Designing and Implementing Green Information Systems in the Danish Healthcare

A Techno-Anthropological Value-Driven Design Approach

AALBORG UNIVERSITY
COPENHAGEN

Author: Emil Rosenlund Bak
Supervisor: Wendy Gunn
Affiliation: AAU Copenhagen
Programme: Techno-Anthropology MSc

Study nr: 20221144
Project period: Fall 2024
Date: 28/08-2024
Project: Masters Thesis

Title Page

Thesis is submitted for MSc programme in Techno-Anthropology, Aalborg University, Copenhagen.

Report title: Designing and implementing Green Information Systems in the Danish Healthcare: A Techno-Anthropological Value-Driven Design Approach.

Education: MSc in Techno-Anthropology

Project: Master thesis

Project Period: February 1st 2024 to 11th of September 2024

Supervisor: Wendy Gunn

Number of Characters: 154,004.

Number of pages: 64

Emil Rosenlund Bak – study no: 20221144

Abstract

This thesis explores the impact of a sustainability dashboard on healthcare professionals' practices, perceptions, and values in the capital region of Denmark. Using iterative prototype testing, participant observations, interviews, and probes, the study identifies key norms and values, enabling a comparison before and after the dashboard's integration to analyse its effect. By following the experiences of unit managers and nurses, it provides insights into how the technology can be meaningfully adopted through a reconceptualization of its design. Positioned within the domain of Green Information Systems in healthcare, the thesis aims to make both theoretical and practical contributions to the design and implementation of such systems in the Danish healthcare. It employs a techno-anthropological value-oriented design approach (VtM), for data collection, analysis, and developing design recommendations. This approach emphasizes integrating value-oriented design features, aligning the dashboard with the core values of healthcare professionals. Substantiated by the concepts of *technological mediation* from Peter-Paul Verbeek (2019) and *translation of values* from Ibo Van de Poel (2021), the study advancrd the discourse on human values in technology design, by elucidating how technology mediates perceptions and practices. Concretely, it informs the design and implementation of a sustainability dashboard through practical design features based on healthcare professionals' experiences. This contributes to the adoption of technology and environmental sustainability in the Danish healthcare and offers theoretical advancements to the Values-that-Matter framework, laying the groundwork for future research in human-centred Green IS development.

KEYWORDS: Green Information Systems in Healthcare; Techno-Anthropology; Values-that Matter Design; Sustainable Practices in Healthcare; Technology Adoption in Healthcare.

AALBORG UNIVERSITY
COPENHAGEN

Preface

The motivation for conducting this study emerged during my internship, where I worked with the Capital Region on the initial development of the Sustainability Dashboard. As I explored topics related to technology adoption and environmental sustainability in healthcare, I identified a significant knowledge gap regarding the role of technology in fostering sustainable practices. A collaboration was established with *the Green Team* in the Capital Region, the primary stakeholders of this thesis, to assist with the design and implementation of the sustainability dashboard.

The study begins by analysing former empirical data alongside literature to develop a framework of important values for healthcare professionals. It then examines how the dashboard impacts these values through prototype testing and other relevant methods. These insights serve as a foundation for redesigning the technology, aiming to mitigate negative effects while ensuring it aligns with the professionals' core values in a sustainable way.

The study offers valuable insights into how technology can effectively promote environmental sustainability in Danish healthcare, when its design reflects the needs and values of its users. The results include design and implementation recommendations for the dashboard, focusing on integrating the core values of autonomy, emancipation, competencies & comparability into the dashboard, enhancing the alignment with human values to encourage meaningful adoption.

I would like to thank to Maria Hornsleth from the Green Team in the Capital Region for her meaningful collaboration, ongoing feedback, and assistance in facilitating data collection. I am also very grateful to Margit Bahnsen, Torben Kragelund, and Catrine Helbo for allowing me to conduct fieldwork at your respective hospital units, as well as to all the participants involved. Lastly, I want to express my deep gratitude to my supervisor, Wendy Gunn from AAU, for her invaluable guidance throughout this often-challenging process.

AALBORG UNIVERSITY COPENHAGEN

Table of Contents

AALBORG UNIVERSITY COPENHAGEN

List of figures

List of abbreviations

Green Information Systems (Green IS)
Values-that-Matter (VtM)

Appendices

List of Tables

AALBORG
UNIVERSITY
COPENHAGEN

Chapter 1

Problem definition

" […] whether an information system is 'successful' or not is decided on the workfloor… " (Holden & Karsh, 2010, p. 1).

The intended use of a technology often diverges with its actual use in practice, frequently resulting in unintended impacts. Numerous cases of technology implementation fail due to a lack of focus on end-users' involvement, contexts, and actual use (Ibid.). Designers cannot fully control how users will interact, interpret, and be affected by the technology at hand (Ihde, 2008). This thesis, however, aims to anticipate how technology will affect its users before being implemented.

The urgency of addressing social, economic, and environmental sustainability has significantly impacted various sectors, including healthcare, necessitating the adoption of green practices. Denmark's healthcare sector stands accountable for a notable 6% of the nation's CO_2 emissions, predominantly attributed to consumption-based activities, with a significant portion of these stemming from single-use medical instruments (Region Hovedstadens Klimaregnskab, 2022). Although numerous initiatives have been formulated, a major challenge lies in effectively implementing these initiatives, without diverting healthcare professionals primary focus from patient care and patient safety.

In this context, Green Information Systems (Green IS) have emerged as critical technological tools for promoting sustainability across different sectors. In 2023, the healthcare sector in the capital region, requested the development of such system which led to the idea of a sustainability dashboard, serving as the primary technological focus of the thesis.

The desire for a sustainability dashboard reflects a broader agenda in the healthcare sectors, emphasizing the increasing integration of healthcare technologies to aid healthcare professionals in providing optimal patient care (Ashcroft et al., 2007, Lange, 2023). However, integrating new technologies also entails practical and ethical barriers, as they are not neutral tools but impact work practices, responsibilities, interactions and values (Christensen, 2024). Approaching the dashboard as a socio-technical configuration highlights how technologies are not single standing entities, but contextually intertwined in our everyday life-worlds, shaping how we act and think. This thesis aims to investigate and unfold how Green Information Systems affect healthcare professionals, to facilitate responsible technological design and a meaningful adoption.

The design and implementation of Green IS, encompassing environmental sustainability values and technological requirements, therefore, necessitate an understanding of the

interplay between technology, contextual values, and the mediation between those two. To achieve this, the thesis employs a techno-anthropological value-driven design approach, aiming to align technological possibilities with the experienced values, practices, and perceptions of healthcare professionals, through their practical engagements with the sustainability dashboard prototype(Green IS).

Research questions and objectives

The primary objective of this research is to explore how Green Information Systems (Green IS[1]) can be designed and implemented within the Danish healthcare sector to encourage sustainable practices among healthcare professionals. This involves understanding their core values, examining how these values are influenced by the technology, and using these insights to inform the re-design of the dashboard.

Main research question: How do Green Information Systems influence nurses and unit managers values, practices, and perceptions within the Danish healthcare sector, and how can these insights be integrated into the design and implementation of Green IS to enhance meaningful adoption?

Sub-questions:

1) **Impact on values and norms:** Which values and norms do healthcare professionals consider important in their daily work, and how are these impacted by the introduction of Green IS?

This question identifies the value frameworks of the healthcare professionals and investigates the impact of Green IS on these frameworks. It also seeks to understand how new technology, aimed at promoting sustainable practices (Green IS), influences professionals' practices, perceptions, and values.

2) **Translation of values into design**: Within the Values-that-Matter (VtM[2]) framework, how can healthcare professionals' value-experiences be integrated into design features that enhance adoption of Green IS and consequently instigate more sustainable practices?

[1] Green Information Systems will be referred to as Green IS throughout the thesis.
[2] Values-That-Matter will be referred to as VtM throughout the thesis.

This question mobilizes the VtM framework to understand how values can influence design processes and be translated into concrete design requirements, applying theoretical concepts to develop practical design recommendations.

To address these questions, the thesis employs a methodological and theoretical approach using the VtM framework.

Theoretical overview

The theoretical framework of this thesis is grounded in the Values-That-Matter (VtM) approach, which offers a methodological, analytical, and a prescriptive framework for conducting empirical investigations, analysing the empirical data, and for mediating the results in specific design features (Smits et al., 2022). Building on post-phenomenology, the framework offers a lens to examine how technology mediates human practices and understandings, and consequently how those practices can inform the design of the Green IS.

Mediation theory makes it possible to anticipate and critically reflect on the ways Green IS mediate and impact human practices, perceptions, and value frameworks (Kudina & Verbeek, 2019). Allowing the thesis to look further into the softer mediations such as values and norms, contributing to an understanding of how technology can enable or constraint certain practices or perceptions (Kiran et al., 2015).

Translation of values from Van de Poel (2013) provides an instrumental tool to identify and translate values to norms, and norms into actionable design features, promoting meaningful practices for its users. Borrowing the term *specification* and furthermore allows the translation of values into tangible design features and enables a discussion of diverging values.

Whereas *mediation theory* helps to address the first research question, investigating the impact of Green IS on healthcare professionals. *Translation of values*, instead, supports the second research question, by offering a lens to translate human experienced values into design features for the dashboard. Together, the two concepts assist in answering the main research question, addressing both the impact and the translation into design features (Kudina & Verbeek, 2019; van de Poel, 2013).

Methodological overview

The research adopts an exploratory and interventionist approach, encompassing *participant observation* at local hospital units, *semi-structured interviews* with healthcare professionals, iterative *prototype testing*, and co-creative *workshops*. Additionally, a *probe exercise* was also conducted with the healthcare professionals involved in the project.

Ethnographic techniques such as *field-notes* and *auto-ethnography*, enhanced the depth of the thesis and enabled a unique way to capture and analyse the empirical data. Empirical data was collected over different phases, firstly in November in the autumn of 2023 and secondly, from February to May in 2024. The data was analysed through iterative value-oriented thematic coding and pattern recognition, inspired by the VtM framework. The technological platform of "otranscribe" was used to transcribe the digitally recorded data, and oral GDPR agreements was employed before data collection. Aligning these methods with the VtM framework ensures a techno-anthropological and value-oriented approach to understanding the impact of Green IS on healthcare professionals.

Contributions

This study is significant for several reasons. Firstly, it contributes to the burgeoning field of techno-anthropology by applying its principles to the design of technology in healthcare. Secondly, by focusing on sustainability, it addresses a critical global issue of our time, offering practical insights that can be applied beyond the healthcare sector. Thirdly, the study advances our understanding of how technology can be designed in alignment with human values, thereby promoting sustainable practices in a meaningful and impactful way. This alignment of technologies with human values is an area of increasing importance in design, not only of Green IS but also every other technological innovation. Understanding how a technology can be aligned with human values, requires an understanding of its impact on healthcare professionals' practices, perceptions, and values, which this thesis provides. Lastly, the thesis aims to contribute practical insights to the newly developed theoretical VtM framework, describing its strengths and limitations.

Summary

This thesis aims to bridge the gap between technological innovation and meaningful user adoption in healthcare, offering insights into how Green IS can be designed and implemented to align with the values and practices of healthcare professionals.

