a systematic producorial agreement stating that all offers should be evaluated in three main areas: price, quality, and sustainability. The informant has experienced a proposal stating *"sustainability must count for 10% of the total offer"* (Communication consultant, NNIT, appendix 3). At the proposal presentation, she got to present the sustainable progress for six minutes and did not receive any questions or

comments on the topic. She believes this is because clients searching for an IT solution are not that invested in digital sustainability and only see it as a bonus but not as a criteria.

4.5.3 Sustainable initiatives

NNIT has been working actively on improving their sustainable profile. These include the following initiatives:

- Sustainable procurement agreement in progress (compliant with ISO 20400 standard)
- Garbage sorting
- Reporting and transparency of sustainable change
- Participation in Digital Clean Up day
- Reducing emails through file-sharing
- Made leasing of electric cars more attractive for employees
- Implemented the SDG framework and ESG goals in their overall strategy
- Improving server efficiency

NNIT hosts their own servers and has three main data warehouses. They have actively improved the overall power and cooling efficiency, making their servers highly sustainable compared to others (Communication consultant, NNIT, appendix 3). One of their main concerns is how to power the servers with renewable energy, as it is only possible to use renewable energy when the energy suppliers can extract power from the wind, sun, and water. Therefore, they are currently working on creating a circular system for the excess heat created by the servers. The idea is to transfer the heat into their local heating system and to the local area.

Even though a system for sorting garbage within the headquarters was assumed to be an easy task, the informant highlights specific problem areas that had made the implementation difficult.

> “Some time ago, we had new bins set up where we have to sort in four different boxes. People cannot figure it out. Our cleaning staff can also not find out that the reason we have a box with a paper bag in it is because we want to save plastic bags. Now, they started putting plastic bags in the paper bin because it is easier to empty it. It just has to go fast and be easy” (Communication consultant, NNIT, appendix 3)

This highlights the need to anchor changes across stakeholders. Another issue was related to Digital Clean-Up day, which involves employees deleting unused data from their PCs and communication platforms. Although the initiative is short-term, the communication department received some complaints, saying that they should be careful about deleting data and aware of security issues and that deleting data will not have any impact on the environment. This shows that clear vison based communication about new initiatives is important to avoid resistance within the organization.

4.5.4 Design process and development

Regarding sustainable work processes, the consultant explains the average process they go through.

> “First, we take a look in the ESG report and figure out what problem areas we should concern ourselves with. This is done by me and my student worker. Then, we propose a list of initiatives to the sustainable committee. When we have received approval from the relevant directors, we gather all the related tasks in our Excel sheet and list relevant stakeholders.” (Communication consultant, NNIT, appendix 3).

While discussing the process of implementing new initiatives, the communication consultant raises awareness about how difficult it is for them to identify the small steps needed to succeed in implementing green processes. *“For each project, we try to identify each step we need to take, but it is difficult to figure out what to do when the goal is unclear”* (Communication consultant, NNIT, appendix 3). To solve this, NNIT focuses on using the SDG and ESG framework and ISO standards (e.g., ISO 20400 procurement standard).

4.5.5 Problem areas

The most prominent problem area addressed during the interview med NNIT was how to collect and validate the data they use for the ESG report that generates the entire profile of the organization. The communication consultant reached out to all of NNIT’s HR and Facility departments on an international scale to ask for documentation, and often, she receives a copy of an electricity bill. This is very time-consuming and lacks validation.

Another issue concerns how different department has fixed practices and preferences regarding their work habits. Examples include Digital Clean-Up day, garbage sorting, and changes in the procurement agreement.

Another factor is the lack of understanding and acknowledgment of sustainable change. The informant explains how they lack a way to compare themselves with other companies of their size but since all companies have different ways of doing things and because of the many ways of measuring (e.g., ESG, CEMA-sys) sustainable progress, NNIT finds it challenging to compare and relate themselves to other stakeholders on the market. There is no common procedure for what parameters companies should measure as this is determined by which reporting system is used. NNIT finds it very important that companies start sharing their knowledge and experiences with green IT instead of seeing it as a business secret (Communication consultant, NNIT, appendix 3). Although NNIT finds collaborations with universities valuable, they struggle with the alignment of practices.

> “The ideas discussed at the meeting were really good, but afterward, my colleges from the Software and Development department told me ‘It is just two completely different worlds (…) We are talking about two very different things here’ and that is where we currently are dealing with.” (Communication consultant, NNIT, appendix 3).

In addition to that experience, the communication consultant expresses agreement with the research question of this thesis, saying:

> “But it is the right thing to do, to work with universities, researchers and practitioners. It's right to put them together and find out how we can make things better. There's just a long way to go.” (Communication consultant, NNIT, appendix 3).

NNIT acknowledges the potential value that sustainability can apply to their business model, but at different levels of the organization, the aspiration to why they need to act more sustainably is suffering from fixed habits and resistance to change.

4.6 AAU IT Department

The AAU IT department is an internal branch in the Aalborg University institution. They provide the Aalborg and Copenhagen campuses with technological infrastructure such as setting up emails for employees and students, providing internet and the technological foundation needed to run a university. They manage the entire IT operation. They have a team of developers ensuring the main touchpoints, such as the AAU website and their five digital applications, are updated and running smoothly, and a support team that makes sure daily requests and obstacles get sorted quickly. To manage these departments, they have a strategy department that deals with the overall digitalization strategy of AAU.

4.6.1 Relevance to the project

The AAU IT department was broad into the project to investigate how public institutions are practicing digital sustainability. As an IT department with various projects reaching across daily operations, and the development of digital touchpoints digitalization strategy, it is relevant to uncover how such an organization deals with sustainable development. As a public institution, AAU is subject to the agendas and goals determined by the Danish Government and the Ministry of Higher Education and Science. Their practices and insights will expand and complement the project's knowledge about existing sustainable practices in IT development. AAU will therefore provide a portrait of how public institutions can adjust to a greener development process. An interview was conducted with the Team Leader and Digitalization partner of AAU's IT department. The interview took place through Teams, as the Team Leader is situated in Aalborg, Denmark.

Figure 11: AAU Aalborg press photo

4.6.2 Sustainable strategy

In a sustainability report from 2020, AAU writes:

> "In 2020, after broad consultation and support among staff and students, sustainability is now an explicit focal point for AAU operations. This is formally expressed in the Aalborg University Policy on Balanced and Sustainable Development." (AAU 2020)

The report highlights the main initiatives implemented by AAU, which include reduced energy consumption, sustainable building, garbage sorting, and biodiversity gardens. The report also states that AAU contributes to sustainable development by providing education in sustainable energy engineering, building design, and sustainable energy management and planning, whereas the latter focuses on creating cost-effective energy solutions. The AAU strategy mainly focuses on using and developing sustainable energy, and they claim that

> "Fully 100% of AAU's electricity consumption comes from sustainable sources (wind power). AAU still focuses on potential ways to reduce – for example, the new green accountancy initiative (2021) to reduce CO2." (AAU 2020)

The interview highlighted a contractionary approach within the IT department. The Team Leader argues that *"No one can promise that they use renewable energy all the time. The security of supply is not advanced enough. If there is no wind, there is no wind power."* (Team Leader, AAU IT, appendix 4). When asked if the department had a specific sustainable strategy, the Team Leader informed that they did not, in fact, have a written strategy on the matter, and they did not have any specific objectives or goals concerning energy efficiency. As a member of the strategy department, the informant did not know of any strategic interventions but that the IT department might be instructed to do so by the directors to create a strategy in the future. He mentions that the procurement department has a policy concerning new hardware but that the overall strategy does not include clear guidelines for digital sustainability. AAU hosts two of their own servers at Aalborg Campus. The informant mentions that the IT Infrastructure Manager has improved their servers and their performance, which contributes to more sustainable energy consumption.

4.6.3 Sustainable initiatives

The following initiatives present AAU's existing sustainable initiatives:

- The procurement department focuses on sustainable supply chains
- Servers that meet new standards in cooling
- Reduced energy consumption (In buildings, e.g., smart lighting)
- Sustainable building
- Garbage sorting
- Biodiversity gardens
- Reporting over progress

The Team Leader of the AAU IT department has not yet implemented any initiatives regarding digital sustainability. When choosing their new host, they did not consider Microsoft's sustainability profile but are now aware that Microsoft is working on becoming CO2 neutral. When asked about sustainable web design, the Team Leader shows resistance due to the lack of impact of such initiatives:

> "I don't think you can say any website is greener than others. There are too many parameters, such as traffic and content. I do not think it matters if we put three more photos on our website. Maybe it does for the giants like Google." (Team Leader, AAU IT, appendix 4)

Instead, the Team Leader focuses on the hardware and methods used to develop IT products. In their work practices, they focus on optimizing the performance of their digital solutions, suggesting that they do, in fact, work on lowering energy consumption. Another perspective is that every time AAU digitalizes a part of their services, the need for paper is being reduced (Team Leader, AAU IT, appendix 4). This suggests that AAU follows the belief that digitalization in itself will reduce their carbon footprint.

In relation to the procurement agreement, the Team Leader shows similar opinions as Clearview Trade, as he thinks the quality of their computers and other hardware is more important than buying sustainably.

> "If I have to be completely honest, I would think my job got worse by sitting with a machine that was four years old. I also do not think that I can technologically fulfill my job if I use technology that does not use the latest speeds, optimizations, and battery life." (Team Leader, AAU IT, appendix 4).

Even though the informant does not believe that using sustainable web design methods and buying recycled hardware would strengthen their business model, he highlights that by using cloud services and lowering their server activity, they can reduce their financial costs and therefore also reduce their energy consumption. He emphasizes that the main reason they improve the performance of their digital solutions is to improve user satisfaction.

4.6.4 Design process and development

The Team Leader highlights that they use an agile framework and a strict SCRUM methodology to ensure a steady development process. They use different artifacts such as use cases, epics, and tasks that they manage through the project management software Jira. The IT department also follows design thinking principles when developing new solutions. As their main users are students, they follow the design thinking approach by empathizing with users and conducting user tests. Prototyping is also an important part of the development process, which is often produced through the online design software Figma. The process of prototyping includes digital design sketching, mock-ups, and high-fidelity prototyping.

> "We don't use a lot of physical drawing technics as the online tools are great for the purpose of prototyping. We also make database diagrams, ER models and so on, with online tools" (Team Leader, AAU IT, appendix 4).

When asked about service blueprints, the informant explains that they try to go from idea to technological prototype as fast as possible. This is because of budgets and negative experiences with creating user journeys and similar models.

> "You can keep making documents about how cool things get, but no one has ever seen or tried anything. But we have a completely rigorous model for what it takes before things can be approved." (Team Leader, AAU IT, appendix 4).

4.6.5 Problem areas

The main problem area raised by the Team Leader was concerning the internal communication about system requirements. It is experienced that aligning the developers is a crucial part of the design process and that using tools such as prototypes and diagrams supports the communication.

Furthermore, the Team Leader mentions how easily employees accidentally can turn on a server and forget to turn it off again. This can cause significant increases in their bills from Microsoft, making it a great deal of concern. By having a focus on the costs and expenses, the AAU IT department manages to touch upon digital sustainability without realizing that they are doing so. This suggests that performance levels are valued higher than sustainability to ensure a fast and efficient user experience. Even though the Team Leader does not believe that sustainable web design can have a significant effect, he uses other methods, such as deleting unused code and server management, to reduce their costs and energy consumption.

4.7 Defining problem areas

This section synthesizes the insights and knowledge collected throughout the empirical studies. The analysis breaks down the complex concepts and problems related to practicing digital sustainability into smaller and more defined components. The synthesis will compare and gather the collected insights to define areas for intervention that can be formulated into an actionable problem statement. The results will be interpreted through the social practice theory framework as a method to define the overall problem areas these companies face when dealing with digital sustainability. Firstly, it presents the stakeholder network related to digital sustainability. Secondly, it defines three personas based on the analytical findings. Third, it presents the main findings of the empirical investigations and presents the problem statement of the further design process.

4.7.1 Stakeholder CVC

Throughout the interviews, various stakeholders were mentioned by the companies. Through a CVC, the most common and influential stakeholders in relation to digital sustainability are identified by merging and categorizing each company's stakeholders. The CVC uses examples of external actors discovered during the interviews (see appendix 6 for full size) and integrates the internal actors of the organization to highlight who of the internal value providers are affecting the overall level of sustainability.

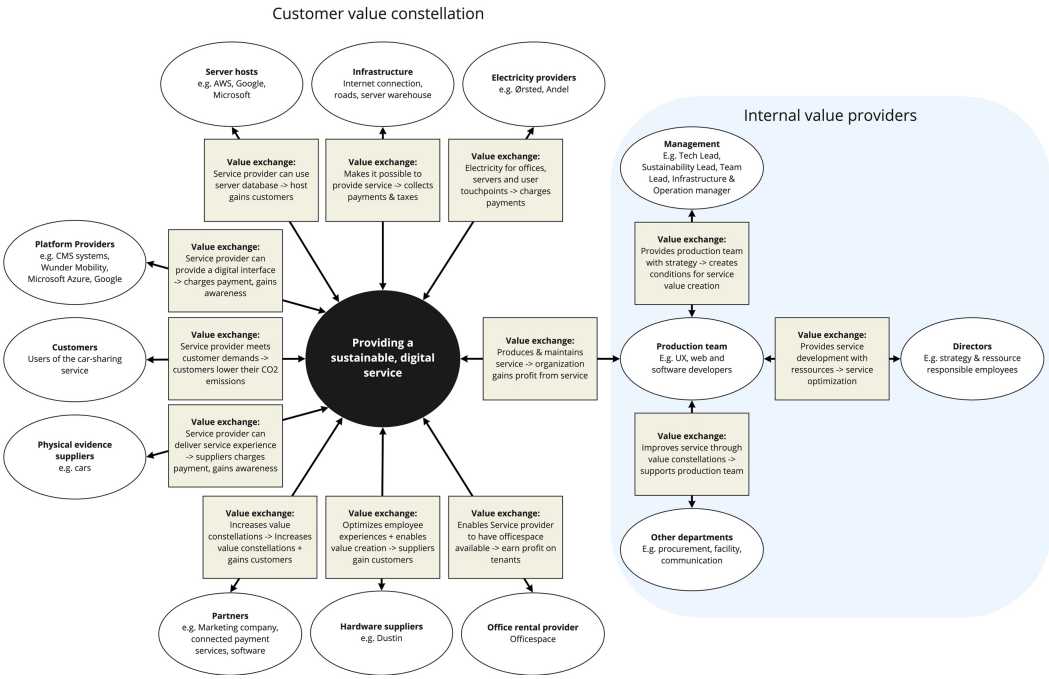


Figure 12: Customer Value Constellation with additional internal stakeholders (appendix 6)

4.7.2 Personas

Four personas based on department roles emerged from the analysis and were visualized to ensure a solution that embraces the various opinions, beliefs, resistance, practices, and maturity. These personas are based on empirical investigation and will be used as guidelines for the ideation phase. Because this thesis is situated within the field of social practices, the personas present behavioral archetypes of roles that can be found within different organizational cultures in IT companies.