Scope of the thesis – Former study with the capital region

Background and motivation

The thesis is inspired by a study conducted by the author with the capital region during the Autumn of 2023. The initial study developed preliminary ideas for two tools: the "Green Handbook" webpage and the "Sustainability Dashboard". The webpage consists of sixteen practical initiatives aimed at reducing carbon emissions at local hospitals. An example of an initiative is the replacing of single-use instruments with reusable ones, or simply removing non-relevant equipment. The dashboard on the other hand was envisioned as a tool to measure the initiatives at the local hospitals, while providing an overview of both general and local emission numbers.

Green information systems

In the pursuit of environmental sustainability, aligning information systems and technologies with organizational practices has become imperative. This alignment is encapsulated in the concept of Green Information Systems (Green IS) (de Camargo Fiorini & Jabbour, 2017). Green Information Systems address not only the sustainable design and operation of information systems, but also encourages organizations to achieve environmental objectives and foster sustainable practices. Both the dashboard and the webpage fall under this category in the thesis.

Focus on the sustainability dashboard

Although both technologies qualify as Green Information Systems (Green IS), this thesis focuses predominantly on the design and implementation of the Sustainability Dashboard. Its current stage in the prototype and design phase offers significant opportunities for an impactful analysis of its development. In contrast, the webpage is not used interactively by all healthcare professionals in their daily activities, limiting investigations into its actual technological use. Additionally, as a finished design, the webpage is a somewhat static object of study, whereas the dashboard is still in development and dynamic in its nature. The sustainability dashboard incorporates data from the sustainability initiatives based on LCA (Life-Cycle-Assessment) analyses of the products removed or changed through the initiatives. Conversely the initiatives are supported by their promotion and awareness through the dashboard, highlighting their symbiotic and dependent relation. When the thesis mentions Green IS, it primarily refers to the dashboard but at the same time perceives the sustainability initiatives in relation to it.

An anthropological thesis could be oriented towards how the sustainability initiatives from the webpage are perceived and implemented in healthcare professionals' practices. Instead, this thesis aims to aid in the design and implementation of the dashboard, whilst critically anticipating its impact on healthcare professionals' practices and values.

Data from the previous study

In the Autumn of 2023, two workshops and three semi-structured interviews were conducted with healthcare professionals at Herlev & Gentofte Hospital. These sessions focused on the design and implementation of the sustainability dashboard and initiatives from the Green Handbook, both in their ideation and preliminary development phases.

The use of the empirical data from 2023 serves as a natural extension for this project, as it seamlessly builds upon and expands the findings from the previous research in another theoretical light.

Whilst reflecting on larger topics such as technology adoption and sustainability, the workshops and interviews revealed relevant insights into underlying norms, requirements, and needs of healthcare professionals. This thesis interprets the empirical data through a value and norm identification lens, analysing stated norms for underlying values of relevance. Despite significant differences in roles and functions of the healthcare professionals involved, the empirical data aids in establishing a general value-framework comprising identified values of importance.

Collaborators

In this thesis, the primary collaborators are *The Green Team*, a department within the capital regions healthcare sector responsible for Green Handbook, and the prototypes of the dashboard. Two engineers from the team became my primary collaborators, working together on the prototypes and facilitating interviews. Furthermore, they operated as gatekeepers, providing multiple data collection opportunities. While my role was more supportive than decisive, given their focus on organizationally established goals, my project allowed for greater flexibility to explore areas of personal and academic interest.

Concept of sustainability

The concept of environmental sustainability is the main value embedded in the Sustainability Dashboard. The goal is to conserve the planet's natural resources and protect global ecosystems to

support health and well-being, both now and in the future, by mitigating the carbon footprint of the health-care sector (Simon, 1987). However, while the sustainability dashboard addresses environmental sustainability, my focus in this thesis will be oriented towards how Green IS can be designed and implemented in a *socially* sustainable way for the healthcare professionals, securing meaningful embeddedness through investigating the impacts.

AALBORG
UNIVERSITY
COPENHAGEN

Chapter 2

Research Design

The thesis research design is illustrated below in figure 1, emphasizing the chosen framework for understanding the impact of Green IS on healthcare professionals' practices, perceptions, and values.

The first phase involves drawing inspiration from the previous field study with the healthcare sector and conducting a literature review, supporting both the formulation of the research questions and the construction of the value-framework for the healthcare professionals.

The second phase encompasses empirical data collection, through workshops, semi-structured interviews, prototype testing, participant observation, and a probe exercise, all informed by the literature review, the former study, and the research questions.

The third phase encompasses the theoretical framework and analysis, consisting of three phases. Beginning with the *explore phase*, utilizing data collected from previous interviews and workshops to establish a contextual value framework for healthcare professionals. In the *conceptualize phase*, the dashboard prototype is developed with inspiration from the value-frameworks identified in the explore phase. The *anticipate phase* consequently involves participant observation, prototyping, semi structured interviews, and a probe exercise with healthcare professionals, to assess their use of the Green IS, anticipating its impact on practices and values. The analysis incorporates the VtM framework as well as Verbeek's *technological mediation theory* and Van de Poels *translation of values* (Kudina & Verbeek, 2019; van de Poel, 2013), to analyse the empirical data.

The final phase of the research design aims to answer the research questions by discussing the positive and negative value experiences derived from the interactions with the Green IS. Design features and design process recommendations are consequently formulated based on these experiences.

Employing the VtM approach enables the thesis to anticipate potential negative value-experiences during the testing of the dashboard prototype. This foresight facilitates a re-conceptualization of the dashboard, with an iterative process that involves design features to address and mitigate the negative value-experiences identified from healthcare professionals.

The research design is supported by on-going collaboration with the capital regions the green team department, as well as insights gained from workshops at the *sustainable hospitals conference*, held in March of 2024 at Skejby Hospital in Aarhus. Feedback sessions with relevant

stakeholders ensured continuous refinement and alignment with research objectives and a future process discussion of the insights.

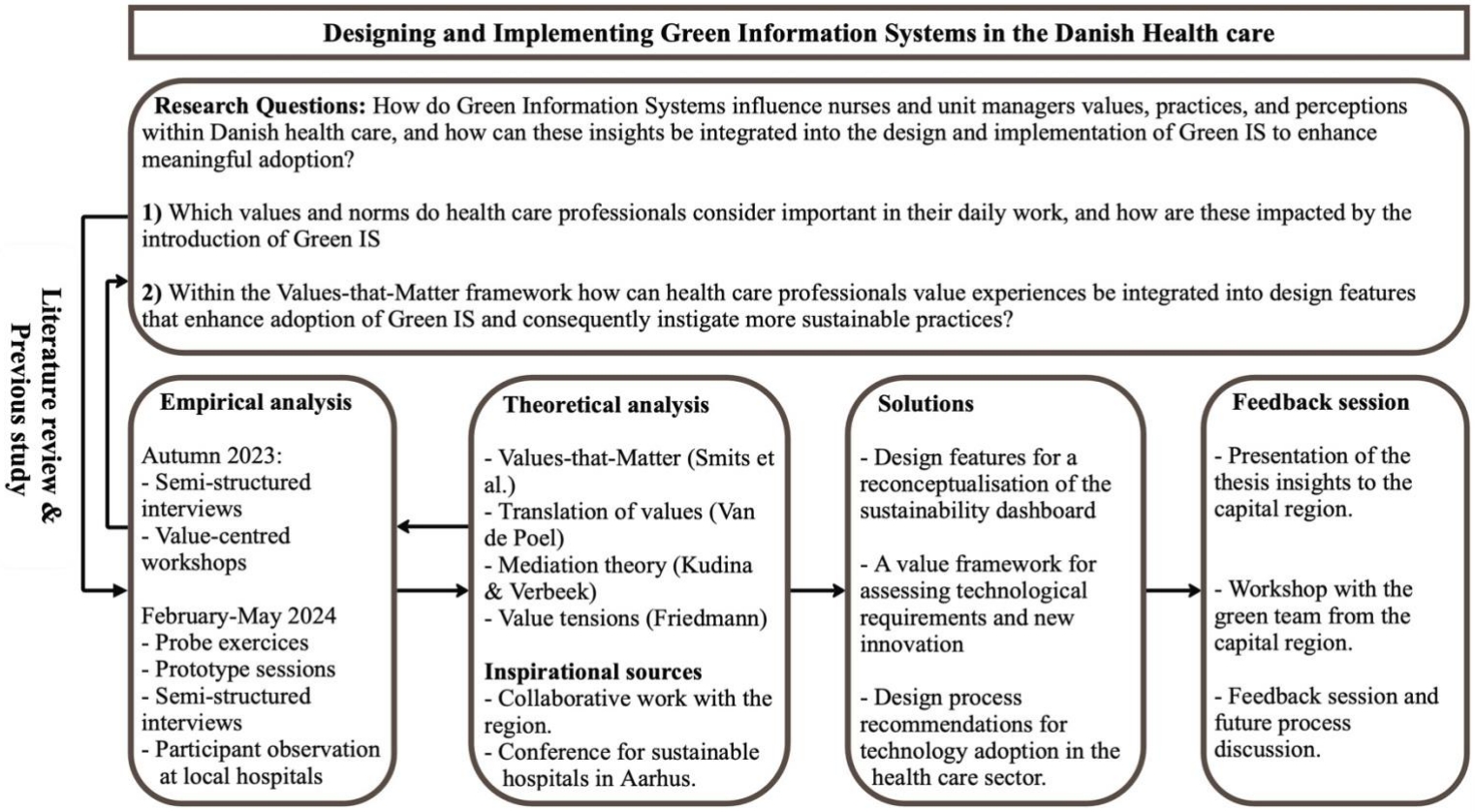

Figure 1 Visualization of Research Design process.

AALBORG
UNIVERSITY
COPENHAGEN

Chapter 3

Literature Review

The literature review assists in answering the research questions by situating the research within an existing body of scholarly work. It draws on established knowledge and contributes to the domain of technology and sustainability adoption in healthcare by expanding upon existing research with the empirical data from the previous study. The review utilizes snowball sampling and iterative searches on Google Scholar and Scopus, employing multiple search strings. Qualitative inclusion and exclusion criteria were established based on the research articles relevance. Specifically, the review centres on the following areas:

1) Environmental sustainability in healthcare
2) Green information systems (Green IS) and dashboards
3) Technology adoption and its effect on healthcare professionals' values
4) Values and technology design
5) Key values for technology and environmental sustainability adoption in the healthcare sector
6) Knowledge gaps and future research directions

Environmental sustainability in healthcare

Denmark's healthcare sector significantly contributes to the nation's CO2 emissions, accounting for 6% of the total emissions, with hospital activities being a major source (Hovedstaden, n.d.). This is slightly higher than the global average of 4.4% (Quitmann et al., 2023b), highlighting the pressing need to address emissions in the sector. Most CO_2 emissions in healthcare come from the consumption of goods and services, especially healthcare products, pharmaceuticals, and surgical equipment. Operating facilities, due to their heavy use of disposables, medicines, and anaesthetic gases, are key contributors to these emissions, which are mainly Scope 3, involving indirect emissions from production, transport, and disposal (Jørgensen, 2023; Osinkolu & Pegna, 2023). One promising approach to reducing these emissions is transitioning from single use to reusable medical equipment. This change can save between 90-100% in carbon emissions, which could significantly impact the operating areas carbon footprint. This potential is underscored by a study conducted by (Thiel et al., 2017), which compared cataract operations in India and England. Despite having the same infection rates, the operation in England emitted 31 times more CO_2. This stark difference highlights the misconceptions around the necessity of single-use personal protective equipment (PPE) and other

disposable items and emphasizes the need for further research into sustainable medical practices and equipment. The capital region aims to reduce CO_2 emissions by 50% by 2030 and achieve climate neutrality by 2050 (Åttingsberg, 2023). Following this goal, the sustainability dashboard and the Green Handbook were developed to counter these emissions. How the use of technological solutions can promote environmental practices, is illuminated throughout the thesis.