Furthermore, they highlight some of the obstacles IT companies and employees are dealing with when implementing new practices. The four personas illustrate how organizations can have different skills and experiences, goals and motivations, design practices, and challenges. All of these factors influence level of readiness and motivation (maturity) needed to start implementing digital sustainability. The background color on each persona symbolizes how much focus they have on sustainability (green being the most, red being the least). The personas will be used in the ideation phase and can be seen in the appendix 7.

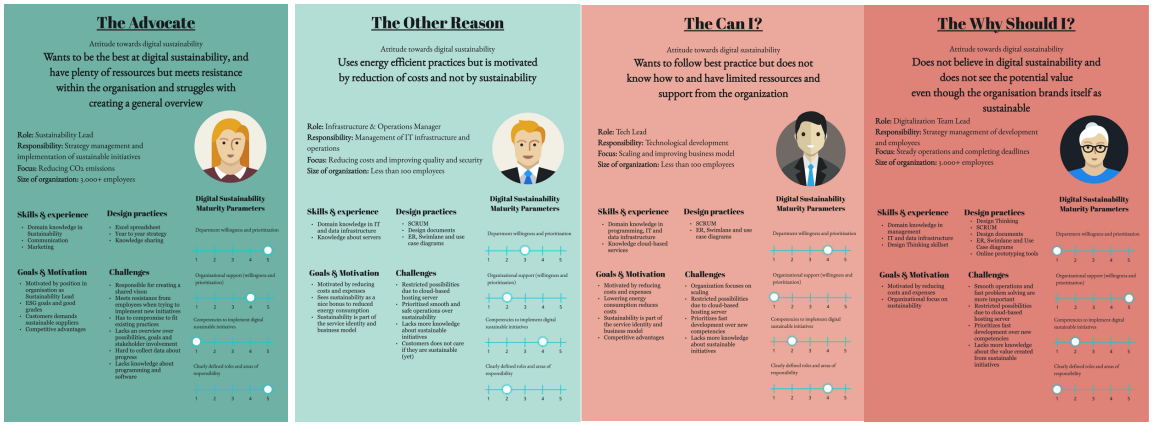
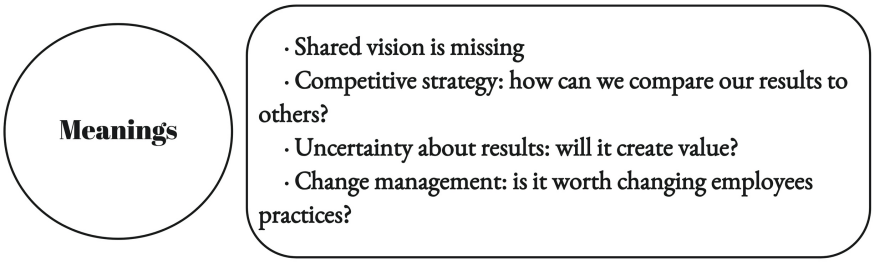


Figure 13: Personas (appendix 7)

4.7.3 Meanings

The four companies express different initiatives to implement energy-efficient methods. NNIT has the strongest will to become more sustainable, as their clients and customers are starting to expect a high level of sustainability from their suppliers. NNIT's focus on the ESG goals also requires them to establish a network of sustainable aware stakeholders. Clearview Trade prioritizes power efficiency due to the reduction of costs and sees the reduction of CO2 as a positive but not necessary bonus for their value creation. Green Mobility also follows the ESG taxonomy and sees themselves as responsible for using sustainably aware technological infrastructure but struggles with prioritizing such a strategy in daily tasks. AAU IT department shows the strongest resistance towards digital sustainability and does not believe such interventions will create sustainable value.

Common for all of the companies is the uncertainty of how big an impact digital sustainability can create. They all have uncertainties about how they will be able to see and compare their results to others. They also struggle with employees not sharing the same need for change and have to negotiate sustainable interventions, often resulting in compromises that affect the sustainable impact negatively. This shows that clear shared vision-based communication between all stakeholders is important to avoid resistance within the organization. It also suggests that their concerns about spending resources on implementing new practices and training their employees outweigh the motivation for using digital sustainability. The model below presents the insights collected during the studies concerning the element of meanings.

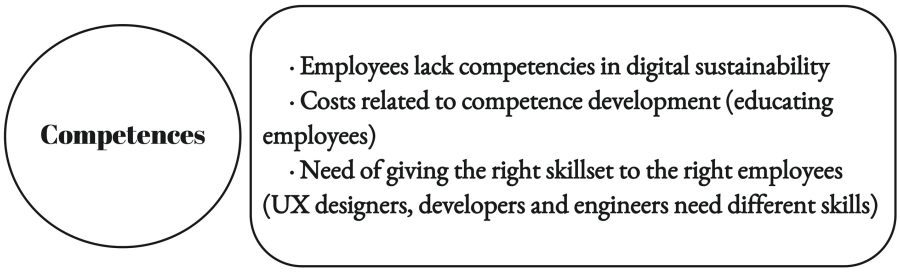


4.7.4 Competencies

The four IT companies have different problem areas concerning competencies. NNIT has the in-house competencies to reduce their energy consumption but lacks a broader understanding of which

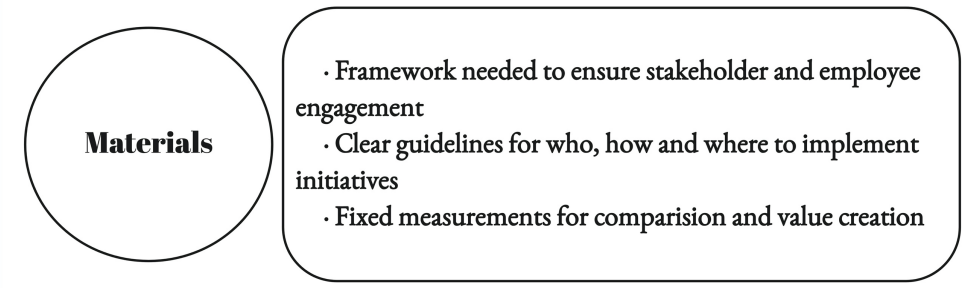
digital initiatives can be implemented and introduced to the employees. They show a strong will to learn about digital sustainable innovation. On the other side of the spectrum, AAU's IT department does not have an interest in using resources on digital sustainability, such as sustainable web design, but they do have a strong interest in promoting themselves as a sustainable organization focusing on green servers and renewable energy. Clearview Trade shows a broad skill set in the reduction of energy and server activity, and Green Mobility is interested in improving their sustainable competence profiles.

Overall, the main problem that the companies mentioned is related to the costs and resources related to developing the employees' competences. To ensure a shared vision and general understanding of digital sustainability, companies will have to educate and give different employees different tools as their practices will impact the sustainable outcome. UX designers need a skillset in sustainable front-end design, developers need a skillset in using performance optimization methods and reducing JavaScript, and the management department needs competencies in creating a structure for the implementation of digital sustainable initiatives.



4.7.5 Materials

The studied companies all have the technological maturity to implement digital sustainability. Even so, the companies are struggling to see how they can reach the value potential that comes with digital sustainable practices. NNIT currently uses an excel sheet to navigate through stakeholders and initiatives. Green Mobility, Clearview Trade, and AAU's IT department have no framework for working with digital sustainability. This suggests that to implement such initiatives, the companies could be supported by a flexible framework that suits their different needs and practices. They also do not have the tools for comparing themselves with other companies, making it difficult to see how well there are doing and how they can produce competitive value from digital sustainable initiatives.



4.7.6 Problem statement

This section presents the main problem areas that should be addressed in the ideation and future solution. It combines all three elements from the social practice theory framework and transforms each bullet point into a three folded problem statement.

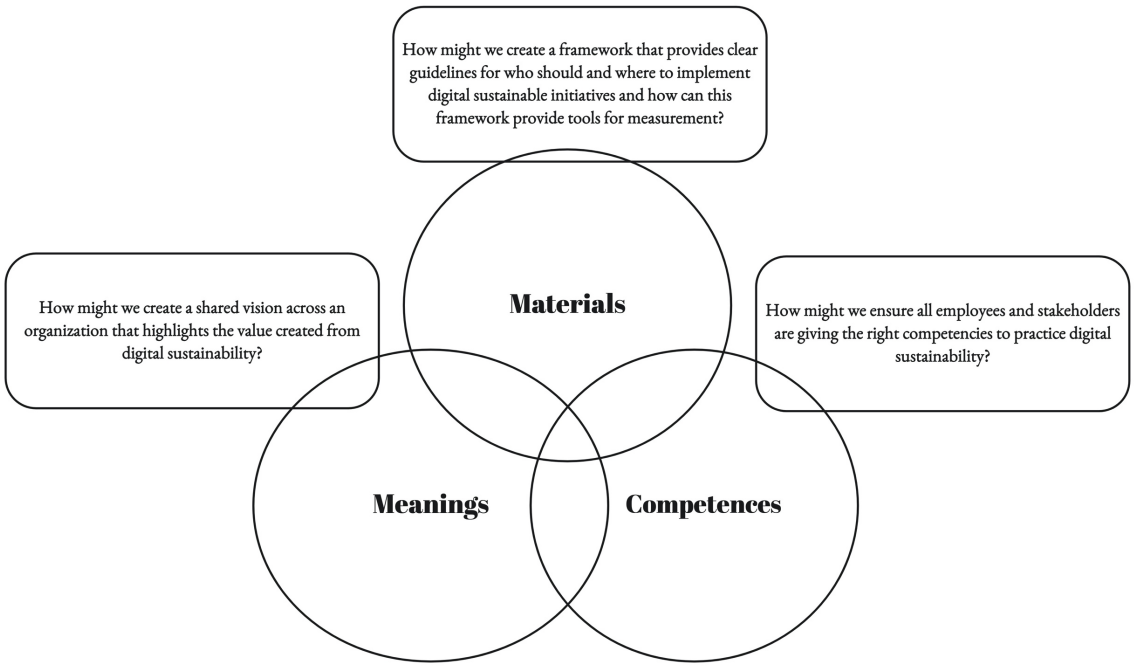


Figure 14: Project problem statement

05

IDEATION

5. Ideation

This chapter presents the activities conducted during the ideation process. First, a walkthrough of the initial brainstorming is presented, where the main purpose was to generate as many possible solutions as possible to each of the three problem areas. Secondly, a co-creation workshop was held with the participation of a software developer from Clearview Trade. The purpose of the co-creation workshop is to enable users to participate in the ideation process and follows the MUST principle of using real user involvement in the design process to ensure that a suggested solution fits the real-life practices in the work organization. As digital sustainability is best achieved through new rules and regulations, having a developer co-create a solution on behalf of his own work practices and the four company personas strengthens the possible realization and implementation of the project outcome.

5.1 Brainstorming

The initial brainstorming session was conducted with old-school pen and paper and focused on using design sketching as a tool to visualize ideas. The aim of the brainstorm was to first diverge and generate as many ideas as possible and then converge these ideas into solid concepts at the co-creation workshop (SDT 2022a). Design sketching was used as a tool for knowledge creation and visualization. Design sketching is seen as a fundamental activity when adopting *"the knowledge construct"* approach (Vistisen 2016).

> "In this approach, design is not seen as primarily concerned with making artifacts but with the construction of knowledge, which forms the basis for all designed artifacts. Sketching is considered the principal activity in this form of knowledge construct." (Vistisen 2016)

In design thinking, sketching can be viewed *"as more than traditional pen and paper sketching"* (Vistisen 2016). Digital tools allow for fast visualizations of ideas, and as Vistisen argues, sketching can be used for investigating, exploring, explaining, and persuasion.

> "We see sketching in terms of an intertwined relationship between the traditions of visual thinking and of visual communication. This relationship is not fixed: during the design process, it can change between the investigative, explorative, explanatory and persuasive functions of sketching." (Vistisen 2016)

In this brainstorming session, sketching was used to explain and explore new ideas. To structure the brainstorm and make sure the generated ideas embraced the problem areas of the project, the ecosystem maps, the four personas, the visual representation of the problem statement, the main diagrams, the ECO SD system model, and the methodological approach, used by the practitioners included in this project, was printed out and laid down on the table were the brainstorm would take place. These visual materials initiated inspiration for the brainstorming session. The brainstorming session focused on generating ideas that supported the questions within the problem statement. To

initiate creativity, the problem statement was printed and examined in smaller pieces as well as a whole to investigate the possibilities within each area of materials, competences, and meanings.