Green information systems and dashboards

Information systems are vital tools for decision-making and managing information effectively. Aligning these systems with environmental sustainability efforts, therefore proves essential for mitigating carbon emissions. Green Information Systems (Green IS) more concretely refer "to the application of IS and IT to create systems that help organizations develop environmental sustainability" (Sayyadi Tooranloo & Rahimi Ashjerdi, 2018). This thesis focuses on a dashboard designed to promote sustainability by facilitating informed decision-making and encouraging sustainable practices among healthcare professionals in the capital region. The need for environmental reporting in the healthcare sector has increased due to rising carbon emissions as well as improved technological capabilities to measure environmental impacts (Hensher & McGain, 2020), highlighting the link between Green IS and healthcare.

Relevance of Green IS in promoting sustainability

Case studies show Green IS's effectiveness in fostering sustainable practices, such as energy-saving systems and climate chatbots, demonstrating the significant impact of strategic Green IS on organizational sustainability efforts (Casado-Mansilla et al., 2020; Hedman & Henningsson, 2016; Hillebrand & Johannsen, 2021). As of now, England's NHS is developing a complex dashboard aimed at mitigating environmental impacts. Sadly, the dashboard is not fully developed and publicly displayed yet (Hensher & McGain, 2020).

Identifying the dashboard as a Green IS allows the research to engage with an established body of knowledge, providing a foundation for a focused examination on Green IS development.

Dashboards

The static nature of performance reporting systems in the healthcare sector has resulted in inconsistent and time-consuming reports that fail to support decision-making effectively (Ghazisaeidi et al., 2015).

With new carbon footprint goals and EU directives for environmental reporting, interactive tools like dashboards are essential. These dashboards can measure, monitor, and manage environmental sustainability efforts more effectively, making them crucial for promoting and reporting carbon initiatives in the healthcare sector (Hensher & McGain, 2020).

Dashboards are layered interface systems that present critical information about strategic objectives in an understandable and action-oriented manner. Supported by a robust IT and data infrastructure, dashboards enable users to focus on key activities, identify areas needing action, analyse root causes of issues, forecast trends, and establish benchmarks (Ghazisaeidi et al., 2015).

Challenges mainly arise from technical aspects with data sources, data generation, and information presentation issues (Smith et al., 2022). While these challenges are mostly technical, the thesis takes a socio-technical approach, by examining how Green IS (Sustainability Dashboard) affects work practices, perceptions, and values among healthcare professionals. This is a technological field in desperate need for social science research (Kitchin et al., 2015).

Technology adoption and its effect on healthcare professionals' values

In Danish healthcare, the increasing elderly population and rising demand for healthcare benefits, combined with a decrease in healthcare staff, necessitates the implementation and innovation of new welfare technologies. These technologies aim to free up time and resources for healthcare professionals, to ensure better care and efficiency. An example of such technology is reflected in the LOOP system and SP in the capital region, used to measure and work with patient needs (Christensen et al., 2024).

While these technologies are beneficial, Christensen et al. highlight the unintended consequences, altering and challenging tasks, roles and responsibilities. They emphasize this challenge, stating: "When we go close, the technology will challenge some of the professional and ethical ground values" (Christensen et al., 2024). This acknowledgement of technology's potential impact on ethical values in a healthcare context not only supports the need for more research in this domain, but also emphasizes the relevance of the first research question, investigating the impact Green IS has on healthcare professionals' values.

Understanding values

Understanding technology's influence on values is crucial, given their significant role in shaping behaviours, choices, and perceptions of technology (Moyo et al., 2016). Building upon Kudina & Van de Poels Dewey inspired value approach (van de Poel & Kudina, 2022), the thesis perceives values as deeply rooted in lived experiences, enacted within specific practices. Values are therefore not mere preferences but deliberate judgments guiding future actions (van de Poel & Kudina, 2022). This pragmatic approach guides the investigation of stakeholders' real-time contexts, decisions, and actions through user testing and participant observation (van de Poel & Kudina, 2022).

Furthermore, drawing insights from scholars like Kudina (2019), Verbeek (2019), and Mol (2018), the study acknowledges that values are contextually interpreted and enacted differently in practice. Consequently, values are neither inherent in technologies nor in humans, but instead mediate new experiences and understandings in our daily lives, thereby shaping the values embedded in our practices (Martin et al., 2018). Recognizing this connection is pivotal in this thesis, particularly since the sustainability dashboard directly aims to promote specific practices among healthcare professionals.

Values in technology design

Value-sensitive Design (VSD), as articulated by Friedman, and its derivative, Values-that-Matter (VtM), proposed by Smits et al. (Friedman et al., 2009; Smits et al., 2019), emphasize the importance of values in technology design. These theories highlight the non-neutrality of technology and underscore the need for ethical design to prevent unintended impacts on healthcare professionals' core values. Peter Paul Verbeek, a co-author of VtM further suggests that technology's intentional use is only effective when it aligns with contextual cultural values, reinforcing the urgency for involving values in technology design. Building upon this framework further supports the integration of healthcare professionals' contextual values into the design of the sustainability dashboard (van de Poel & Kudina, 2022).

Key values for healthcare professionals regarding technology and sustainability adoption

This section includes a meta-analysis of the most important values for healthcare professionals regarding sustainability and technology adoption. The study is supported by empirical data from two domains i.e. a literature review and qualitative empirical data:

1) A synthesis of findings from ten articles identifying values that healthcare professionals consider important regarding both the introduction of environmental sustainability initiatives and technology adoption. Additionally, five articles on the adoption and barriers of Green Information Systems and dashboards are analysed to support the identified values related to technology adoption.
2) Empirical contextual data from the previous study[3] with the capital region, comprising two workshops and three semi-structured interviews with healthcare professionals. The sessions focused on the preliminary ideation of the sustainability dashboard and the initiatives connected to it.

The values identified consist of barriers, motivators, and knowledge gaps, offering foundational insights into what is important for the professionals regarding both the design and the implementation of sustainability and technology. The data from the previous study is analysed through a value-thematic coding process (Figure 3) and translated into overarching values with inspiration from Van de Poels concept of *specification,* i.e. identifying norms and translating these norms into overarching values (van de Poel, 2013).

As identified in the literature and the previous empirical data, healthcare professionals have varying perceptions of sustainability and technology adoption, reflecting their diverse roles and experiences. To address this complexity, synthesizing these diverse perspectives into a unified understanding is essential. Identifying common values rooted in empirical evidence and literary analysis provides a better and more streamlined foundation for a unified value-framework, guiding the design and conceptualization of the dashboard. The values are related not only to the design of the technology (Green IS) and the initiatives, but also to their implementation and communication.

[3] Study with the capital region in the Autumn of 2023 (See scoping section).

Recognition

The investigation reveals that recognition plays a pivotal role in driving technology and sustainability adoption among healthcare professionals. Acknowledging that their actions lead to tangible benefits and impacts serves as a strong motivator and, consequently as a potential barrier if not presented. Further articles describe this validation through the concept of *Eco-feedback*, providing real-time demonstrations of environmental or technological benefits, further reinforcing this motivation through areas such as carbon emission reduction, economic savings, waste mitigation, quality patient care and population health (Chalal et al., 2022).

While technology adoption in healthcare is widely intended for enhancing patient care, environmental contributions often go unnoticed unless directly aligned with Green IS objectives (Casado-Mansilla et al., 2020; Kalogirou et al., 2021; Smith et al., 2022).

Informed competencies

The need for practical and technological competencies is crucial for healthcare professionals when it comes to sustainability and technology adoption. Clear guidelines, manuals, instructions, training, and onboarding information are essential to ensure meaningful use and adoption, as reflected in apparent barriers for healthcare professionals. Not having the competencies and being informed can, on the other hand, mediate feelings of exclusion, hierarchical inequality, and a lack in motivation. Having access to support contacts and a prominent background understanding proved valuable for the professionals (Bhutta, 2006; Christensen, 2024; Kirchner-Krath et al., 2024; Stancliffe & Bhutta, 2008). The value of informed competencies also includes a clear and effective communication of these competencies. Rather than overly distributing excessive information it is preferable to have designated contacts communicate the technology use and the new practices. Additionally, comprehensible information with simple frames of reference, context-suited language and shared guidelines were found to be vital needs in the literature and empirical data (Anåker et al., 2015; Quitmann et al., 2023b, Empirical data 2024).

Patient Care

Being the cornerstone of healthcare professionals' responsibilities, the workshops reflected critical concern that sustainability initiatives and new technologies might compromise patient care. Anåker

et al, formulate the problem in the following way: "Being green is not a primary task in a lifesaving, hectic and economically challenging context" (2015, p. 1).

Time, essential for providing care, also emerges as a critical norm, with its scarcity being identified as a barrier for both technology adoption and sustainable practices. Budget savings from the Danish Ministry of Health new public governance policies (2005) has also forced healthcare staff to solve more tasks with fewer hands, further underlining the time pressured day-to-day they find themselves in.

In the design and implementation of Green IS, it is therefore crucial not to burden healthcare professionals with additional time-consuming tasks that could remove focus from patient care.

The section underscores how the core value of patient care, supported by the norms of safety and time, can be impacted by the introduction of new technology or sustainable efforts. Therefore, when designing and implementing Green IS, it is imperative to ensure that the technology supports and enhances patient care rather than compromise it (Anåker et al., 2015; Christensen, 2024; Quitmann et al., 2023a).

Inclusion

Inclusion is a pivotal value for healthcare professionals, encompassing active involvement in decision-making, understanding, and incorporating existing user practices, and assessing workflow impact. Barriers and knowledge gaps arise from these needs, resulting in conflict with existing tasks, leading to an alienation of the initiatives and technologies. Collaborative design is therefore essential, as articulated by Christensen et al., emphasizing the necessity for solutions designed in collaboration with end-users (Christensen, 2024; Quitmann et al., 2023b).

Inclusion as a value is also represented by the need for an inclusive access to the initiatives and the technology implemented, securing a democratic participation (Anåker et al., 2015). This also entails being open and inclusive to healthcare professional's ideas, acknowledging their expert insights from their practices.

Institutional support

Through pattern recognition in the empirical data and synthesis findings in the literature, institutional support emerged as a critical value. This value operates on multiple levels, including the importance of economic support for financing specific solutions or practices, and top-down acknowledgment

from the hospital management to ensure healthcare professionals feel their actions are supported and valued (Sayyadi Tooranloo & Rahimi Ashjerdi, 2018). Furthermore, promoting unified goals and consistent guidelines fosters a sense of collective unit, shared responsibility, and motivation among professionals.

As reflected by the need for informed competencies, structural support, including background understanding and access to support contacts was prominent as well (Kirchner-Krath et al., 2024). The interviews and workshops carried out by the author in 2023, underscored the importance of institutional support in motivating commitments and sharing responsibility. Conversely, the absence of such support can hinder adoption due to complex organizational structures, lack of funding, or diminished motivation (Quitmann et al., 2023a).

Reason for synthesizing values

Sustainability and technology adoption

Even though the domains of environmental sustainability and technology adoption are fundamentally different, the meta study showed how the needs and norms from healthcare professionals are quite similar, allowing for a synthesis and generalization in values. The merging of values serves a unified approach to addressing both areas, especially in the context of Green IS which combines these elements. However, it is important to acknowledge that there are differences in perception and priorities and that the listed values (Institutional Support, Patient Care, Informed Competencies, Inclusion & Recognition) are a synthesis of the former empirical data and the literary analysis. This holistic approach ensures a detailed understanding of a diversity of healthcare professionals.

Literature and the empirical data

The value framework outlined above serves as the theoretical foundation for healthcare professionals, guiding the conceptualization of the dashboard. While there may be distinctions between the underlying values found in the literature and those observed in empirical data, they complement each other. The articles often articulate overarching values and needs, providing a theoretical backdrop, while empirical data offers concrete examples and illustrations to support them. Together, they provide a comprehensive understanding of the values guiding healthcare professionals and their implications for the design and implementation of the dashboard.

Knowledge gaps and future research directions

Technology's effects on values, practices, and perceptions

Christensen et al. (2024) and empirical data provide valuable insights into the challenges and opportunities of technology adoption in healthcare. However, further exploration is needed to understand *how* it affects the healthcare professionals' practices, perceptions, and values. This thesis aims to address this knowledge gap by investigating the practical and contextual engagements of healthcare professionals with the technology. Future research should therefore delve deeper into understanding the interplay between technological advancements and core values, as well as developing tailored solutions that effectively address the evolving needs and values of healthcare professionals and patients.

Technology's role in promoting sustainability in healthcare

While research has examined how Green IS and dashboards can be used to lower carbon emissions in organizations, there is a notable gap regarding the implementation in a healthcare context. Investigations into the effectiveness Green IS have mostly focused on technical adoption barriers regarding data infrastructure and data generation. This thesis will instead focus on the end-users' experiences of the technology using it to promote sustainable practices (Ghazisaeidi et al., 2015; Hensher & McGain, 2020; Smith et al., 2022).

End-user perspectives of Green IS adoption

While the focus predominantly has been on the economic, organizational, technological, and regulatory challenges associated with the adoption of Green IS (Sayyadi Tooranloo & Rahimi Ashjerdi, 2018), a knowledge gap exists within the individual end-user's involvement in Green IS adoption. This direction has formed the study's inquiries as it aims to extend the existing body of knowledge, by concentrating on the individual and socio-cultural adoption barriers. Kirchner-Krath et al. (2024) encapsulates this claim through the following statement: " […] it would be valuable to more comprehensively explore individual employees' perceptions and motivations in the adoption process, especially in the context of operational green IS where voluntary adoption is pivotal for behavior change" (2024).

Summary

The presented state of the art regarding sustainability and technology adoption in healthcare, helps to establish the context of inquiry while further framing which contributions the thesis aims to make, and the discussions it wishes to engage in. The next chapter will present the research design of the thesis, offering an overview of the approach.

AALBORG
UNIVERSITY
COPENHAGEN

Chapter 4

Theoretical framework

Techno-anthropological foundation

Techno-anthropology examines the intricate relationships between humans and technology, emphasizing how technology is embedded in everyday life and influences perceptions and actions (Børsen, 2020). Influenced by the disciplines of anthropology and science & technology studies (STS), techno-anthropology employs a hybrid research approach involving a diversity of theoretical frameworks including post-phenomenology. I argue that a techno-anthropological foundation is crucial for understanding technological transformations in healthcare, driven by increasing digitalization. The Values-that-Matter framework enables the investigations into how Green IS influences healthcare professionals' practices and values, allowing real-time investigations of change and focusing on moments when technologies create new meanings and interpretations for its users.

Values-that-Matter approach

This section introduces the theoretical and methodological framework of the thesis by operationalizing the Values-that-Matter approach. By employing this framework, the thesis gains analytical and methodological tools to anticipate and investigate technological transformations (Smits et al., 2022).

Values-that-Matter and Value-Sensitive Design

VtM emerged from Dutch scholars' efforts to combine post-phenomenological understandings of technology with empirical, conceptual, and analytical investigations for value-centred technology design. Serving as an extension and critique of Value-Sensitive Design (VSD), VtM focuses on integrating contextual values important to users into technology design, addressing a gap where VSD often relies on pre-established value checklists (Friedman et al., 2009; Smits et al., 2022).

VtM differs from VSD in several key aspects. First, while VSD tends to perceive values as stable, VtM acknowledges the fluidity of values, emphasizing their emergence in the interplay between users and technologies. An example is the introduction of digital technologies, altering our perception of what safety is, shifting from something physical and tangible, to concerns about data compliance and legal standards (Kudina & Verbeek, 2019). Secondly, VtM offers a clear anticipatory and iterative approach, anticipating social and moral implications of technology, unlike the speculative approach of VSD. Lastly, VtM sources values directly from stakeholders' contexts,

diverging from VSD's reliance on established value checklists, which can risk privileging certain values over others, not accurately reflecting stakeholders' perspectives. Despite its strengths, VtM also faces limitations, such as lacking a normative ethical foundation, and challenges in acknowledging stakeholders (Friedman et al., 2009; Smits et al., 2022). This thesis concentrates on healthcare professionals' value contexts, justified by their role as direct and indirect users of the sustainability dashboard. While integrating values from other stakeholders could enrich the framework, the focus here is on incorporating healthcare professionals' experiences into the design to promote adoption and usability.

Values-that-Matter: Explore, Conceptualise & Anticipate

The visualization beneath illustrates the study's methodological and theoretical approach, using VtM's three phases of Explore, Conceptualize and Anticipate (see figure 2).

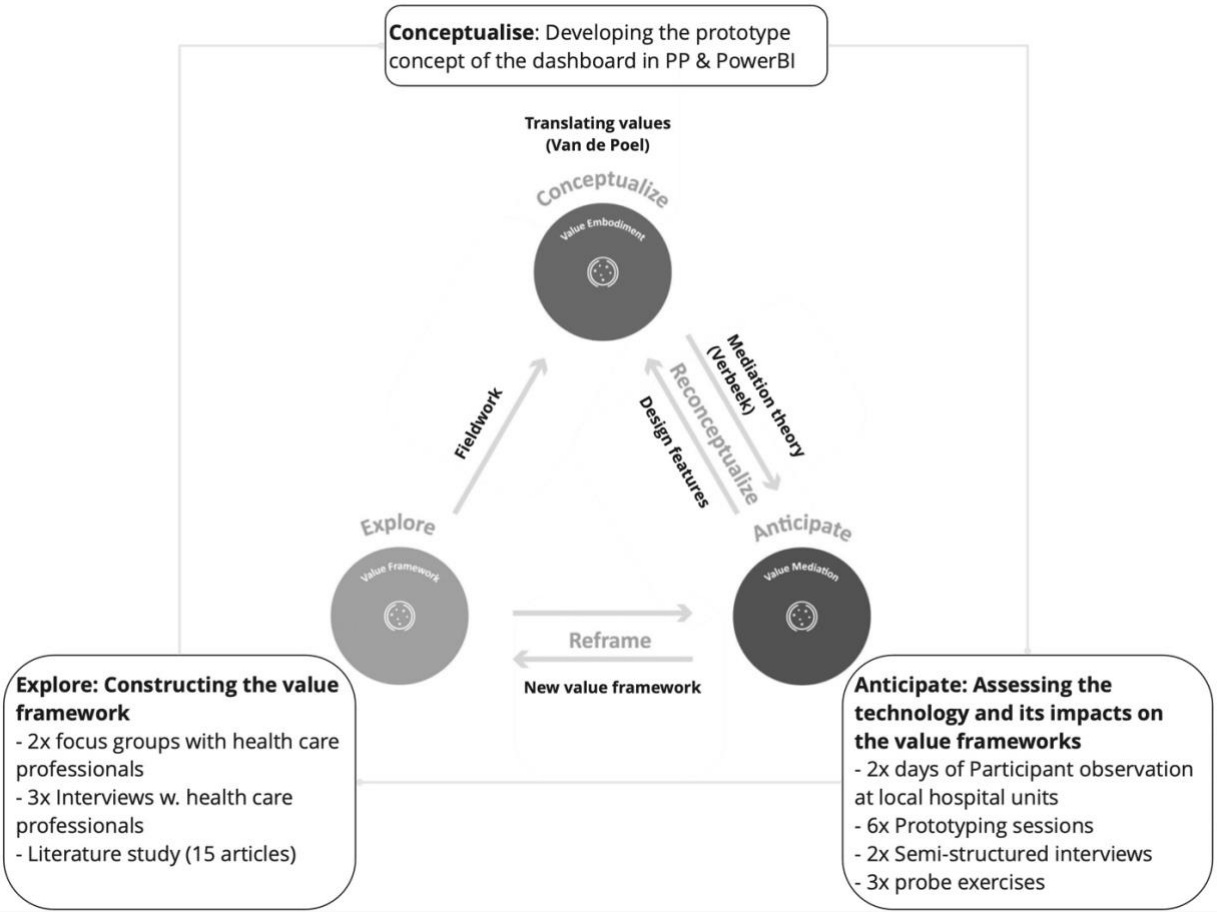

Figure 2 The three iterative methodological phases of Values-that-Matter (Smits et al. 2022)

The figure illustrates the authors' interpretation of the VtM Framework, reflected as an iterative process. The "Explore" phase involves gathering the data needed to develop the initial dashboard concept. With guidance from Van de Poel, visualizations of the dashboard are presented in the "Conceptualise" section. The "Anticipate" phase then assesses the impact of the prototypes on healthcare professionals, leading to insights that prompt a reframing of their value framework and of the prototype concept.

Exploring values: constructing the value framework

The exploration phase begins with identifying the values through context-specific approaches. This thesis targets hospital unit managers as *direct* stakeholders, engaging directly with the dashboard, and, nurses as *indirect stakeholders*, engaging implicitly with the dashboard through the sustainability initiatives connected to it. The empirical material for the value framework is derived from qualitative data gathered in workshops and interviews with healthcare professionals, emphasizing authentic values over pre-established checklists, and 15 articles surrounding technology and sustainability adoption from the literature review (Friedman et al., 2009).