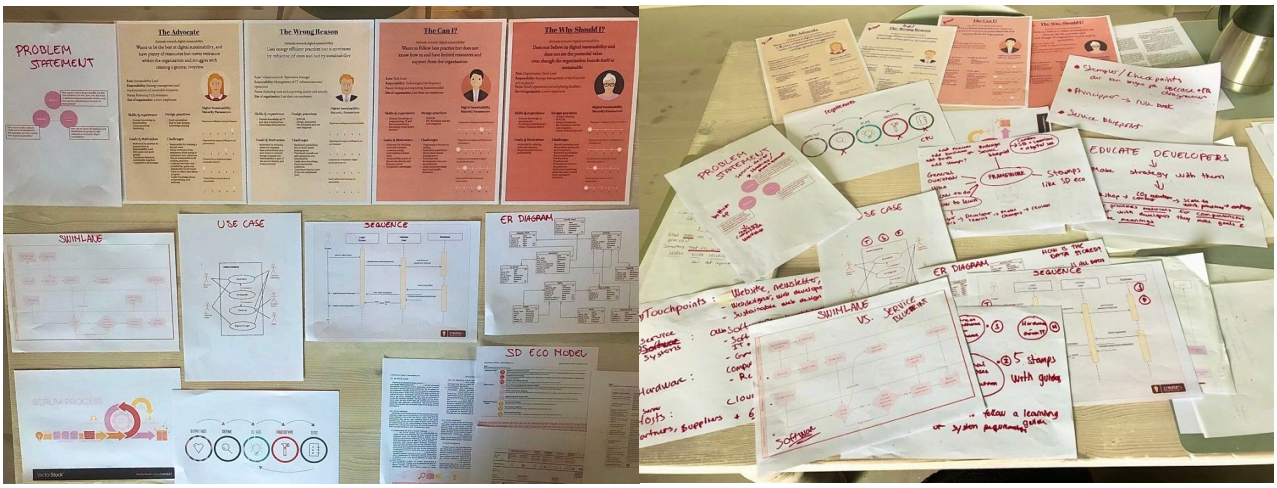


Figure 15: Brainstorming session

The brainstorm resulted in various ideas involving different methods, concepts, and tools. During the diverging process, it was discovered that certain tools were only used by practitioners such as web designers, web developers, and software developers and would not be developed before late in the design process of a new service. These include ER diagrams, Use Case diagrams, and sequence diagrams. Other tools, including service blueprints and process models such as SCRUM and Design Thinking, are mostly used by executive employees at a c-level, such as managers, team leaders, and strategy developers. This highlighted a gap between strategy, competences, and actual practice, referring back to the say/do problem.

To start the converging in the ideation process, the ideas developed through the brainstorm were therefore grouped together based on the level of employees that they touched upon. This created an intuitive selection process, resulting in three main ideas with many variations that each had a specific focus: overall strategy and overview, specific service requirements, and competence development. These ideas were investigated and developed further at the co-creation workshop.

5.1.1 Design proposal 1: Strategy and overview

The first idea centralizes itself around creating an overall structure of where to implement digital sustainable initiatives. To help managers of departments and sustainable leads to get an overview of where there is potential for improvement, an extended version of a swim lane diagram or service blueprint could be developed. The diagram or blueprint should add elements such as hardware to the psychical evidence row, tools employees use to communicate in front-stage and back-stage processes, and what hosts and partners are involved in the value creation. Each element will thereafter be combined with a principle from digital sustainability to provide guidance on what can

be improved and which stakeholders it may concern. There might be pros and cons to each model as the swim lane model is already used by various IT departments and was mentioned within the empirical investigation in contrast to the service blueprint, which was unknown to most of the project informants. On the other hand, the blueprint entails a much more detailed description of service artifacts, measurements, and systematic processes. One solution could be to create a combination of the two process models, but before exploring the idea further, it would need to be confirmed by practitioners.

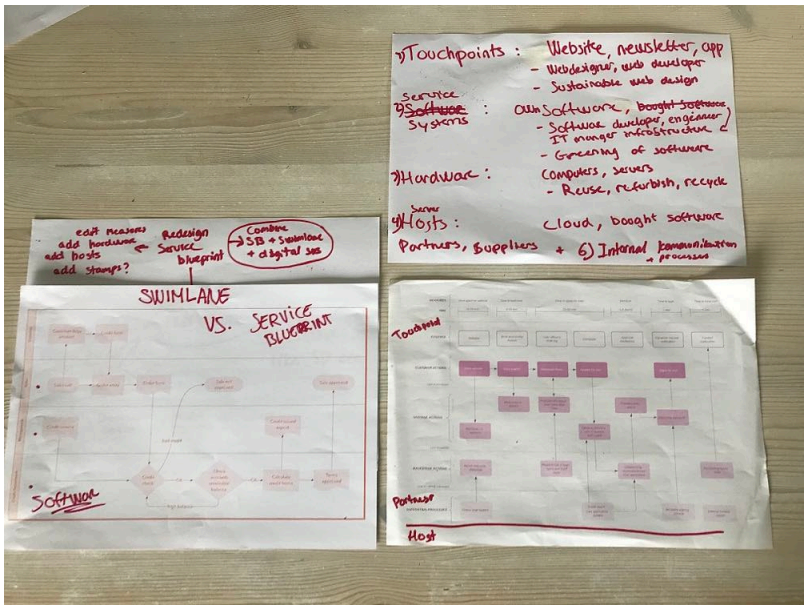


Figure 16: Swimlane and blueprint sketching

5.1.2 Design proposal 2: Specific Service Requirements

The second idea uses a stamp-like approach to clarify what principles can be implemented in a service system. It focuses on software models, as software design is one of the main factors in digital sustainability. The idea takes inspiration from the ECO-SD model and uses a similar classification approach to communicate potential impacts through design requirements. The idea suggests creating specific categories visualized through stamps that can be used in design documents. As the ECO-SD model (Sierra-Péreza et al. 2021) focuses on product design, it does not encompasses what methods and principles to follow if the goal is to reduce energy consumption from a digital service. Each stamp would act as a representation of a principle that must be followed to ensure greener technology. Therefore, the idea suggests creating five different symbols for the following focus areas:

- Touchpoints – e.g., websites, apps, newsletters
- Software – e.g., own software and purchased software
- Hardware – e.g., computers, servers, cellphones, monitors
- Partners – e.g., suppliers, partners, server hosts

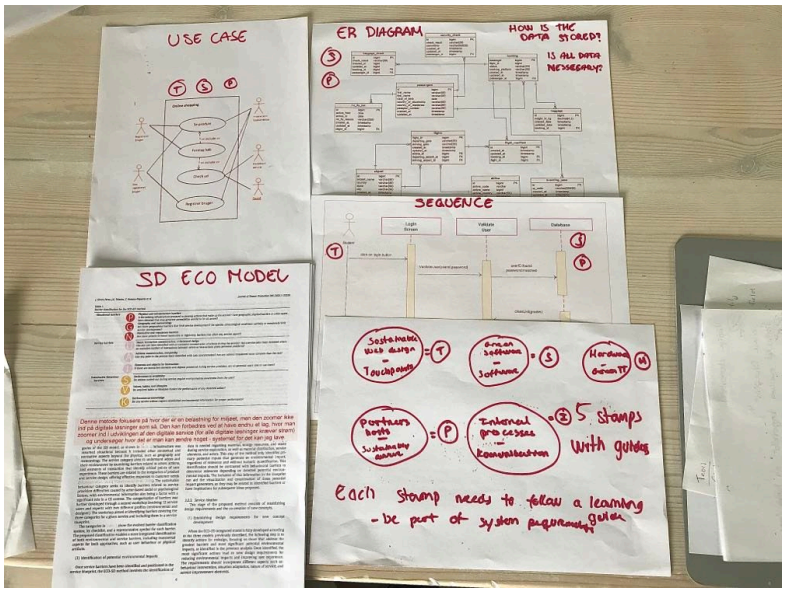


Figure 17: Diagrams and principles sketching

- Internal processes – e.g., tools for communication (teams, email), file-sharing systems, garbage sorting

To ensure the use of these symbols in real-life practices, they have been created to fit different diagrams. When implemented in a diagram, the symbols act as system requirements.

5.1.3 Design proposal 3: Competence Development

The third idea emphasized the need to develop the employees' competences and capabilities concerning digital sustainability. As green IT and sustainable web design is an upcoming fields, it is most likely that many employees do not know how to follow and implement green initiatives in their daily work and tasks. Therefore, the third idea suggests a framework to co-create a green strategy with managers and developers. The idea takes a bottom-up approach, as many green initiatives are not properly anchored within the organization and its employees. In digital sustainability, developers play an important role and have the final say in what code is written and how energy efficient the outcome is. Therefore, this idea focuses on creating a four-step process that will ensure a team has the right competencies and a shared vision before initiating a new development project.

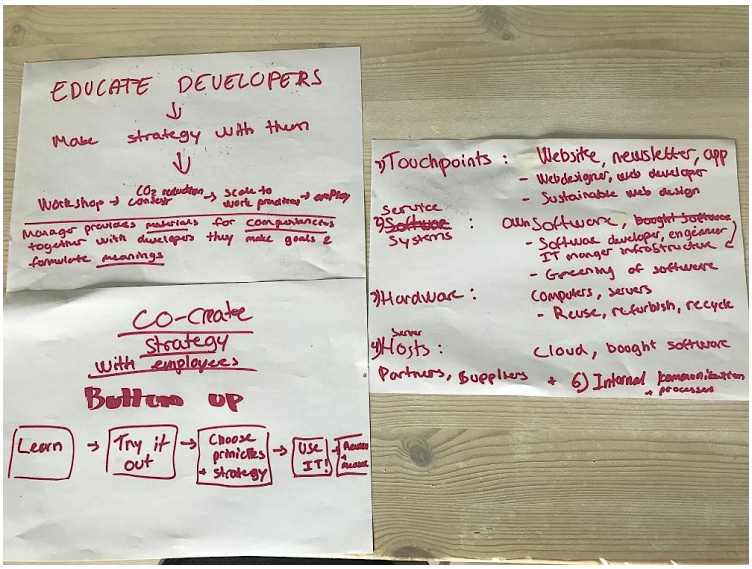


Figure 18: Process model sketching

Step 1) provides developers and designers the right knowledge about what they can do to improve their work by teaching them how to code and create greener software, websites, or platforms. Step 2) Try out the new learnings through a test project. The purpose of this activity is to test and see if the employees have gained enough experience to implement the new knowledge in their future work and collect insights on what is challenging. Step 3) Based on the collected insights and experience, create a strategy for the team. The strategy should include what principles should be followed at all times and how this will be measured and evaluated. The strategy should focus on what the team finds interesting to work with and possible to implement to ensure a change in practices. Step 4) Try out the new strategy in a real project and evaluate.

5.2 Co-creation workshop

Throughout the brainstorm, the different levels and hierarchies amongst employees were highlighted as an important factor in creating a framework that will suit all levels within the organization. The informants included so far in this project have all been managers or leads with a team of developers or assistants beneath them. Therefore, it is important for the feasibility of the project outcome to include all types of end-users of the framework, including both managers and employees such as

web designers and developers. Co-creation is an act of collective creativity shared by two or more people (Sanders & Stappers 2008). Collective creativity is often referred to as participatory design, as co-creation can be a part of the design process but not the foundation for the entire design. By collaborating with users of the design outcome, co-creation has proven efficient when solving complex problems and has shown positive results in long-term implementation projects (Sanders & Stappers 2008). A co-creation workshop was held to investigate the potential of the brainstorming ideas and further develop a potential framework for the project problem statement. Ideally, the workshop would have included multiple persons from each of the four companies and perhaps even more participants from other companies, but due to a lack of resources and priorities, the workshop was held with one participant, a software developer from Clearview Trade. The developer was very interested in the project and signed up to participate in the workshop despite being the only participant. The workshop was conducted in a conference room at DTU campus located close to Clearview Trade's office space and lasted two hours.

The structure of the workshop was as follows:

- Ice-breaking game (Find 10 things in common)
- Presentation of the project findings and problem statement
- Presentation of four personas and the three brainstorming ideas
- Evaluation of project findings, statements, and ideas
- Further ideation
- Design sketching and prototyping

To create a safe space for creativity, criticism, and knowledge sharing, the workshop started by performing an icebreaker game called 'Find 10 things in common'. After getting to know each other, a presentation and evaluation of the project findings and problem statement were conducted. Thereafter, the three ideas were presented and explained according to the problem statement.

5.2.1 Evaluating the problem area

The participant was asked to be honest and use his own experiences to confirm, dismiss or comment on the findings and ideas. He was asked to write down his feedback on paper and post-its and then present it at the workshop. The feedback has later been synthesized into two overall areas.

Comments on project findings and problem statement

- The participant would very much like to have the competencies to write green code and think it would be fun to practice together as a team. He sees green code as energy efficient code.
- He agrees with the problem statement but adds that he thinks the most important part is not to measure the outcome but to get people to do it, either way, suggesting that if digital sustainability were considered a best practice, everyone would do it.
- A shared vision might not be very effective as developers, managers, and CEOs are motivated by completely different things.
- The idea of using a framework is good, but it would need to be super simple for it to be implemented.

Comments on brainstorm ideas

- He did not have any comments on the first idea, which contained a Swimlane diagram and Service blueprint. The reason was that none of the process models was related to his daily tasks, but he did like the idea of having an overview of the entire service, or more specifically the software they create, to see where they could optimize the energy/sustainability and see what is actually consuming electricity.
- The first idea that the participant commented on was idea number two. The symbols were what he meant by a simple framework but he was concerned with how they would learn all of these new principles. It seemed overwhelming.
- Then he took out the third idea of having a framework for learning and suggested using this method in the first idea. He liked that the development team would have an impact on how the strategy and implementation of these principles should be as he found that more realistic.

5.2.2 Further ideation

After giving feedback, the participant was asked to participate in an ideation session where he would use his feedback to spark new ideas. The ideation session was facilitated through conversations and sketching that created a back-and-forth process which resulted in additional inputs that were put together as one overall solution. Some of the inputs included:

- The initiative should be anchored in the department by the team manager
- The manager should take part in the competence development
- Companies and employees are mostly motivated by money, not ethics
- Results should be anchored within the department and not through the communication department of the entire company
- Keep it short and simple

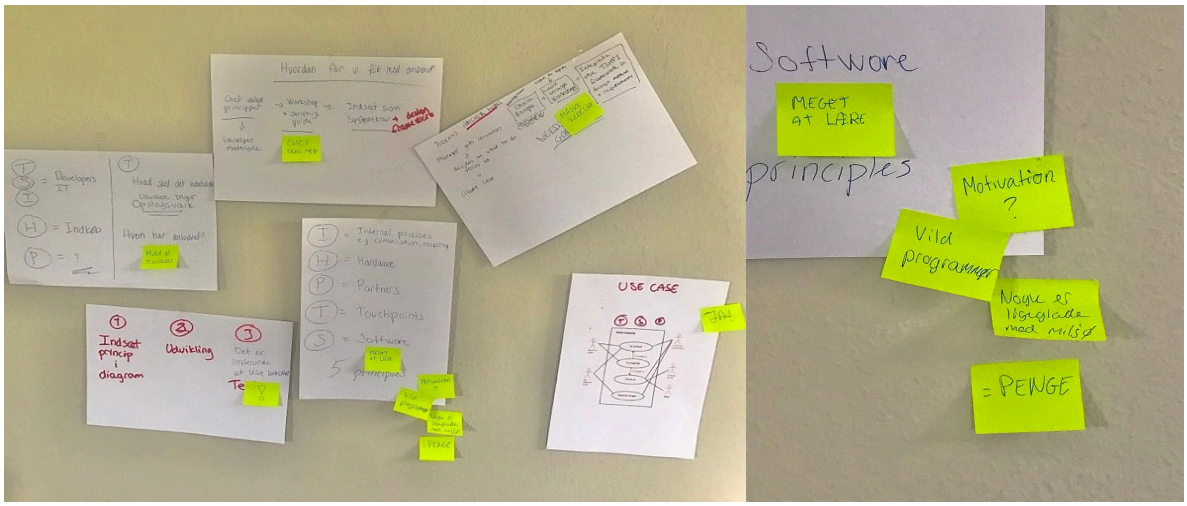


Figure 19: Co-creation session

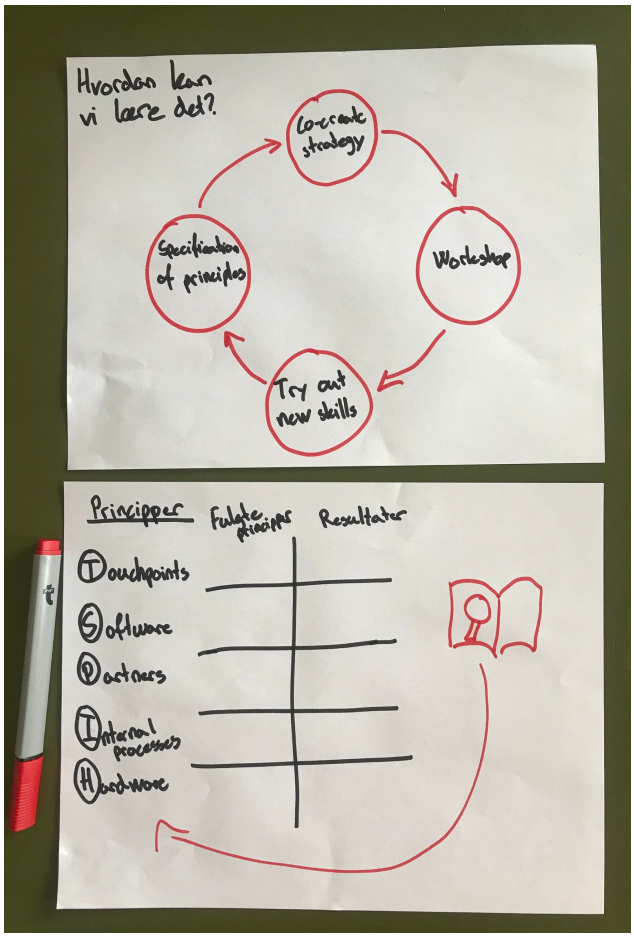


Figure 20: Co-creation sessions, sketching of prototype by developer

5.2.3 Design sketching and prototyping

The final activity conducted in the workshop was synthesizing all of the inputs, ideas, and criteria into a design sketch. Design sketching was chosen as an activity for fast prototyping. These prototypes would highlight uncovered problem areas and tie together the overall vision. Below, the final prototype sketched out by the participant is shown.

The first sketch visualizes how developers and other relevant employees can develop their competences and co-create a strategy for the implementation of digital sustainable principles. It consists of a four-step iteration process which includes 1) co-create strategy, 2) workshop, 3) Trying out new skills through a game or competition, and 4) specification of how to work with the principles in the future. The second sketch shows a model of how to keep track of initiatives and results. It combines the principles and results in a grid format. A book is drawn to the right to emphasize the need of being able to retrieve guidelines and knowledge about each principle.

5.2.4 Reflections of co-creation workshop

The workshop provided the project with many unknown insights and strengthened the empirical investigation with real user involvement. As the workshop only included one participant, the participant found it difficult to be creative and noticed that the final result was a combination of two out of the three ideas presented to him at the beginning of the workshop. If the workshop had had more participants, the result might have been different and varied more from the presented ideas.

This highlights a potential bias in the co-creation workshop. By showing and explaining potential solutions, the participant might have been limited in creative thinking as he found it easier to adjust the existing ideas to his own work and preferences. Therefore, the ideation process might have resulted in a different design proposal if the activities were switched, starting with a co-creation workshop and brainstorming based on the outcome of the workshop. Overall, the workshop did provide many new insights that strengthened the overall investigation of the research question.

06

PROTOTYPING & TESTING

6. Prototyping & Testing

This chapter presents the process of prototyping and testing the proposed framework. By building and testing prototypes, the project will collect feedback and insights to iterate further on the prototype and make improvements (Stevens 2021). First, a presentation of the prototyping process will be addressed, followed by a walkthrough of the concept validation conducted within this product. Lastly, the final prototype will be shown and explained.

Prototyping helps designers and stakeholders fail fast and succeed faster (Savioa 2011). Prototyping is commonly referred to as an external representation that provides a common reference point for collaboration and evaluation of design suggestions (Blomkvist 2011). Blomkvist (2011) advocates that prototypes are essential when the design space is complex and fuzzy. It can be difficult for stakeholders to understand the progression and usefulness of design activities without tangible prototypes, e.g., scenarios and visualizations (Jégou & Manzini 2008). In service design, testing service prototypes is recognized as an essential part of understanding customer, and employee experiences as services often contain the attributes of intangibility, heterogeneity, inseparability, and perishability (Blomkvist 2011). This makes every customer and employee experience unique and personal. Prototyping in the field of service design, therefore, tackles this issue by testing prototypes through concept validation, feedback sessions, or service walkthroughs (SDT 2022b) to deal with this complexity.

6.1 Building prototypes

After the co-creation workshop, the sketches were reviewed and recreated to fit the overall design question. A visual prototype was created in Miro. The prototype represents the framework conducted through the brainstorming session and co-creation workshop. As design sketching was used throughout both of these activities, many small and early prototypes had already been drawn out and were therefore used as guidelines to create a prototype that combined the three overall areas of action. The prototype is called 'the GRIT model' and frames the implementation of green IT through three steps. In addition to the first prototype, three secondary prototypes were created to test out each element of the model. This process consisted of a lot of iterations and back-and-forth conversations with the developer from Clearview Trade, who participated in the co-creation workshop. The prototypes can be seen in the appendix 8.

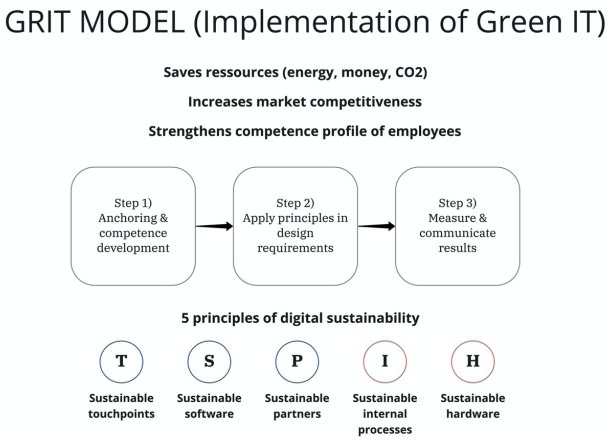


Figure 21: Prototype GRIT Model (appendix 8)

6.2 Concept validation

The purpose of testing prototypes on users is to see how users interact with the prototype, where the prototype succeeds, and where it needs to be improved (Stevens 2021). To ensure the viability of design suggestions, building early low-fidelity prototypes is an inexpensive and efficient way to test a new concept (Stevens 2021). Concept validation is a method to validate a design before testing it in a real-life scenario. It allows designers to expose target users to multiple design concepts to confirm the value of the experience and the design direction before building high-fidelity prototypes (Bowman 2017). Concept validation is often conducted as quantitative surveys, but by adjusting to a qualitative interview, the test can uncover conceptual and behavioral insights (Bowman 2017).

As the first concept validation (Bowman 2017) of the initial design ideas has already been conducted through the co-creation workshop, this validation focuses on collecting feedback on the prototype shown in the section above. Firstly, the prototypes were prepared by adding some detailed descriptions for clarity amongst the users. Next, research questions were formulated to structure the concept validation. The feedback collected for each research question has been synthesized and is presented below. The feedback was conducted individually online through email correspondences and video meetings with the four informants from each study. Furthermore, the prototype was validated by the co-creation participant through a psychical meeting to combine user reflections with user interaction (Bowman 2017).

The research questions and feedback were as follows:

- What is the users' first impression of the GRIT model?
- Can users explain what the purpose of the model is? And what do they think about the purpose?
- Can users figure out what each step entails and suggests for actions?
- What possibilities or problems are related to step 1? What do users think about anchoring through a bottom-up approach?
- What possibilities or problems are related to step 2? Are the categories in step 2 useful, and can users see themselves using them in their daily work?
- What possibilities or problems are related to step 3? What do users think about writing down their progress through the grid?
- Do users find digital sustainability more valuable, attractive, and easy after seeing this model?
- Unidentified areas – do users have any other comments?

6.2.1 User feedback

The model has both useful and overly academic features. Step 1 was described as very important as employees lack competences and knowledge about how to practice digital sustainability, but there was an overall agreement that when applying a bottom-up approach would help employees understand and not resist new sustainable initiatives. The critique of step 1 highlighted that competence building happens as an ongoing process, and within their workflows, employees often need to create solutions fast and reduce time spent on preparation and instead *“go with the flow and learn along the way”* (user feedback, appendix 9).

One useful feature for the users is the ‘stamps’ in step 2. The word ‘stamps’ was consistently used by the users to describe the principles of touchpoints, software, partners, internal processes, and hardware. The users thought that ‘stamps’ were associated with ‘decline or approval’, which suited the model's purpose well. The users could see themselves using these stamps to structure what they needed to do with individual designs. They mentioned that although the stamps would come with a clear description and guidelines, focus areas of departments and employees should probably be defined earlier to avoid misunderstandings of responsibility across departments (e.g., who is in charge of buying sustainable hardware, who is in charge of the server management, etc.). The solution might require a stakeholder map of internal departments to align employees and departments with areas of responsibility and new initiatives.

Step 3 was mentioned in relation to measurement and progress overview. The users thought that the results of working with digital sustainability should highlight the purpose of implementing the GRIT model to a further extent. One user mentioned that having a percentage measure would really boost the affection of the model. This measurement should be defined in step 1.

One overall problem was the structure of the model. The word ‘steps’ was critiqued, as steps are associated with on-time actions, and the users saw this model as an ongoing process, which should be visualized to reflect their actual workflows.

6.2.2 Reflections of the testing process

The concept validation provides feedback and highlights new ideas that should be added to the existing one. The feedback collected shows that this activity is crucial for the development of the framework. Therefore, validation and testing procedures should have been established earlier in the design e, to ensure proper testing after iterating and adjusting the framework to the user feedback. By doing so, the project could have conducted more in-depth user testing and ensured that the outcome of the project had been evaluated, tested, and approved by its future users.

Through a conversation with one of the project participants, a discussion of the possibility of testing such a framework emerged. The participant highlighted the fact that this sort of prototype could not be tested in one day, but it would require multiple employees to evolve their competences through a real-life IT project which normally takes the company at least 3 months pr. Project. Therefore, it can be discussed if the time frame of this project did even allow for real context testing. Although the design proposal was estimated to take a long time to test, performing service walkthroughs and roleplays as testing methods could potentially have strengthened the final steps of the design thinking process.

07

FINAL PROTOTYPE

7. Final prototype

The following section presents the final project prototype. This design suggestion was created based on the user feedback from the validation sessions and personas and marks the end of this thesis design thinking process. The framework has been adjusted to entail three main phases of the implementation process through seven concrete steps. Furthermore, the categories ‘hardware’ and ‘partners’ have been merged to avoid confusion about department responsibility.

7.1 The DS Framework

The Digital Sustainability (DS) framework aims to propose a plan of action for IT companies to meet the emerging corporate responsibility concerning the environmental impacts of digital services. The framework is based on four IT companies' experiences and results regarding green IT. By saving resources through energy-efficient design and processes, companies will lower their expenses and increase their market competitiveness as green IT is a growing tendency within the IT industry. The framework is developed to initiate a sustainable practice within IT departments that are struggling to practice digital sustainability because 1) they do not know where to start, 2) they lack knowledge and competences about digital sustainability, or 3) they struggle with creating and following a shared vision for the implementation of new sustainable initiatives. To incorporate measurements for progress, the framework proposes two methods in sustainable web and sustainable software development.