Conceptualizing the prototype

In the conceptualization phase, the value framework obtained from the exploration phase guides the translation of values into design requirements for the dashboard prototype. Van de Poel's framework assists in this process, ensuring alignment with healthcare professionals' values. The prototype is refined through iterative processes based on reflections on the technology's mediating impacts on practices and values (van de Poel, 2013). These iterations occur after prototyping with the dashboard.

Anticipating impacts: Testing the prototype

The anticipate phase focuses on understanding the prototype's mediating impacts on stakeholders' value frameworks through testing and evaluation of the Green IS. Methods include participant observation, prototype testing, semi-structured interviews, and a probe exercise. Theoretical support comes from *technological mediation theory* and *moral frameworks*, which illuminate how technology shapes perceptions, values, and morality. This phase allows for insights into the technology's moral mediating effects and aids in reframing the value frameworks for the stakeholders (Smits et al., 2019).

The anticipation phase furthermore enables the testing of identified value tensions through new reconceptualization's.

Theoretical concepts

Technological Mediation: This concept, originating from Kudina & Verbeek (2019), explicates how technology influences and shapes human values, practices, experiences, and understanding. Drawing inspiration from Don Ihde's post-phenomenological perspective, it highlights the interactive relationship between humans and technology, emphasizing how they co-constitute each other. Kiran et al. (2015) further support this notion, asserting that society evolves alongside technology, necessitating an understanding of how values are reconstituted in relation to new technological developments. In this framework, technological mediation serves as a tool to comprehend how Green IS influences human perception and behaviour (Kudina & Verbeek, 2019). The concept enables investigations into studying change as it is happening, anticipating the change in perceptions and practice entailed by the introduction of Green IS.

Moral Framework: The thesis incorporates the concept of a moral framework to explore the ethical implications Green IS has on established moral frameworks. Inherent in technology are certain moral implications. Therefore, it is pertinent for this project to analyse how, and if, certain moral perceptions or actions are mediated in the testing phase of the sustainability dashboard. While moral frameworks and value frameworks are related, they are distinct from value frameworks in how moral frameworks specifically focus on how changes in perceptions of values influence individuals' practices and ethical choices. This concept is crucial when discussing the practices and perceptions new technology entails (Smits et al., 2019).

The concept of *value tensions* by Friedmann will furthermore be used in the discussion, to nuance and solve the value conflicts entailed by the dashboard (Friedman et al., 2021).

Translation of Values: Where the mediation theory can be used to analyse which perceptions and values are mediated, it falls short in concretizing how these values could be implemented into the design. This is one of the reasons why Van de Poel's framework (2013) of translating values into design is necessary to include. The value of "safety" can for example be translated into the norm of

"reducing fatalities", leading to specific design specifications such as "including seat belts in cars" (Ibid.). Smits et al. (2019) define *norms* as the conditions necessary to realize values in practice. Norms furthermore encompass goals and constraints, further articulated by Van de Poel as "prescriptions for, and restrictions on, action" (Smits et al., 2019; van de Poel, 2013). This iterative process allows for the alignment of design features with stakeholder values and enables design conceptualizations and re-conceptualizations based on the negative and positive impacts of the technology. The concept of *specification* enables this value judgement, translating higher-level elements into lower-level elements. This process it not always top-down (i.e. from Values → Norms → Design Requirements) but can also be achieved the other way around. In this thesis, the translation approach reflects two iterations of translation, further elaborated in the analytical techniques section on page 46-47.

AALBORG UNIVERSITY
COPENHAGEN

Chapter 5

Methodological framework

The framework integrates various qualitative ethnographic research methods to explore the moral and technological mediation of values through the Green IS. While not being rigid in its choice of methods, the VtM framework allows for contextual interpretation of the most suitable methods, which in this thesis includes *workshops* and *semi-structured interviews*, *participant observation*, *prototyping* and a *probe* activity. Each method is grounded in established qualitative research theories, emphasizing the values of importance, and their identification, incorporation, and conceptualization in the design process. These methods allow the thesis to investigate how the dashboard can be adopted in the most meaningful way.

Direct and indirect stakeholders

An important aspect of the VtM approach is delineating who your stakeholders are (Smits et al., 2019). When investigating the anticipated impact Green IS has on healthcare professionals in the testing phase, a distinction in stakeholders is needed, as to tailor the reconceptualization of the technology to different needs and interactions. The thesis therefore identifies two stakeholder groups in the thesis which is *hospital unit managers* and *nurses*, incorporating a direct and indirect interaction with the sustainability dashboard. The following illustration (Figure 4) serves to visualize the divide and their respective roles. Whereas both unit managers and nurses fall under the category of healthcare professionals, their roles differ, as reflected in the visualization.

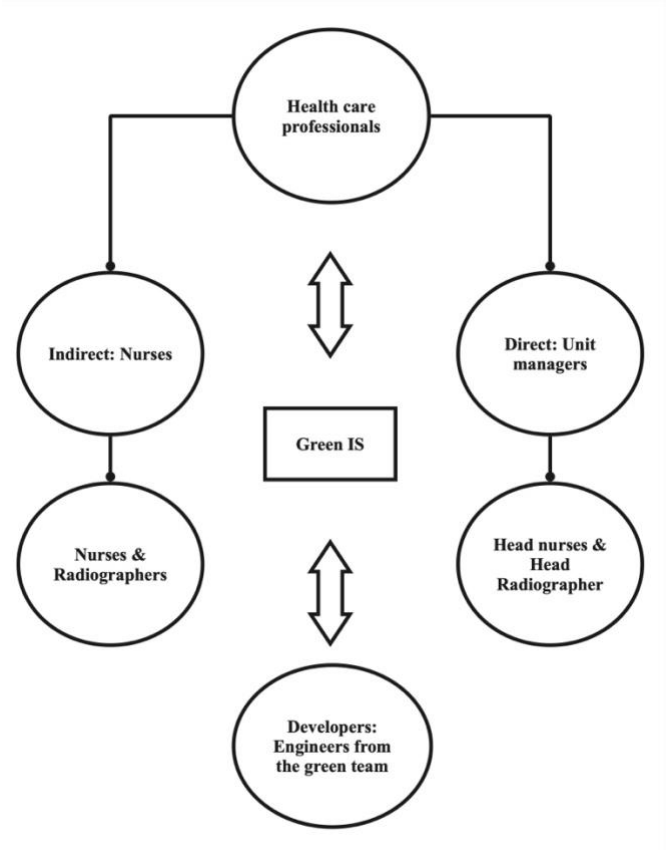

Figure 4 Identification of direct and indirect stakeholders.

Hospital unit managers as direct stakeholders

Direct stakeholders are those who influence the development of a technology and those who are going to actively use it (Friedman et al., 2009). In the thesis, the direct stakeholders include three semi-structured interviews with head nurses from the previous study as visualized in Table 1.1 on the page below. This empirical data is used in the explore phase, to theorize the value framework of the healthcare professionals. In the present study, the unit managers include one head radiographer and two head nurses at Rigshospitalet and Gentofte hospital (See table 1.1). The stakeholders involved have been subject to three prototyping sessions each and one probe activity. In this thesis they encompass the group of *hospital unit managers*.

Nurses as indirect stakeholders

The indirect stakeholders, on the other hand, are those affected by the technology without having the ability to directly shape or use it. They are influenced implicitly through others' use of the technology (Davis & Nathan, 2015). In the context of this thesis, nurses and radiographers at the respective

hospitals are part of this group. In the previous study with the capital region in the Autumn of 2023, developing preliminary ideas for the two Green IS, the healthcare professionals from the workshops are also included in this stakeholder group, given their indirect future engagements with the dashboard (See table 1.1 for clarification). The nurses do not directly interact with the Green IS dashboard but are impacted by its implementation implicitly through the sustainability initiatives. In the current study, two interviews were facilitated with nurses at the hospital units, whereas informal conversations and participant observation involved a higher number. This distinction is crucial for comparing how different groups perceive the technology and its effects.

Table 1.1. Data collected in the autumn of 2023 (Explore Phase)

Methods	Site	Time period	Selection criteria	Participants	Demographic and profession	Focus
Semi-structured interviews (3x)	Herlev & Rigshospitalet	November 2023	Participants working as unit hospital managers.	3x	Unit hospital managers, 35-50.	Underlying values, norms and needs regarding technology and sustainability.
Workshops (2x)	Herlev & Rigshospitalet	November 2023	Participants working at the hospitals, involved with sustainability programs and initiatives.	12x	Bioanalyst, 37 Clinical nurse specialist, 38. Physiotherapist, 47. Social and healthcare assistant, 53. Radiographer, 31 Nurses, 35, 45,47,46,60, 53 Chief physician, 60	Implicit value identification through co-creative discussion on technology and sustainability integration.

Table 1.2 Data collected during the fall of 2024 (Anticipate & Reconceptualize Phase)

Methods	Site	Time period	Selection criteria	Participants	Demographic and profession	Focus
Semi-structured interviews	Rigshospitalet & Gentofte hospital	April 2024	Nurses working at the two hospital units	2x	Nurses: 26-48	Implicit effect of the sustainability dashboard.

Participant Observation	Rigshospitalet & Gentofte Hospital.	April 2024	Hospital units where the dashboard was tested and where the initiatives had been employed.	No exact number.	N/A	Tacit knowledge and observation of practices related to values.
Prototype testing	Rigshospitalet & Gentofte	February to May (2024)	Participants working as unit hospital managers. Participants having tested the dashboard.	6x:3 sessions with each respective hospital unit and representatives.	Rigshospitalet: Unit manager, 57. Unit manager, 65. Gentofte: Unit manager, 44. Nurses, 48, 29.	Usability and functionality. How the dashboard mediates the values differently.
Probe exercise	Rigshospitalet & Gentofte	May 2024	Hospital unit managers & Nurses formerly involved in the project	3x individual exercises	Rigshospitalet: Unit manager, 57. Unit manager, 65. Gentofte: Unit manager, 44.	Impact on values and usability testing.

One value framework, two Stakeholder groups

To maintain clarity and avoid redundancy, one value framework will be constructed, encompassing the values experiences from both stakeholder groups. This approach acknowledges that while some values are universally significant, others are higher prioritized by specific stakeholders. The new framework will detail which stakeholder groups prioritize which values, reflecting their distinct relationships to the technology and their varying needs (Smits et al., 2019).

Methods

Workshops

Workshops were employed to actively involve the participants in the design process, ensuring that their values and perspectives were integrated into the value framework and the design of the prototypes (Smits et al., 2022). This method was used in the explore phase to empirically identify which values are of importance for the healthcare professionals when developing technological

platforms with sustainable purposes. The workshops primary aim was to discuss sustainability and technology adoption regarding the ideation of the sustainability dashboard and the initiatives, implicitly reflecting values and norms of importance. The workshops were facilitated at two hospitals, lasting approx. 90 minutes each. This method helped the study gather qualitative insights into healthcare professionals' norms, needs and values, further qualifying the value framework.

Semi-structured interviews

Semi-structured interviews were facilitated during both the explore and the anticipation phase with nurses and unit managers. They were conducted to gain in-depth insights into participants value experiences. The open-ended nature of semi-structured interviews encourages rich, subjective responses, which are essential for understanding the complex values and norms that matter to participants, tailoring the interview guide in this direction (Kvale, 2011). The choice of using interviews also aligns with the research goal of understanding the user's needs, norms, and value experiences, which can be hard to solely grasp from observation studies (Knott et al., 2022).