The framework addresses four main principles in digital sustainability: touchpoints, software, partners, and internal processes. Within the description of each principle, a list of important stakeholders and key activities are provided with references to get started with building competences within the team. These references are examples of organizations and guides for how to create more sustainable services, and thus it is suggested to extend the research to include supplementary references. Each principle has its own stamp to be used as a reminder in design requirement specifications (e.g., design documents, design models, procurement agreements).

7.1.1 Preparation phase

The preparation phase focuses on anchoring a shared vision for all involved stakeholders connected to each principle. A shared vision and clear responsibility areas for each department will strengthen the managers' and employees' understanding of what competences and strategies are needed. The framework (step 1) suggests that managers and employees of the department co-create a strategy based on the principle chosen for each department (departments can have multiple principles attached to their strategy). Furthermore, the framework proposes to gather stakeholders when delegating principles and areas of responsibility. This can be done through a service blueprint with the integration of principle stamps.

After creating a specific strategy for each department, the framework (step 2) proposes that department teams gather for a discovery workshop that uncovers the current state of the company's digital services and locates areas for improvement. This workshop should result in a specific vision and concrete goals for the department. Here, the framework proposes to use a CVC to gain an

overview of relevant partners and stakeholders who might be impacted by or have an impact on sustainable changes.

7.1.2 Design phase

The framework advocates that anchoring is most effective when done through a bottom-up approach, as employees will more likely follow sustainable initiatives if their knowledge and competences allow them to. The use of knowledge building as a tool for anchoring will enhance the probability of successful implementation of digital sustainable practices (Simonsen et al. 2008).

It is suggested (step 3) to allocate resources for extended research, workshops, and courses related to the department principles to ensure a high level of capability within development teams. After gain competences, the framework strongly recommends integrating stamps (step 4) from each chosen principle in design documents, models, sketches, processes, procedures, etc., as a reminder and to ensure alignment across managers, employees and departments. After defining and integrating the principles within a design, production teams can begin to produce and develop more sustainable services. To be sure of progress, it is recommended (step 5) to test if each production element aligns with the overall goal setting.

The design phase is an iterative phase, where the strategy and managers need to be prepared and open to the need to spend more resources on competence building. As digital sustainability is a broad topic and each principle entails complex details, it will be necessary to readvise and adjust capabilities throughout the implementation process.

7.1.3 Evaluation phase

The evaluation phase focuses on (step 6) testing and gathering results with a ‘before and after’ perspective to highlight what was achieved and what can be done next. This step is also to evaluate to need for further competence development. Furthermore, (step 7) proposes to create a strategy for maintaining the level of sustainability within digital products and processes. To ensure the expectations and alignment of the overall results and future strategy, it is highly recommended to invite all employees who will be in charge of maintaining the outcome to a strategy meeting.

The framework is shown on the following page.

Digital Sustainability Framework

A tool for sustainable development of digital touchpoints, software, partnerships & internal processes

Increase market competitiveness • Save ressources • Strengthen employees' competence profiles

Principles

T Stamp — TOUCHPOINTS (DIGITAL)

Includes websites, apps, newsletters, marketing material etc.

KEY ROLES: Clients, project and product managers, production team (UX, web developers, graphical designers), site admins, content managers, sustainability lead, tech lead

KEY ACTIVITIES: Set a page weight budget (measure), select green hosts, follow best practices in Sustainable Web Design

GET STARTED REFERENCES:
Page weight budget
Green hosting
Sustainable web design

S Stamp — SOFTWARE

Includes internal and external software

KEY ROLES: Clients, project and product managers, production team (software developers, UX), infrastructure & operations manager, sustainability lead, tech lead

KEY ACTIVITIES: Monitor real-time energy consumption and control features with the highest consumption (measure), choose serverless options, select green hosts

GET STARTED REFERENCES:
Monitor energy consumption
Sustainable Software Development
Green hosting

P Stamp — PARTNERS

Includes partners, all suppliers (e.g., hardware, physical evidence), platform and server hosts

KEY ROLES: Project and product managers, production team, sustainability lead, tech lead, head of procurement

KEY ACTIVITIES: Choose eco-labels partners, create a sustainable procurement agreement, get inspiration from Green IT initiatives

GET STARTED REFERENCES:
Find and become a sustainable partner
Procurement suggestions
9 tips for Green IT document

I Stamp — INTERNAL PROCESSES

Includes communication, transportation, building efficiency

KEY ROLES: Project and product managers, production team, sustainability lead, tech lead, head of procurement, HR, local building authorities

KEY ACTIVITIES: Use cloud based services, create sustainable policy and initiatives, sustainable office management

GET STARTED REFERENCES:
Cloud services
Reduce energy consumption in commercial settings
20 steps to sustainable office management

Plan of action

PREPARATION PHASE

1 **Strategy development**
Pre-meeting where the agenda includes delegation of principles to departments and identification of employee responsibility
Proposed action: Service Blueprints can help identify the relationships between actors, processes and ressources. Principle are added to create plan of action.
Stakeholders Department managers, sustainability lead, infrastructure & operations manager, directors, production team

2 **Discovery workshop**
Kick off meeting where a team of employees meet to document the current energy consumption of digital solutions to create a new vision and goal objectives.
Proposed action: Stakeholder overview, e.g. Customer Value Constellation mapping can help identify focus areas for investigating the company's digital footprints.
Stakeholders Department managers, sustainability lead, production team

DESIGN PHASE

3 **Build competences**
Build and develop employee's and managers' competences in relevant DS principles
Proposed actions: participate in workshops and courses, prioritize time for research
Stakeholders Department managers, production team

4 **Integrate principles in design practices & processes**
Add principles in design models, documents and manuals to ensure employee alignment
Proposed action: Use the principle stamps as reminders in the production teams
Stakeholders Department managers, production team

REPEAT CYCLE

5 **Produce and test design according to principles**
Test the energy consumption continuously to confirm if the design meets the goal requirements
Proposed actions: Test for each update to ensure ongoing control
Stakeholders Department managers, production team

EVALUATION PHASE

6 **Evaluate**
Evaluate goals and test results to adjust principles and employee competences and set new goals.
Proposed action: Share and reward good practice across organization
Stakeholders Department manager, production team, test manager, site admins, content managers

7 **Maintain**
Create strategy for maintenance of digital sustainability principles and test regularly
Proposed action: Invite employees who regularly maintains the digital solution to co-create strategy
Stakeholders Department manager, production team, test manager*

Figure 22: Final prototype, Digital Sustainability Framework (appendix 10)

7.1.4 Example of use

The following section illustrates how the framework and the principle stamps is used in a use case diagram. The use case is a mockup of Green Mobility's car-sharing application in the early stages of the development of the service. The principle stamps show where and what developers must consider to create a sustainable digital platform.

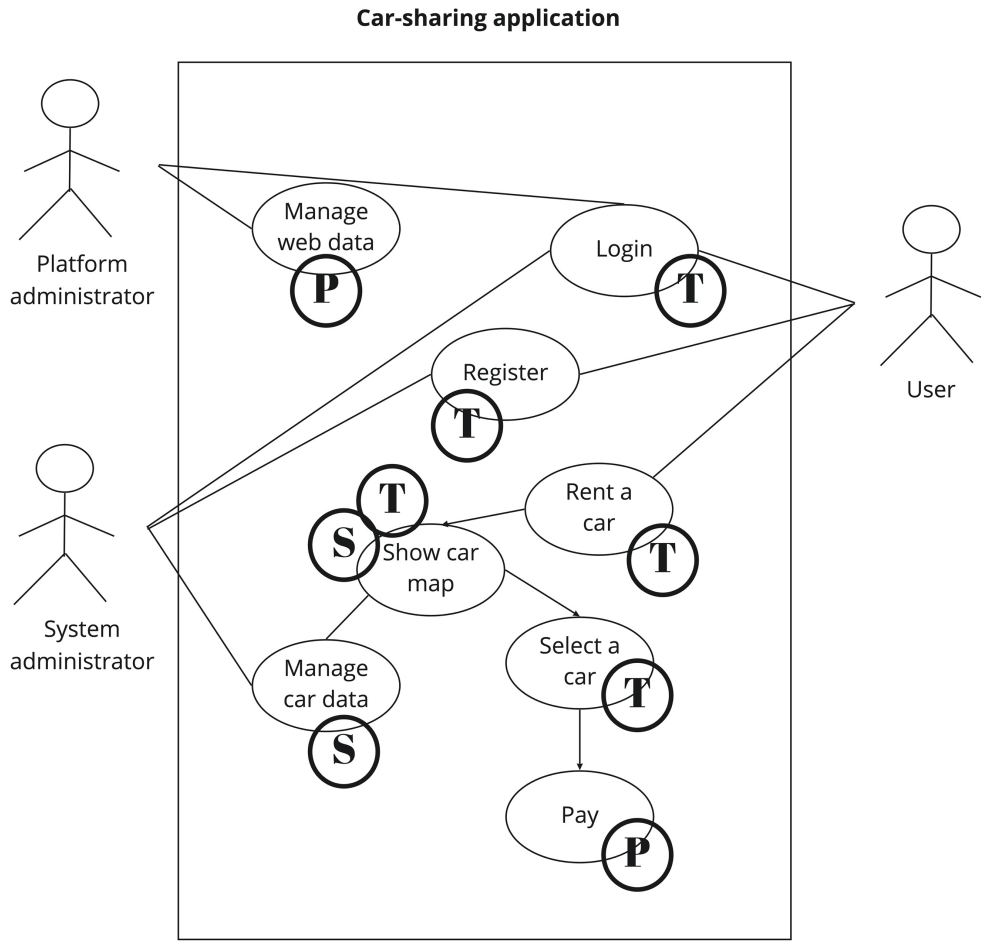


Figure 23: Example of use of principle stamps in a use case diagram from Green Mobility

7.1.5 Conditions for successful implementation

Based on the empirical insights and user feedback created throughout this project, some important aspects of the organization must be in place for optimal use of the DS framework. Firstly, the organizational structure must be open for co-creative strategy making. This framework advocates co-creation and bottom-up approaches, which will require openness towards the inclusion of different levels of employees in strategy processes.

Secondly, some knowledge about digital sustainability is required to construct a feasible strategy in the preparation phase. It is wherefore advised that stakeholders in step 1 have researched each principle before developing a strategy. This is related to the third aspect of allocating resources for each department, manager, and employee to build their competences before starting an actual design process. This will save time and redo's in the end. Therefore, it is also important that the organization is open to using resources on digital sustainability and has defined an overall sustainable strategy agreement in which resources are allocated to deploy the DS framework. The last but very important aspect of the success rate of this framework is that sustainability is perceived to be as important as costs and quality when creating and reviewing proposals. This is the most efficient way to align stakeholders and decision-makers in a progressive strategy toward digital sustainability.

08

DISCUSSION

8. Discussion

This chapter discusses the academic research question based on the findings and insights gained from the four company studies. The chapter elaborates on how a participatory and social practice research approach impacted the design project, the potentials and challenges that were identified from deploying the approach, and how it affected the role of the service designer in relation to digital sustainability. Furthermore, the chapter addresses the potential of the DS framework in relation to the research question and the potential of using the framework in current company practices. Lastly, it is discussed how change management can impact service design practice in general and how it can broaden the perspective on service design, its outcomes, and value contribution.

8.1 Methodological approach

This project used a participatory approach to design and social practice theory to address the participants' experiences concerning digital sustainability and their current work practices. This approach attempted to involve all relevant stakeholders in the design process to help ensure the result would meet their needs and would be easy to implement in their current practices. The recruitment of participants became a problem for the project's design approach, as the recruitment process failed to recruit variated stakeholders across organizations. One reason that companies did not want to participate was that they did not believe that improvement of their company's IT structures would generate enough to affect the environmental impact of the global IT industry. This argumentation highlights a problem in the acknowledgment of green IT and digital sustainability as most companies do, in fact, have the opportunity to lower their CO2 emissions despite their size, as literature shows (Ontkush 2007; Roberson et al. 2002; Greenwood 2021). It, therefore, stresses the need for a shared vision and competence building as presented by the DG framework and MUST methodology (Simonsen et al. 2008) but highlights the problems related to distributing this vision knowledge if companies are declining to take action before knowing what they actually can do to become more sustainable. As IT Branchen, DTU, and the Alexandra Institute (Buch 2020) are currently developing a methodological tool to measure the energy consumption of digital services before and after implementing sustainable practices, the DS framework is not yet able to implement such a measurement. When this tool becomes available, the framework will be able to answer element of measurement within the problem statement successfully. Furthermore, an energy certification would create a natural boost in the interest in digital sustainability as these measurements would expose possible savings and the true value proposition of digital, sustainable services.

Social practice theory was used to generate a clear understanding of what was needed to improve current practices within IT companies. Combined with the MUST method, the theory provided a focus on real-life practices, first-hand experiences, and real user involvement. All these methods rely on observational studies to avoid the say/do problem and oversee important aspects. In this project, no field observations were conducted, and as a result, the empirical understanding of the project scope might be superficial and inadequate in describing detailed employee practices. Instead, the project investigates how managers can provide the right meaning, competences, and technology for their employees (and themselves) to become better at creating sustainable solutions. This contrast

between observations and interviews is reflected in the framework, as the framework became generic instead of specific. Instead, the framework uses the digital sustainability principles to highlight specific areas of action that digital sustainable services will always rely on.

The lack of observation and participation of stakeholders suggests that the recruitment process should have been longer and more persistent throughout the project. It can also be argued that a project so closely related to the work practices of directors, managers, employees, and other stakeholders, would have benefitted from using a co-design-oriented framework (Sanders and Stappers 2008). Focusing on co-design as the overall methodological approach could have generated a more stable user involvement and, thus, a higher level of participation, as the main purpose of the project would have been to co-design and not just have users participate in specific activities. To further explore individual practices within a company, a case study approach might also have been preferable. This would allow the project to deeply investigate one company and their employees' needs to create a framework suited for their practices. This would potentially have resulted in a non-scalable solution but could have uncovered deeper and underlying issues related to competence building, meaning creating or technological advancements.