Participant Observation

Participant observation was utilized to understand the context in which the technology is used and to observe interactions and behaviours in real-time. This ethnographic method, as described by (Spradley, 1980) enables researchers to immerse themselves in the participants' environment, gaining a nuanced understanding of the social dynamics and cultural norms that influence value perceptions and technological interactions. The observations were carried out during the anticipation phase, comprising approximately 5 hours at each hospital unit, including 1 hour each place for interviews.

Prototype testing

Prototyping involved creating tangible or virtual versions of the technology for participants to interact with. This method allowed for iterative testing and refinement of the conceptualized design of the Green IS. This included two high-fidelity prototypes, one in Powerpoint with UI mockups and one in Power BI, for the users to engage with. The two versions are demonstrated in the following two figures. The screenshot visualizes a bar graph describing the employee driven sustainability initiatives, differencing between the actualized and potentialized carbon emission savings. The green aspects in the graphs describe the actualized carbon emission reduction.

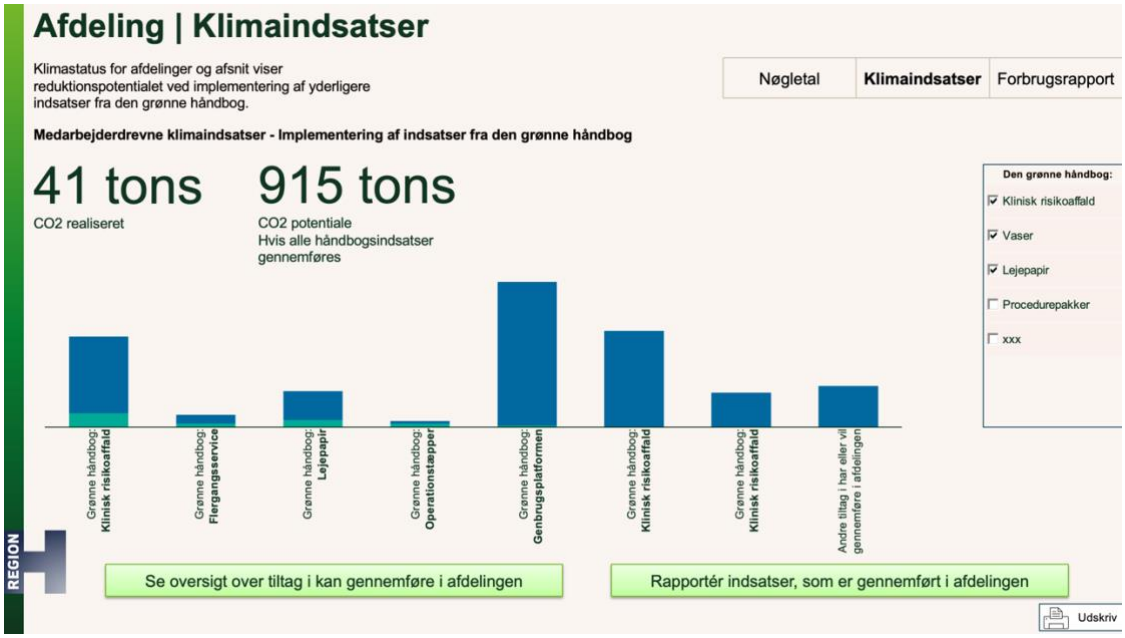

Figure 3: Visualization of graph in first prototype in PP.

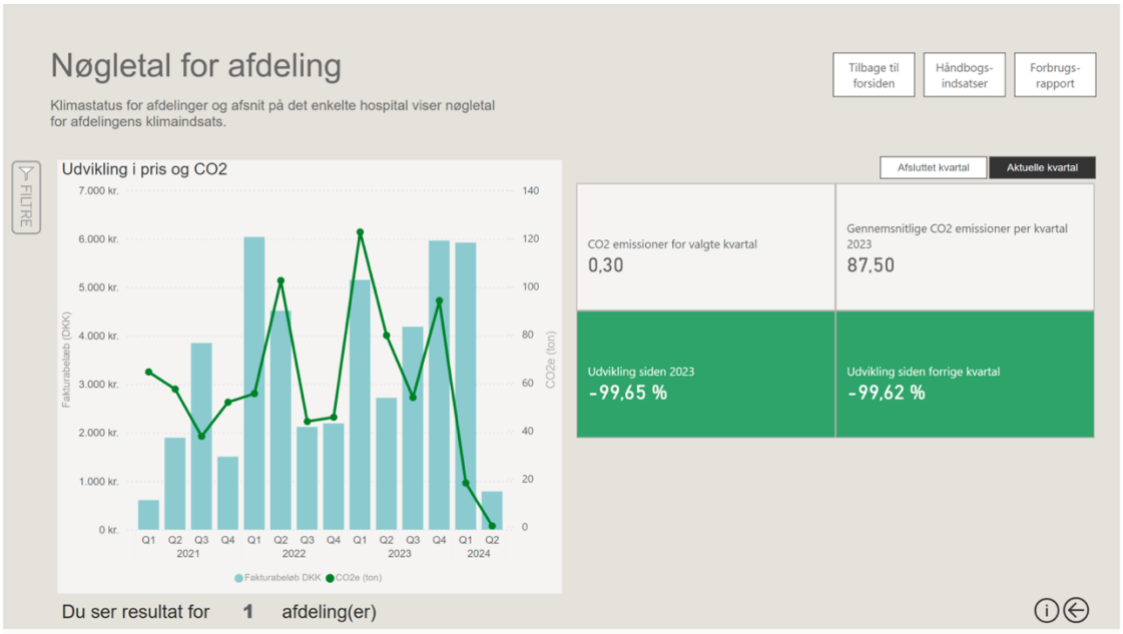

Figure 4: Visualization of second prototype in PowerBI.

The second prototype screenshot provides key numbers for the respective unit in price and carbon emission. To the right a matrix comprises the development in emission reduction in the chosen quarter and since the same time last year.

Prototyping serves as a form of mediation, where users can engage with the technology in a controlled environment, revealing its potential moral impacts on their values and behaviours (Smits et al., 2019). The *Think-aloud method* was instrumental in eliciting participants' value

articulation during prototype interactions. By encouraging participants to verbalize their thoughts and reactions, insights were gained into how the technology resonated with their values in real-time (Jaspers et al., 2004). This approach allowed to address the problem statement by directly capturing users' subjective experiences and perceptions of the Green IS impact on their practices and perceptions (Ibid.).

Additionally, *task-specific assignments* uncovered contextual barriers and understandings, simulating practical interactions to identify challenges and opportunities for the healthcare professionals. Three prototype sessions were facilitated at each hospital, equalling six sessions in total. These sessions included the author, the stakeholders and the two developers from the capital region.

Probe exercise

A *cultural* and *technological probe* is a tool typically used to gather qualitative data about users' contextual experiences, feelings, and attitudes. Being rich in detail, they involve providing the participants with a set of tools or an exercise. In this thesis, the probe served as an exercise distributed to the involved healthcare professionals (Mattelmäki, 2005). Combining elements from both cultural and technological probes as well as prototyping, the exercise focused on individual experiences, needs, and values, while also documenting and testing the dashboard. Removing myself from the investigation site offered new reflections that might not have occurred with me or my co-workers from the region being present.

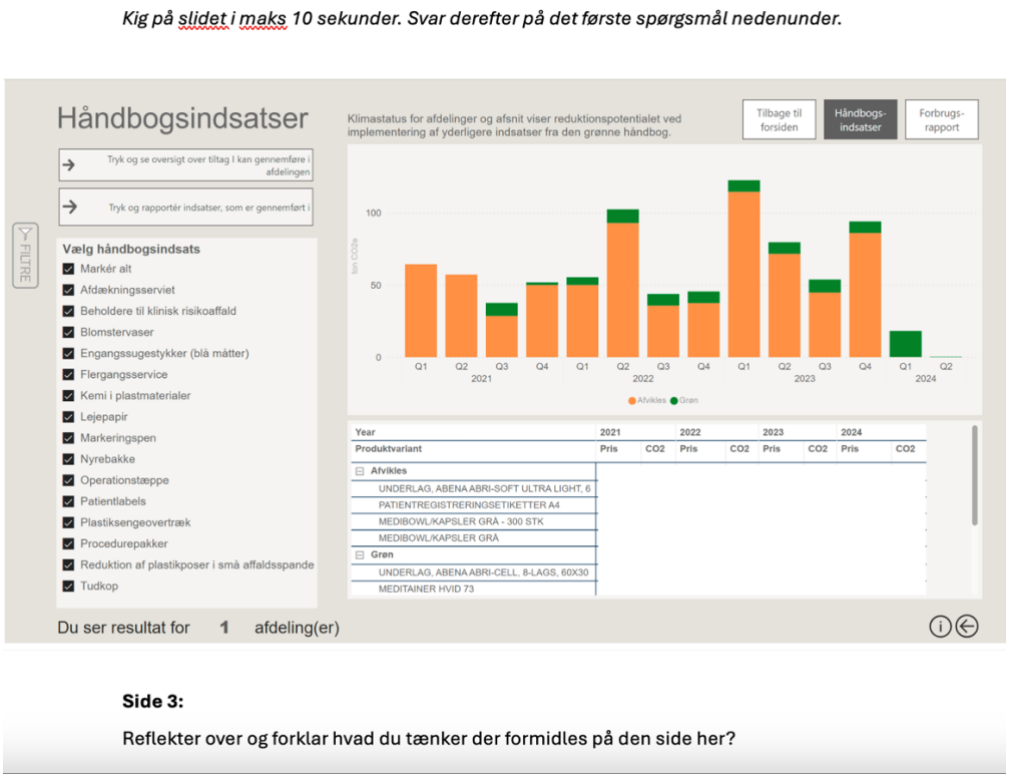

Figure 5: Visualization of probe exercise with accompanying instructions.

GDPR and Anonymization

Written GDPR declarations were signed before every workshop during the 2023 fieldwork, whereas oral GDPR agreements were employed during the 2024 fieldwork, since no patient interaction occurred. Transparency was fulfilled by both the author of the thesis and the collaborators from the region, but also between the stakeholders involved, having the opportunity at any times to withdraw their consent, and to review any material gathered or written. The declarations cannot be attached due to company regulations and the participants statements have been anonymized throughout the entire thesis.

Methodological and ethical reflections

Ethical reflections of hospital presence

Conducting research within a hospital setting brings unique ethical considerations. Being present in such an environment requires sensitivity to the context and the potential impact on patient care. It is crucial to balance the objectives of the research with the ethical imperative to do no harm. This

involves being mindful of how research activities might influence the behaviours of healthcare professionals and patients.

Positioning

As a techno-anthropologist in a healthcare setting, positioning oneself appropriately is crucial. This involves balancing the roles of observer and participant, being both an insider and an outsider. The goal is to gain deep insights while minimizing disruption to the natural setting (Spradley, 1980). Especially during participant observation at the hospitals this *dual-purpose* approach was employed (Ibid.).