As this project set out to uncover how service design can contribute to more sustainable IT practices and digital solutions, many problematic and important aspects were uncovered. Through design thinking, insights and experiences were collected from four different companies, showing both similar and different obstacles that hindered them in progressing their sustainable profile. To encompass all of these different opinions and motivations, four personas were created to create a collected perspective on different company profiles. Even though the personas were useful within the brainstorming, the co-creation workshop, and later again when ensuring the design solution was fitted to each company's profiles, the method might have benefitted from using a more personal approach by adding employees from different levels within the organizations. By doing so, employee goals and motivation could have been strengthened within the framework.

8.2 From theory to practice

The project investigation showed that digital sustainability is difficult for companies to implement due to the lack of competences within the organization. This project has shown that implementation models for green IT must address practice-creating factors such as vision building, anchoring, competence building, and transparency in order for employees to adapt to new practices. It does so by introducing a framework that focuses on developing the right competences within the right departments of an IT company. The literature on green IT lacks a comprehensive overview of that departments should do, and as a response to this need, the DS framework develops responsibility-specific competences and reminds production teams and other actors to use the principles through clear representation in design documentation. The principles stamps and the DS approach are fitted to integrate well with development methodologies such as SCRUM and design thinking, but also in design documents, stakeholder maps, and visual models. It thereby creates a stronger foundation for implementation than standard frameworks within the field of green IT (Buch 2021). The framework should not be seen as a competitive component to current green IT practices but rather as a contribution to strengthening the implementation of green IT principles.

The framework also combines green IT with sustainable front-end design, as many lists within the field of green IT overlooks the potential of sustainable web design (Greenwood 2021). Even though the principles within DS consist of broader categories, it comprises green digital initiatives into four overall principles that must be followed to develop digital sustainability. The research conducted within this project shows that the simpler a new initiative can be presented to employees, the more likely it is to be adopted. Therefore, the stamps proposed within this project are likely to ease the understanding and feasibility of the final prototype.

Furthermore, this study shows that going from theory to practice is highly case-specific. Many academic theories require time and resources to understand and deploy, but the research conducted in this project shows that time and resources in IT companies are sparse due to the fast workflows and short production deadlines. Therefore, many companies struggle with seeing the value of digital sustainability over the value of delivering on time. As one company within this study showed, linking sustainability directly to costs reduction may be encouraging for others. This would not, though, solve the underlying problems of environmental priority. Even companies with sustainable-oriented services, such as Green Mobility and Clearview Trade, do not find it valuable enough to work with digital sustainability since they are already doing their part for the environment. The DS framework is by itself not enough to anchor the value gained from using IT, as stated in the problem statement, as the investigation suggests that to truly implement a digital sustainability practice within the field of IT, corporate responsibility must have a higher priority in general when choosing partners and stakeholders. The development of digital sustainable competences should therefore be an essential part of the education systems of software and web developers. As the future relies on greener IT, these competences must be developed before they are put into business-oriented practices.

8.3 Service designers role in digital sustainability

As stated in the research question, this thesis set out to explore how service designers can support the design and implementation processes regarding digital sustainability services. Here, research showed that service designers are becoming more and more involved with change management (Bau 2020) as change managers can improve strategies and decision-making through a service design mindset. Organizational change is a process that requires management of experiences around specific changes (Coene 2021; Bau 2020). Coene (2021) argues that when seeing change management as a service provided to an organization and its employees, many skills, tools, principles, and methods from the field of service design are very applicable in change processes (Coene 2021). She also emphasizes that the use of design in change management will reduce the need for many change management initiatives (Coene 2021).

This project contributes to the understanding of what tools and skills can contribute to positive and effective change management. Within the investigation of how company practices can begin to include sustainable touchpoints, software, partners, and internal processes, it became clear that service blueprinting and stakeholder management skills are important skillsets to obtain in order to align an organization and create a shared vision. The understanding of customer value constellations and the ability to map out important stakeholders and value exchanges is furthermore an important skill set to possess when dealing with digital sustainability. Implementing an understanding of corporate responsibility, and more specifically, the environmental impact of IT, in the business model is also a change process that requires high levels of anchoring which service design methods can

help accomplish (Bau 2020). Lastly, within the design process of a service, service designers have great potential to influence the sustainability of the digital product. This project will therefore also argue that service designers should take on the responsibility of digital sustainability and can use the DS framework to do so. Depending on the maturity level of an organization, not all steps are required, but an overall focus on digital sustainable touchpoints, software, partners, and internal processes early in the design process with significantly improve the overall outcome of a design process.

This paper has uncovered the complexity of implementing new practices in current IT companies and suggested a framework for solving some of the main problems related to design and implementation. To further develop the DS framework, the framework should be tested in a real context-setting with a specific pilot project. By testing the framework in a service-specific context, the practicability of the framework can be improved and adjusted to fit current practices in IT companies even more. Further testing will also show how existing and more principle-specific methods and tools can be used for developing energy-efficient digital designs and measuring results (e.g., Greensoft model, Naumann et al. 2011; ECO-SD model, Sierra-Péreza et al. 2021).

09

CONCLUSION

9. Conclusion

The thesis explores the gap between social practices, service design, and change management in relation to digital sustainable services as it aims to provide a supportive contribution to the design and implementation of green and sustainable IT processes. Furthermore, it addresses how service design in the field of change management can potentially reduce resistance from the employees within an organization when implementing digital sustainable strategies. Through literature about green IT, digital sustainability has been defined as the orchestration of digital touchpoints, software, partners and server hosts, internal processes, and hardware towards reducing CO2 emissions. Whereas green IT focuses more on *what* should be done to create greener services, digital sustainability focuses on *how* this is done in a business-oriented organization.

Through a service design lens, the thesis' theoretical and methodological standpoint is centered around human-centered design (Stickdorn 2011; Dam 2021; Brown 2008) and change management (Simonsen et al. 2008; Bau 2020). It explored the research question through design thinking and the MUST methodology's four principles: a shared vision, real user involvement, first-hand experiences, and anchoring. Furthermore, the methodological framework implements the Social Practice framework (Shove et al. 2012) to identify and analyze the discoveries from the empirical study. The empirical study consists of four qualitative in-depth interviews with danish IT companies; a sustainable car-sharing service, a digital export portal, a global IT and system supplier, and an IT department from a danish public university. These companies were chosen to investigate current IT companies' experiences, practices, and results with digital sustainability. All interviews were systematically analyzed through an affinity diagram (Simonsen et al. 2008) and customer value constellation mapping (Patricio et al. 2011).

The analysis showed that the four companies shared uncertainty about the impact digital sustainability can have on the environment and their value creation. Their concerns about spending resources on implementing new practices and training their employees outweigh the motivation for using digital sustainability. They also struggle with employees not sharing the same need for change and have to negotiate sustainable interventions, often resulting in compromises that affect the sustainable impact negatively. These discoveries were categorized as meaning-relation problem areas that should be addressed in the project's design phase. In relation to competence development, the analysis showed that the main problem that the companies experience is associated with the costs and resources related to developing employees' competences as different employees need different capabilities to practice digital sustainability. The studied companies all have the technological infrastructure to implement digital sustainability but are struggling to understand how they should implement such a strategy in their current practices. These discoveries were defined and formulated into a problem statement that was integrated into the project's further design process. Four personas were created to further highlight the different characteristics, attitudes, and opinions that affect each company and its work practices. During the project's ideation phase, a brainstorming session and a co-creation workshop were held to inspire ideas and center the design proposals on real user experience. At the co-creation workshop, three design suggestions were synthesized into one overall design concept that addressed the need for a framework that could provide companies with the right vision and competence-building processes. The design concept

was further iterated upon and prototyped together with a software developer and later validated by the four participating companies. After the validation, a final prototype was created to present the project solution: the Digital Sustainability (DS) framework.

The framework proposes a plan of action for IT companies to meet the emerging corporate responsibility concerning the environmental impacts of digital services. The framework is developed to initiate a sustainable practice within IT departments that are struggling to practice digital sustainability because 1) they do not know where to start, 2) they lack knowledge and competences about digital sustainability, or 3) they struggle with creating and following a shared vision for the implementation of new sustainable initiatives. The framework addresses four main principles in digital sustainability: touchpoints, software, partners, and internal processes. Within the description of each principle, a list of important stakeholders and key activities are provided with references to get started with building competences within the team. Each principle has its own stamp to be used as a reminder in design requirement specifications (e.g., design documents, design models, procurement agreements). To incorporate measurements for progress, the framework proposes two methods in sustainable web and sustainable software development. By saving resources through energy-efficient design and processes, companies will lower their expenses and increase their market competitiveness, as digital sustainability is a growing tendency within the IT industry. Additionally, the framework proposes a structure for including service design in change management by centering the implementation strategy around employee experiences.

9.1 Future work

Future work of this thesis includes testing the DS framework through a case study. The testing should involve a team of web or software developers and their manager, trying out the framework on a specific case and following their development. In this study, time was allocated to the production of the framework and lacked testing opportunities. This is a consequence of the complexity of the research question and a minimum of experience with the development of frameworks.

Furthermore, knowledge about measuring results and specific value creation should be addressed as well. This study did not successfully implement a solution to the specific issues related to measurements of results. Researchers (Buch 2021) are currently developing a method to unlock the true impact of digital sustainability and precise numbers on what companies can save in costs and energy. When this knowledge is available, companies will be able to calculate and thoroughly plan out budgets for green IT within a sustainable business model. Together with the energy efficiency-oriented education for new developers, designers and managers, digital sustainability will have better opportunities to be implemented. Before this will be an integrated part of society, IT companies and each employee will have to take responsibility for the CO2 emissions coming from digital service infrastructures, and they will have to take action along with service designers and all other stakeholders. Additional models from the field of digital sustainability, such as the GreenSoft model (Naumann et al. 2011) and the ECO-SD design model (Sierra-Péreza et al. 2021) could also be addressed in future work and potentially implemented within the DS framework to further strengthen the bridge between theory and practice. This will need more research.

10

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11

APPENDIX

11. Appendix

Appendix 1

Interview with Green Mobility – Tech Lead

Interview recording can be found in the separate file "Appendix 1_Green Mobility.m4a"

Interview guide:

Profil

Anonymt? GDPR til optagelse

Hvad er dine primære arbejdsopgaver?

Opbygning og konkret viden om platformen

Hvad er Idéen og strategien bag GreenMobility?

Hvordan har I opbygget appen og hjemmesiden (evt. valg af CMS system, app-builders)

Hvordan er jeres hosting- og server aftaler?

- Har i nogle udfordringer med det? Datamængde vs. Pris

Hvordan I indsamler og opbevarer data (evt. on-site eller cloud)

Hvilke systemer bruger I til at drive servicen?

Hvem samarbejder I med for at kunne drive jeres service og interne processer?

- Bruger i nogle visuelle modeller til at holde styr på jeres stakeholders og samarbejdet imellem?

Bæredygtighed

Hvordan arbejder Green Mobility med bæredygtighed? Jeres service er med til at gøre transportsektoren grønnere, er der andre steder, hvor I prøver at gøre en indsats?

Hvad gør Green Mobility for at være bæredygtige miljømæssigt?

- Indkøb og materialer

- Interne arbejdsprocesser (såsom hvordan i kommunikere)
- Grøn strøm

Hvad er jeres målsætning?
- Hvordan måler I det?

Hvilke principper følger i inden for bæredygtighed? Cirkulær, co-2 besparende? Miljø, mennesker, økonomi?

Hvor er I mest bæredygtige?

Hvor mangler I?

Hvordan holder I styr på det?

Digital bæredygtighed

Kender I til digital bæredygtighed? Hvis ja, hvad betyder det for jer?

1) Fysisk udstyr genbruges og sorteres (IT, papir, skraldesortering)
2) Data og digitale processer er energioptimeret
3) Intern kommunikation foregår enten via chat og video fremfor emails
4) Bæredygtigt web design (mindre data, mindre strøm)

Arbejder I med bæredygtig digitalt design? Og er i interesseret i at få en bæredygtig platform?

Design processen

Hvordan er jeres proces, når I indfører et nyt initiativ eller opdatere appen? Bruger I en speciel strategi?
- Hvad sker der under hvert trin i processen?

Hvilke principper og værdier benytter I jer af, når I designer en hjemmeside? Tilgængelighed, digital bæredygtighed, informativ, unik?

Har I nogle samarbejdspartnere, som hjælper jer med at blive bæredygtige? fx. grøn server host, et IT-udstyr-service?

Hvilke problematikker står i ofte overfor?
- Hvad kunne hjælpe på disse problemer?

At skabe en praksis

Har I teknologien og midlerne til at blive mere bæredygtige?

Har jeres medarbejdere kompetencerne til at implementerer og arbejde med bæredygtighed?
- Hvordan underviser I dem i det?

Hvordan udbreder I visionen og formålet med at blive bæredygtige?

- Forstår den enkelte medarbejder, hvorfor det er vigtigt at de følger bæredygtighedsprincipperne?
- Forstår afdelingslederne meningen og formålet med de bæredygtige tiltag?
    - Følger de dem altid selv i nye projekter?

Afslutning

Bruger I nogle værktøjer/modeller til at holde styr på hvor organisationen er bæredygtig og hvor den kunne blive bedre?

Kunne i tænke jer at have sådan et værktøj?

Hvad skulle sådan et værktøj tage hensyn til? Hvordan skulle det bruges? Hvem har brug for det?

Må jeg sende den løsning jeg finder ud af på mail, omend det så bliver et værktøj eller nogle principper, hvor du giver din mening omkring det og hvor realistisk det er at I kommer til at bruge det?