There is a distinction between doing ethnography *for* an organization and doing ethnography *of* an organization (Neyland, 2008). The two approaches foster two different data results. Even though this thesis is founded in doing a project *for* the capital region, I was still provided with a prominent amount of autonomy in following my own investigations, not having to adhere to strictly predefined requirements.

Focus on the users

This thesis specifically engages with healthcare professionals in the design and implementation of the dashboard. While a holistic approach would involve a broader range of stakeholders such as developers, policymakers, and patients, this study concentrates on the users. Future research could address this gap by incorporating diverse stakeholder groups. However, this thesis aims to capture the perspectives of the users, emphasizing their impact and use of the Green IS. This user-centric focus allows for a detailed understanding of how the technology affects their practices, perceptions, and values, which is crucial for creating a tool that truly meets their needs. The small sample size furthermore limits generalizability, suggesting that future research should integrate multiple stakeholder viewpoints to enhance understanding and effectiveness.

Responsibility as researchers

Techno-anthropologists play a pivotal role as intermediaries between IT developers and users, tasked with translating values in the technological design process. Given the inherent ambiguity of values, the reliability in this translation is paramount. We bear the responsibility as researchers and establishing trust in our ability to navigate complexities and translate empirical needs, norms, and values is paramount. Engineers and developers often lack expertise to qualify human experienced

values, which it why the social scientific researcher is crucial in this translation (van de Poel, 2013). The concept of *Specification* from Van de Poel furthermore helps making these value-judgements (Ibid.).

Strengths and limitations of the chosen methods

The methods employed in this thesis provide a solid qualitative basis for addressing the research questions, but also have notable limitations. Ideally, the same participants would have been involved in both the former and current data collection phases, allowing for continuity and deeper insights. However, this study included different healthcare professionals in similar roles, which may affect the consistency of the findings.

In the explore phase of the VtM framework, in-depth investigations into the professionals' work contexts were not thoroughly conducted due to the study's reliance on workshops and interviews. These methods, while valuable, do not capture the real-time contextual nuances that direct observation would provide, meaning that some contextual and behavioural nuances may have been overlooked in the explore phase. This limitation was somewhat mitigated by gathering observational data in the anticipate phase, but the timing and sequence of data collection were not optimal due to a lack of resources and flexibility from the hospitals involved.

Despite these limitations, involving a variety of stakeholders is considered a strength, as it supports the design of a dashboard that meets diverse user needs. The qualitative methods allowed capturing a broad range of perspectives, contributing to a more holistic understanding of the impact of the Green IS on healthcare professionals' practices, perceptions, and values

Analytical methods and techniques

This thesis adopts an inductive hermeneutic approach, interpreting the empirical data through an interpretative lens, generalizing subjective observations and evidence into a hypothesis about the impact technology has on healthcare professionals' practices (Brinkmann, 2014). I employed a thematic coding process of the empirical data, firstly examining the identified and expressed norms from the stakeholders, then considering which values they encompass or relate to (See Figure 7). All the data was coded, analysed and anonymized to respect the stakeholders involved. Specifically, a value-thematic coding was employed, examining the norms and the revealed values in the empirical data, inspired by Van de Poels (2013) concept of *specification*.

The translation and coding process was done in two different sections. The first oriented towards identifying values of importance, and the second, concerning the translation of values into design features. The first process is illustrated in the following figure:

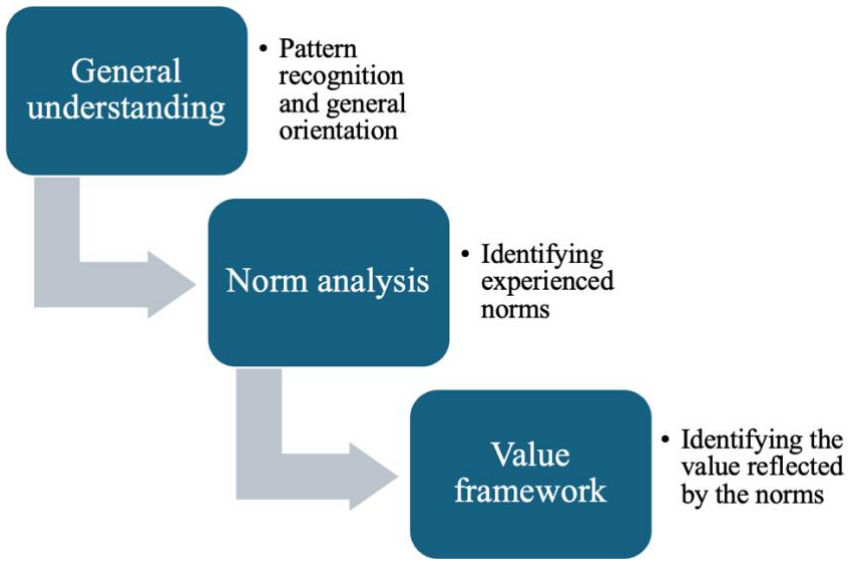

Figure 6 Process going from value experiences to value identification.

First iteration: Understanding and translation

In the initial iteration, the empirical data was read multiple times to develop a broad and consistent understanding. During this phase, workshops, interviews, prototype tests, and probe exercises were translated from Danish into English. This translation aimed to make the subsequent coding iterations more intuitive and coherent.

Second iteration: Norms analysis

In the second iteration, the empirical statements were analysed, looking for implicit norms, reflecting what is important to the stakeholders. After extracting these norms, the statements were further delimited by examining them across different stakeholder groups, identifying their relative importance in relation to the research question.

Third iteration: Value identification

With the norms identified, I employed what Margit Saltofte (2017) refers to as a *learning portfolio*. This involved creating a Word document with various data columns (see Appendix) to analyse the identified norms into overarching values of importance. It served as an iterative and living document, capturing the changing values reflected by the norms. A key task was to condense only the most relevant values identified by professionals.

Final iteration: Translating values to norms, then into design features

The final iteration involved translating the identified values into norms and then the norms into tangible design features. The process also included analysing the empirical data for negative value experiences, formulating design features mitigating the experiences. This process is visualized in Figure 9 below.

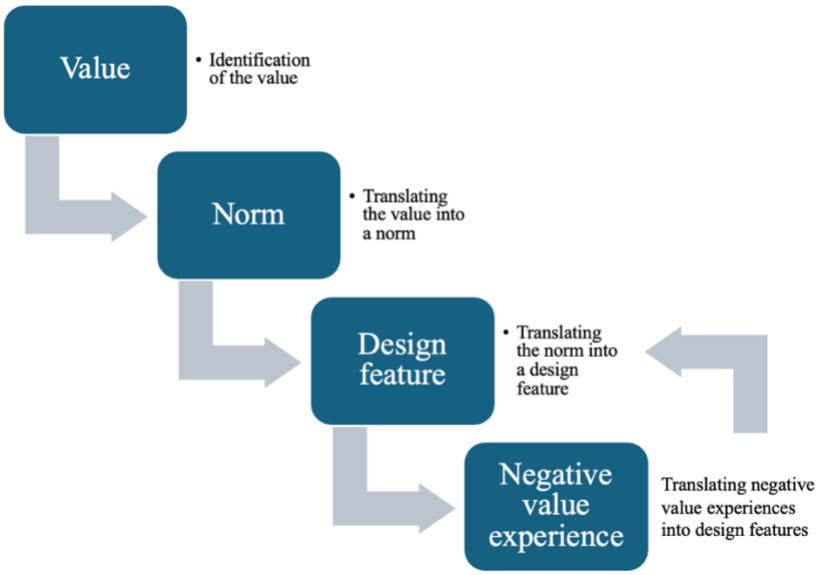

Figure 7 Process going from values to design features.

Reflective Ethnographic techniques

To support the analysis and the collection of empirical data, certain ethnographic techniques were employed to support the analysis and the collection of data. These comprised in field notes, a learning portfolio, and auto-ethnography.

Field notes

Field notes played a prominent role in my data collection process, particularly during participant observation sessions where some interviews could not be recorded. These notes served as crucial tools in understanding participation dynamics. Gathered during or after interviews, observation, prototyping, or informal conversations (Geertz in Nielsen & Rapport, 2017).

Auto-Ethnography

Auto-ethnography was used to incorporate the researcher's personal reflections and experiences with the technology being studied. This method involves self-observation and the analysis of personal experiences to gain insights into broader cultural and social phenomena. As Ellis & Adams (2014) suggest, auto-ethnography provides a unique perspective that combines the personal and the analytical, offering deep introspective insights (Ellis & Adams, 2014).

AALBORG UNIVERSITY
COPENHAGEN

Chapter 6

Analysis

The analysis is structured in four sections:

1) **Exploring the values of importance:** This section presents the initial framework of healthcare professionals' values, based on the literature review, and expanded with empirical statements from the authors fieldwork in 2023. The framework includes the values of Institutional support, Recognition, Patient Care, Comprehensibility, Inclusion & Informed competencies.
2) **Conceptualizing the prototype**: This section illustrates the prototypes conceptualization, using screenshots taken from the two prototypes (PP & PowerBI formats). Statements are provided to show how empirical data informed specific design features.
3) **Anticipating the impact:** This section examines the professional's engagement with the prototypes and analyses its mediating impacts on the original value framework (See Table 3.1), leading to new perceptions and understandings.
4) **The new value framework:** The final section develops a reframed value framework based on the anticipation analysis, incorporating re-interpretations, and emphasized values shaped by the dashboard interactions. The framework also involves specific design features for designing and implementing Green IS in the Danish healthcare.

Figure 8 Demonstration of the value framework process

Exploring the values of importance

This section presents the first value framework (See Table 3.1) originated from the analysis in the literature review, comprising of empirical data gathered in the former study and fifteen articles of relevance (see literature review). By demonstrating the values of importance with empirical statements, the section aims to answer the first part of the main research question: *Which values, practices, and norms do healthcare professionals consider important in their daily work?*

The empirical data and the state-of-the-art literature highlighted the importance of several key values when integrating new technologies and environmental initiatives in healthcare settings (see table 3.1 below). The empirical data is here analysed through a VtM lens, to understand how it influenced the design of the prototype, by identifying norms and design features.

Even though the values are open to ongoing change, they provide a foundation for the conceptualization of the prototype, as visualized in figure 7 and 8. Examples are the integration of a print-out function of the initiatives, availability of contact personnel, and a prominent navigation description.

The values in the framework relates not only to the perception of sustainability initiatives and technology, but also towards their implementation - which involves how they are communicated internally in the organization and how information is mediated.

Table 3.1 – The 1st Value Framework

Values	Norms	Design feature	Empirical quotes
Recognition	Visible positive feedback	Comparability with other hospitals and units.	"It's important we have some background information if someone asks into it."
	Shared goals	Integration of shared goals and benchmarks.	"It's not everyone who is ready to use technology in their daily work."
			"What does 3 tons of CO_2 correlate to?"
Informed Competencies	Practical and technical competencies development	Comprehensible pie chart and graphs.	"We can work more goal oriented with bigger "pondus" if we are working towards reducing local goals."
	Relatable and comprehensible	Navigation guidelines.	"Could be interesting to also compare with other regional hospitals."
		Function for printed version.	