Appendix 2

Interview with Clear View Trade – IT Manager of Infrastructure & Operations

Interview recording can be found in the separate file "Appendix 2_ClearViewTrade.m4a"

Interview guide:

Opbygning og konkret viden om platformen

- Idéen og strategien bag eksportportalen
- Opbygningen af hjemmesiden og jeres software
- Jeres hosting- og server aftaler
- Hvordan I indsamler og opbevarer data (evt. on-site eller cloud)
- Back-end systemer

Design- og arbejdsprocesser

- Jeres proces når I designer og optimerer jeres portal
- Hvilke udfordringer I har og har haft i forbindelse med en digital service (SaaS)
- Arbejdsprocesser i afdelingen (herunder remote arbejde og kommunikationsmetoder)

Digital bæredygtighed

- Jeres prioriteringer indenfor digitalt design (eksempelvis bæredygtighed, tilgængelighed, effektivitet) – både front-end og back-end
- Indkøb af IT udstyr
- Medarbejder kompetencer og normer

Profil

Anonymt?

Hvor længe har du arbejdet i ClearViewTrade?

Hvad er dine primære arbejdsopgaver?

Har nogen ansvaret for den generelle bæredygtighed i ClearViewTrade?

Strategien bag platformen

Hvad er ideen bag ClearView trade?

Hvordan har I opbygget jeres platform – findes den som hjemmeside, software, app? (hvem udvikler disse)

Hvor bliver jeres software hostet?

- Har i nogle udfordringer med det? Pris, datamængder

Hvordan indsamler i og opbevarer data? On site eller cloud

Hvem er jeres primære samarbejdspartnere?

Digital bæredygtighed

Hvilke systemer bruger du til at udføre dit arbejde?

Kender I til digital bæredygtighed?

1. 1) Fysisk udstyr genbruges og sorteres (IT, papir, skraldesortering)
2. 2) Data og digitale processer er energioptimeret
3. 3) Intern kommunikation foregår enten via chat og video fremfor emails
4. 4) Bæredygtigt web design (mindre data, mindre strøm)

    Arbejder i med bæredygtig digitalt design?

    Hvor får i jeres strøm fra?

Bæredygtighed

Hvad gør ClearViewTrade for at være bæredygtige? Indkøb og materialer

Interne arbejdsprocesser (såsom hvordan i kommunikere (teams), Eksternt arbejde - er det noget i får jeres kunder til at tænke over?

Hvad er jeres målsætning? Hvordan måler I det?

Hvilke principper følger i inden for bæredygtighed? Cirkulær, co-2 besparende? Miljø, mennesker, økonomi?

Hvor er I aller mest bæredygtige? Hvor mangler I?

Hvordan holder I styr på det?

Design processen

Hvordan er processen, når I gerne vil implementere et nyt tiltag for bæredygtighed? Følger i en bestemt procedure?

Hvem skal kontaktes og godkende initiativet?

Har I nogle samarbejdspartnere, som hjælper jer med at blive bæredygtige? fx. grøn server host, et IT-udstyr-service

Hvilke problemer oplever I, når I skal undersøge hvor i skal være mere bæredygtige? Hvordan løser I disse problemer?

Hvilke problemer oplever I, når I skal have nye tiltag igennem?

Hvordan løser I disse problemer?

At skabe en praksis

Har I teknologien og midlerne til at blive mere bæredygtige?

Har jeres medarbejdere kompetencerne til at implementerer og arbejde med bæredygtighed?

Hvordan underviser I dem i det?

Hvordan udbreder I visionen og formålet med at blive bæredygtige?
Forstår den enkelte medarbejder, hvorfor det er vigtigt at de følger bæredygtighedsprincipperne?
Forstår afdelingslederne meningen og formålet med de bæredygtige tiltag?

Mircosoft rapport – interprise sustainablitiy calcutator

Følger de dem altid selv i nye projekter?

Afslutning

Bruger I nogle værktøjer til at holde styr på hvor organisationen er bæredygtig og hvor den kunne blive bedre?

Kunne i tænke jer at have sådan et værktøj?

Hvad skulle sådan et værktøj tage hensyn til? Hvordan skulle det bruges? Hvem har brug for det?

Må jeg sende den løsning jeg finder ud af på mail, omend det så bliver et værktøj eller nogle principper, hvor du giver din mening omkring det og hvor realistisk det er at I kommer til at bruge det?

Appendix 3

Interview with NNIT – Sustainability Lead & Senior Communications Consultant

Interview recording can be seen in the separate file "Appendix 3_NNIT.m4a"

Interview guide:

Profil

1. Anonymt? GDPR til optagelse

2. Hvor længe har du arbejdet i NNIT?

3. Hvad er dine primære arbejdsopgaver?

4. Hvordan har kommunikations og marketing afdelingen ansvaret for den generelle bæredygtighed i NNIT?

Digital bæredygtighed

1. Hvilke systemer bruger du til at udføre dit arbejde?

2. Kender I til digital bæredygtighed?
    5) Fysisk udstyr genbruges og sorteres (IT, papir, skraldesortering)
    6) Data og digitale processer er energioptimeret
    7) Intern kommunikation foregår enten via chat og video fremfor emails
    8) Bæredygtigt web design (mindre data, mindre strøm)

3. Arbejder i med bæredygtig digitalt design?

Bæredygtighed

1. Hvad gør NNIT for at være bæredygtige miljømæssigt? SDG

Transport: el-biler, mircosoft partner plendge IT, bæredygtighedsudvalg i IT branchen, dansk erhverv, datacentre renable energy – kunne i bare ændre det? Vestforbrænding står for datacenteret

- Indkøb og materialer – head of precurement og facility (ISO 20400 certificeret)
- Interne arbejdsprocesser (såsom hvordan i kommunikere (teams),
- Eksternt arbejde - er det noget i får jeres kunder til at tænke over?

2. Hvad er jeres målsætning?
    - Hvordan måler I det?

3. Hvilke principper følger i inden for bæredygtighed? Cirkulær, co-2 besparende? Miljø, mennesker, økonomi?

4. Hvor er I mest bæredygtige?

5. Hvor mangler I?

6. Hvordan holder I styr på det?

7. Bæredygtighedsrapport – hvad er der ændret siden 2020?

Design processen

1. Hvordan er processen, når I gerne vil implementere et nyt tiltag for bæredygtighed?
    - Følger i en bestemt procedure?
    - Hvem skal kontaktes og godkende initiativet?
    - Har I nogle samarbejdspartnere, som hjælper jer med at blive bæredygtige? fx. grøn server host, et IT-udstyr-service

2. Hvilke problemer oplever I, når I skal undersøge hvor i skal være mere bæredygtige?

3. Hvordan løser I disse problemer?

4. Hvilke problemer oplever I, når I skal have nye tiltag igennem?

5. Hvordan løser I disse problemer?

At skabe en praksis

1. Har I teknologien og midlerne til at blive mere bæredygtige?

2. Har jeres medarbejdere kompetencerne til at implementerer og arbejde med bæredygtighed?
    - Hvordan underviser I dem i det?

3. Hvordan udbreder I visionen og formålet med at blive bæredygtige?
    - Forstår den enkelte medarbejder, hvorfor det er vigtigt at de følger bæredygtighedsprincipperne?
    - Forstår afdelingslederne meningen og formålet med de bæredygtige tiltag?
        - Følger de dem altid selv i nye projekter?

Afslutning

1. Bruger I nogle værktøjer til at holde styr på hvor organisationen er bæredygtig og hvor den kunne blive bedre?
2. Kunne i tænke jer at have sådan et værktøj?

3. Hvad skulle sådan et værktøj tage hensyn til? Hvordan skulle det bruges? Hvem har brug for det?

4. Må jeg sende den løsning jeg finder ud af på mail, omend det så bliver et værktøj eller nogle principper, hvor du giver din mening omkring det og hvor realistisk det er at I kommer til at bruge det?

Appendix 4

Interview with AAU – Team Lead

Interview recording can be found in the separate file "Appendix 4_AAU.m4a"

Interview guide:

Profil

- Kan du sætte nogle ord på hvad den primære service AAU's IT afdeling udbyder er?
- Hvor mange hjemmesider, apps og andre digitale touchpoints gør AAU brug af?

Design proces

- Hvordan er jeres process, når I designer hjemmesiden? Bruger I en speciel strategi?
- Hvad sker der under hvert trin i processen?
- Hvilke principper og værdier benytter I jer af, når I designer en hjemmeside? Tilgængelighed, digital bæredygtighed, informativ, unik?
- Hvem bestemmer opbygningen af hjemmesiden? Og hvordan gør de det?
- Hvem bestemmer selve designet af hjemmesiden? Farver, billeder, former, tekstindhold? Og hvordan gør de det?
- Hvem opdaterer hjemmesiden løbende? Og hvordan gør de det?
- Hvem bestemmer server-hosten og har kontrol over selve IT-driften af hjemmesiden? Og hvordan gør de det?
- Hvordan arbejder disse afdelinger sammen? It-afdelingen, kommunikationsafdelingen.
- Indsamler I data fra hjemmesiden? Hvordan opbevarer I den? Har I sorteret i det, så der ikke er unødvendig data?

Bæredygtighed

- Arbejder i generelt med bæredygtighed?
- Hvordan er I bæredygtige?

Digital bæredygtighed

- Kender I til digital bæredygtighed? Hvis ja, hvad betyder det for jer?
- Er I interesseret i at få en bæredygtig platform? Hvorfor/Hvorfor ikke?
- Arbejder I med brugerrejser? Fokuserer I på at forkorte brugerrejsen?

Værktøjer til designproces

- Arbejder I med visuelle værktøjer? Hvordan er det / ville det være at bruge?
- Hvorfor har I valgt Umbraco som CMS system? Hvilke fordele og ulemper får I?
    - Har Umbraco
- Hvad ville det betyde at skulle skifte til et grønt CMS system nu? Hvilke udfordringer ville det bringe? Hvorfor cloud løsning? Har I undersøgt hvor bæredygtige datacentrene er?

Problematikker

- Hvilke problemer oplever I ofte, når I designer og opdaterer hjemmesiden?
- Hvordan løser I disse problemer?
- Vil I være interesseret i at give feedback og afprøve en struktur for at gøre jeres hjemmeside mere bæredygtig?

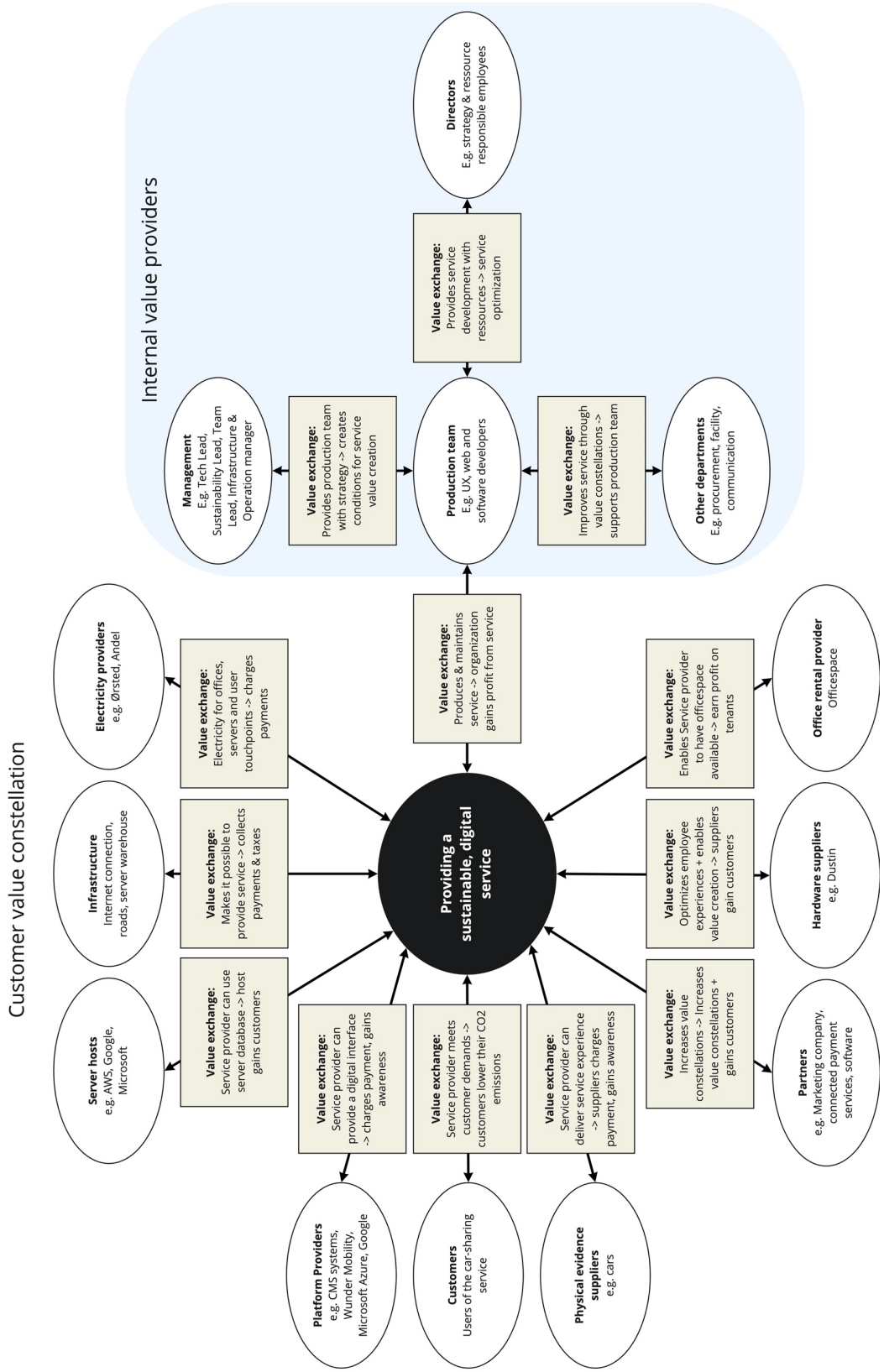
Appendix 5

Affinity diagram

The affinity diagram can be seen in the separate excel file “Appendix 5_Affinitydiagram_2022.xlsx”

Appendix 6

Customer value constellation map



Appendix 7

Personas

The Advocate

Attitude towards digital sustainability

Wants to be the best at digital sustainability, and has plenty of ressources but meets resistance within the organisation and struggles with creating a general overview

Role: Sustainability Lead
Responsibility: Strategy management and implementation of sustainable initiatives
Focus: Reducing CO_2 emissions
Size of organization: 3.000+ employees

Skills & experience

- Domain knowledge in Sustainability
- Communication
- Marketing

Design practices

- Excel spreadsheet
- Year to year strategy
- Knowledge sharing

Goals & Motivation

- Motivated by position in organisation as Sustainability Lead
- ESG goals and good grades
- Customers demands sustainable suppliers
- Competitive advantages

Challenges

- Responsible for creating a shared vison
- Meets resistance from employees when trying to implement new initiatives
- Has to compromise to fit existing practices
- Lacks an overview over possibilities, goals and stakeholder involvement
- Hard to collect data about progress
- Lacks knowledge about programming and software

Digital Sustainability Maturity Parameters

The Almost There

Attitude towards digital sustainability

Uses energy efficient practices but is motivated by reduction of costs and not by sustainability

Role: Infrastructure & Operations Manager
Responsibility: Management of IT infrastructure and operations
Focus: Reducing costs and improving quality and security
Size of organization: Less than 100 employees

Skills & experience

- Domain knowledge in IT and data infrastructure
- Knowledge about servers

Design practices

- SCRUM
- Design documents
- ER, Swimlane and use case diagrams

Goals & Motivation

- Motivated by reducing costs and expenses
- Sees sustainability as a nice bonus to reduced energy consumption
- Sustainability is part of the service identity and business model

Challenges

- Restricted possibilities due to cloud-based hosting server
- Prioritized smooth and safe operations over sustainability
- Lacks more knowledge about sustainable initiatives
- Customers does not care if they are sustainable (yet)

Digital Sustainability Maturity Parameters

Department willingness and prioritization

Organizational support (willingness and prioritization)

Competencies to implement digital sustainable initiatives

Clearly defined roles and areas of responsibility

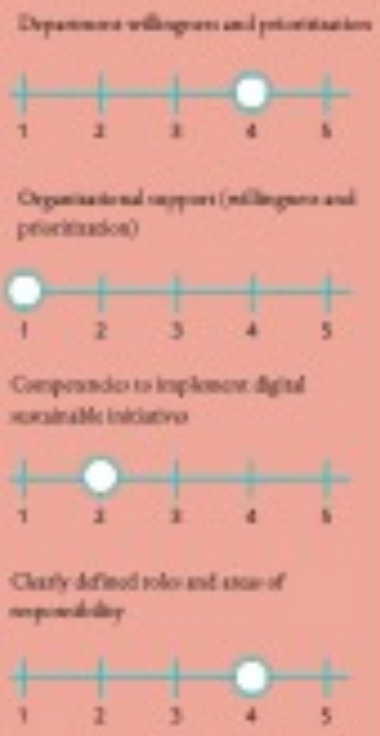
The Can I?

Attitude towards digital sustainability

Wants to follow best practice but does not know how to and have limited ressources and support from the organization

Role: Tech Lead
Responsibility: Technological development
Focus: Scaling and improving business model
Size of organization: Less than 100 employees

Digital Sustainability Maturity Parameters



Skills & experience

- Domain knowledge in programming, IT and data infrastructure
- Knowledge cloud-based services

Design practices

- SCRUM
- ER, Swimlane and use case diagrams

Goals & Motivation

- Motivated by reducing costs and expenses
- Lowering energy consumption reduces costs
- Sustainability is part of the service identity and business model
- Competitive advantages

Challenges

- Organization focuses on scaling
- Restricted possibilities due to cloud-based hosting server
- Prioritises fast development over new competencies
- Lacks more knowledge about sustainable initiatives

The Why Should I?

Attitude towards digital sustainability

Does not believe in digital sustainability and does not see the potential value even though the organisation brands itself as sustainable

Role: Digitalization Team Lead
Responsibility: Strategy management of development and employees
Focus: Steady operations and completing deadlines
Size of organization: 3.000+ employees

Skills & experience

- Domain knowledge in management
- IT and data infrastructure
- Design Thinking skillset

Design practices

- Design Thinking
- SCRUM
- Design documents
- ER, Swimlane and Use Case diagrams
- Online prototyping tools

Goals & Motivation

- Motivated by reducing costs and expenses
- Organizational focus on sustainability

Challenges

- Smooth operations and fast problem solving are more important
- Restricted possibilities due to cloud-based hosting server
- Prioritizes fast development over new competencies
- Lacks more knowledge about the value created from sustainable initiatives

Digital Sustainability Maturity Parameters

Department willingness and prioritization

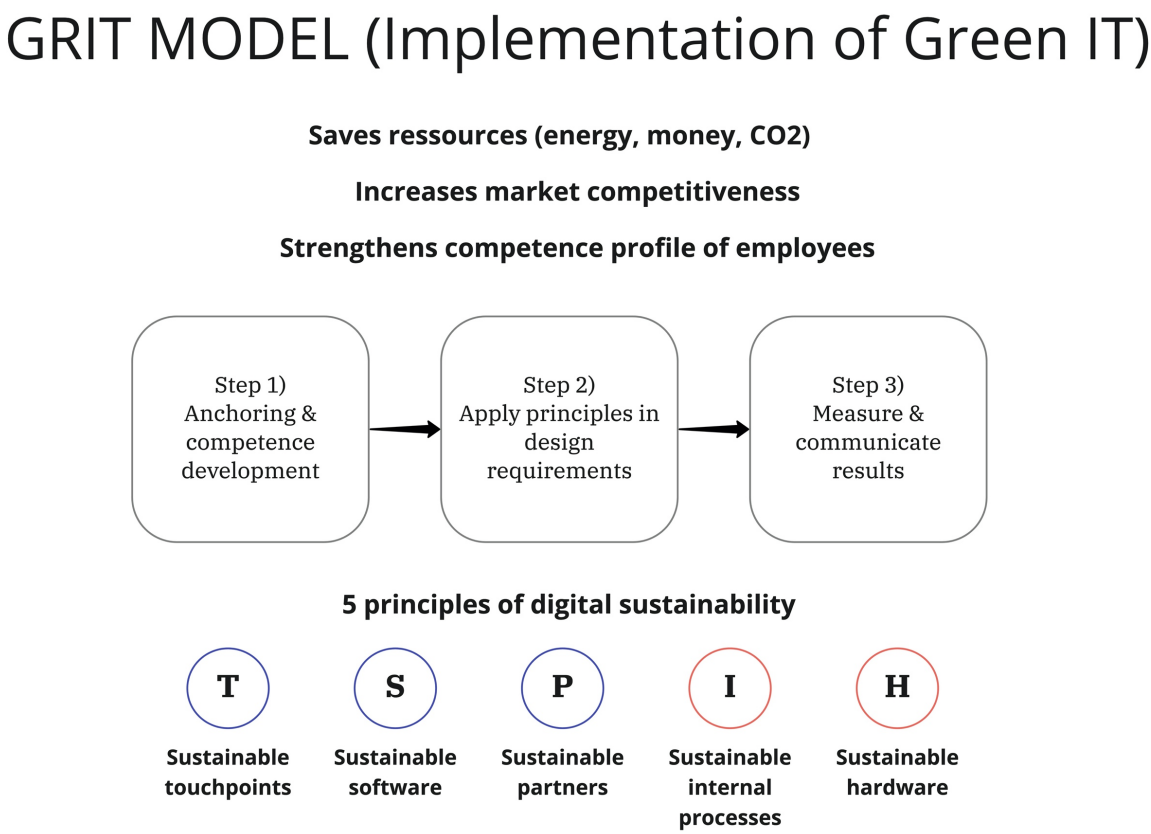
Organizational support (willingness and prioritization)

Competencies to implement digital sustainable initiatives

Clearly defined roles and areas of responsibility

Appendix 8

Prototype - GRIT model



STEP 1) ANCHORING & COMPETENCE DEVELOPMENT

STEP 2) APPLY PRINCIPLES IN DESIGN REQUIREMENTS EARLY IN THE SPECIFICATION OF REQIUREMENTS

T

TOUCHPOINTS
Thorough descriptions, guidelines and requirements for each principle with references
- e.g sustainable web design (websites, apps, newsletters, marketing material)

S

SOFTWARE
Thorough descriptions, guidelines and requirements for each principle with references
- e.g. green coding

P

PARTNERS
Thorough descriptions, guidelines and requirements for each principle with references
- e.g. requirement for environmentally aware partners, suppliers and server hosts

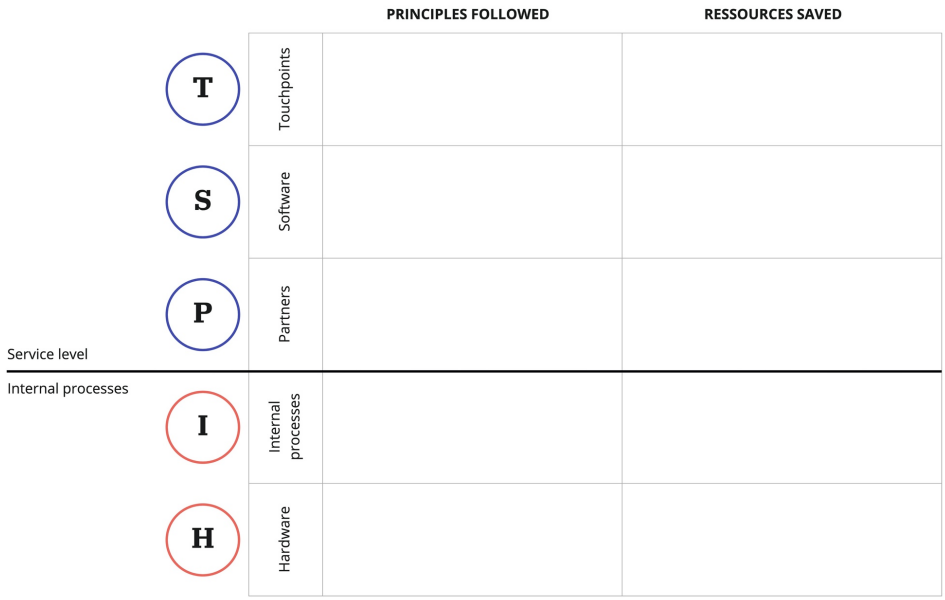
I

INTERNAL PROCESSES
Thorough descriptions, guidelines and requirements for each principle with references
- e.g. how to communicate, how to get around (travel, cars)

H

HARDWARE
Thorough descriptions, guidelines and requirements for each principle with references
- e.g. sustainable procurement agreement

STEP 3) MEASURE & COMPARE
COMMUNICATED INTERNALLY AND EXTERNALLY



Appendix 9

Notes from user feedback sessions

Co-creation workshop
Comments on project findings and problem statement (developer from Clear View Trade)

- The participant would very much like to have the competencies to write green code and think it would be fun to practice together as a team. He sees green code as energy efficient code.
- He agrees with the problem statement but adds that he thinks the most important part is not to measure the outcome but to get people to do it either way, suggesting that if digital sustainability was considered as best practice, everyone would do it.
- A shared vision might not be very affective as developers, managers and CEO's are motivated by completely different things.
- The idea of using a framework is good, but it would need to be super simple for it to be implemented.

Comments on brainstorm ideas

- The first idea that the participant commented was idea number two. The symbols seemed to be he meant with "super simple framework" but he was concerned with how they would learn all of these new principles. It seemed overwhelming.
- Then he took out the third idea of having a framework for learning and suggested to use this method in the first idea. He liked that the development team would have an impact on how the strategy and implementation of these principles should be as he found that more realistic.
- He did not have many comments on the first idea that contained a Swimlane diagram and Service blueprint. The reason being, that none of the process models was related to his daily tasks but he did like the idea of having an overview of the entire service, or more specifically the software they create, to see where they could optimize the energy/sustainability and see what is actually consuming electricity.

Notes from user feedback, concept validation

- Umiddelbart synes jeg, det virker som et fornuftigt framework.
- Dog vil jeg pointere, at hvis sådan en model skal fungere i virkeligheden (i hvert fald hos os), så skal det være mere hands-on. Der skal være en helt klar manual til: Sådan kommer I i gang, sådan kommer I videre, sådan skaber I resultater.
- Det er korrekt (igen, i hvert fald for os), at det fungerer bedst med en bottom-up-forankring. Men medarbejdere kræver lederskab, så ledelsen er nødt til at være med og til tider gå forrest. Og så skal der skabes en framing, som gør, at medarbejderne ikke føler, at arbejdet er en add-on til deres øvrige opgaver. Der skal skabes luft til, at man kan engagere sig i arbejdet, så det ikke bliver gjort halvt.
- Hvor er virksomhedens motivations faktor – det er ikke alle virksomheder der dyrker det grønne medmindre det samtidigt kan give besparelser, derfor vigtigt at dette nævnes.
- Typisk vil der være et mål at gå efter, det er ikke synligt/defineret i Step 1.
- Savner ligeledes om mål opnås, kunne være procent etc.
- Generelt er mit fokus på at effektiviserer alle steder hvor det er muligt. Det betyder at vi nogen gange ligeledes får en besparelse på compute (omkostning samt forbrug af strøm/hw). Mener derfor det er vigtigt der er et mål for denne rejse, om det skal være besparelse i omkostning eller det grønne islæt er op til hver enkelt virksomhed.

Appendix 10

Final prototype – The Digital Sustainability Framework

The final prototype can be seen in the separate pdf file "Appendix 8_Final prototype_DS framework.pdf"