			"We need some data saying that what we do works, cause then you can show it higher up in the system, that we are onto something here."

Patient Care	Ensure patient safety. Minimize additional workloads, removing focus away from the patient.		"I believe it's a shared assignment we have around the patient and the workplace we have". "It's not like this is the only thing (sustainability) which is important for the staff, it must be able to fit in their heads while caring for the patient." "It shouldn't just be a system that puts more weight on our shoulders."

Inclusion	Collaborative decision-making Inclusion of healthcare professionals' ideas, needs and expertise.	User-testing and participant involvement.	"When one think about how hard it has been to engage the management, it could be nice to be a part of that process. "I felt that I almost had to barge in to the management and yell at them."

Institutional support	Acknowledgement from the management Standardized guidelines Economic resources	Contact persons included in the dashboard for questions.	"You need to know that there is someone thinking about it in the other end (management)". "There should be some acknowledgement from the management". "I would need more technical and practical capabilities."

Prioritization of values

As previously mentioned, values are contextually interpreted and interacted. While all the mentioned values in the framework (Table 3.1) were important to both nurses and unit managers, some were emphasized differently than others by the two stakeholder groups. The nurses prioritized inclusion and involvement more than the unit managers, reflecting their lack of awareness and engagement with the dashboard, contrary to the unit managers. The unit managers instead prioritized informed competencies more than the nurses, as they are the ones expected to use and interact with the dashboard, therefore needing certain technical and practical competencies. Although both groups acknowledged the importance of informed competencies and inclusion in the empirical data, qualitative observations revealed a difference in how these values were prioritized.

Scoping measures

While most of the design features in the prototype were developed by the engineers from the Green Team, several design features were influenced by the empirical data. This will be illustrated in the next section when conceptualizing the prototype of the dashboard, reflected in figure 7, 8 & 9.

A key insight, already reflected in the data, is that many norms and values in the value framework focus more on the dashboard's implementation and communication rather than the GUI (Graphical user-interface) itself, indicating a potential challenge for healthcare professionals. These implementation challenges will be further elaborated and addressed in the mediation section of the analysis.

By constructing a value framework (Table 3.1) from the explore phase data, we can compare values before and after prototype use, providing insights into the dashboard practical impacts and the areas for improvement.

Conceptualizing the prototype

As visualized in figure 7 and 8 on the next page, institutional acknowledgement is reflected implicitly in the dashboard itself, and its regional scope, rather than being limited to a single unit. Figure 8 also illustrates the inclusion of contact persons in the prototype, addressing healthcare professionals needs for physical and direct assistance when using the dashboard. The ability to measure and compare units was also highlighted in the empirical data, reflecting a desire to compete and collaborate with other units working towards mitigating carbon emission.

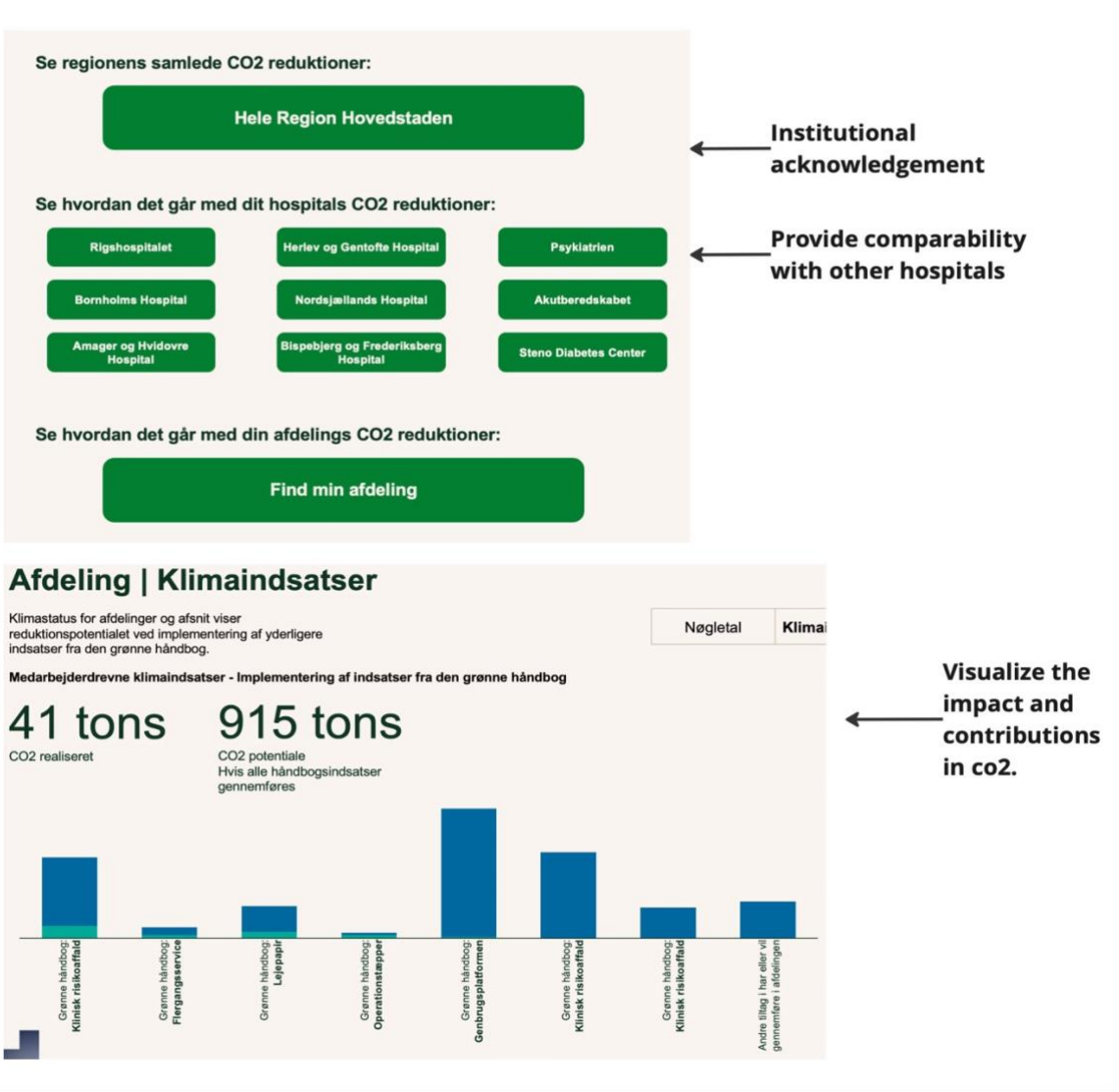

Figure 11 Prototype with integrated design recommendations. Shows how the prototype was refined through continuous feedback, emphasizing an iterative process. The inclusion of the design features also addresses the values from the first value framework in table 3.1 of the professionals.

The value framework further illustrated the need to visualize the CO_2 impact, as reflected in figure 7. The figures also highlight the importance of an intuitive and comprehensible user interface, specifically using colours to contextualize shared goals and the integration of navigation guidelines (See Fig. 8). A crucial design feature reflected in the prototype is furthermore the availability of a print function for the dashboard, addressing healthcare professionals' need for physical dissemination and understanding (See Fig. 9).

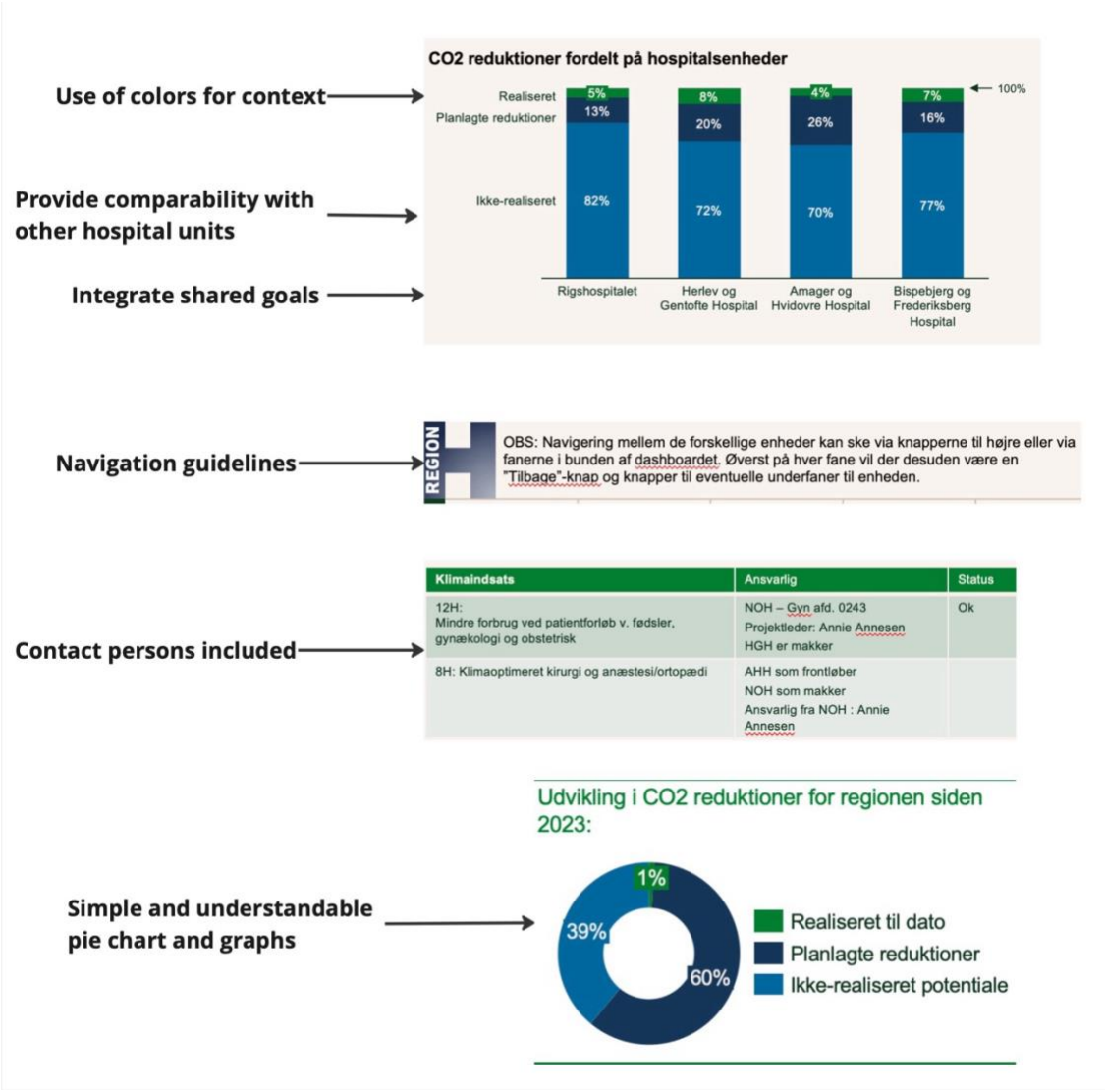

Figure 12 Detailed view of the prototype with integrated design recommendations, showcasing key features.

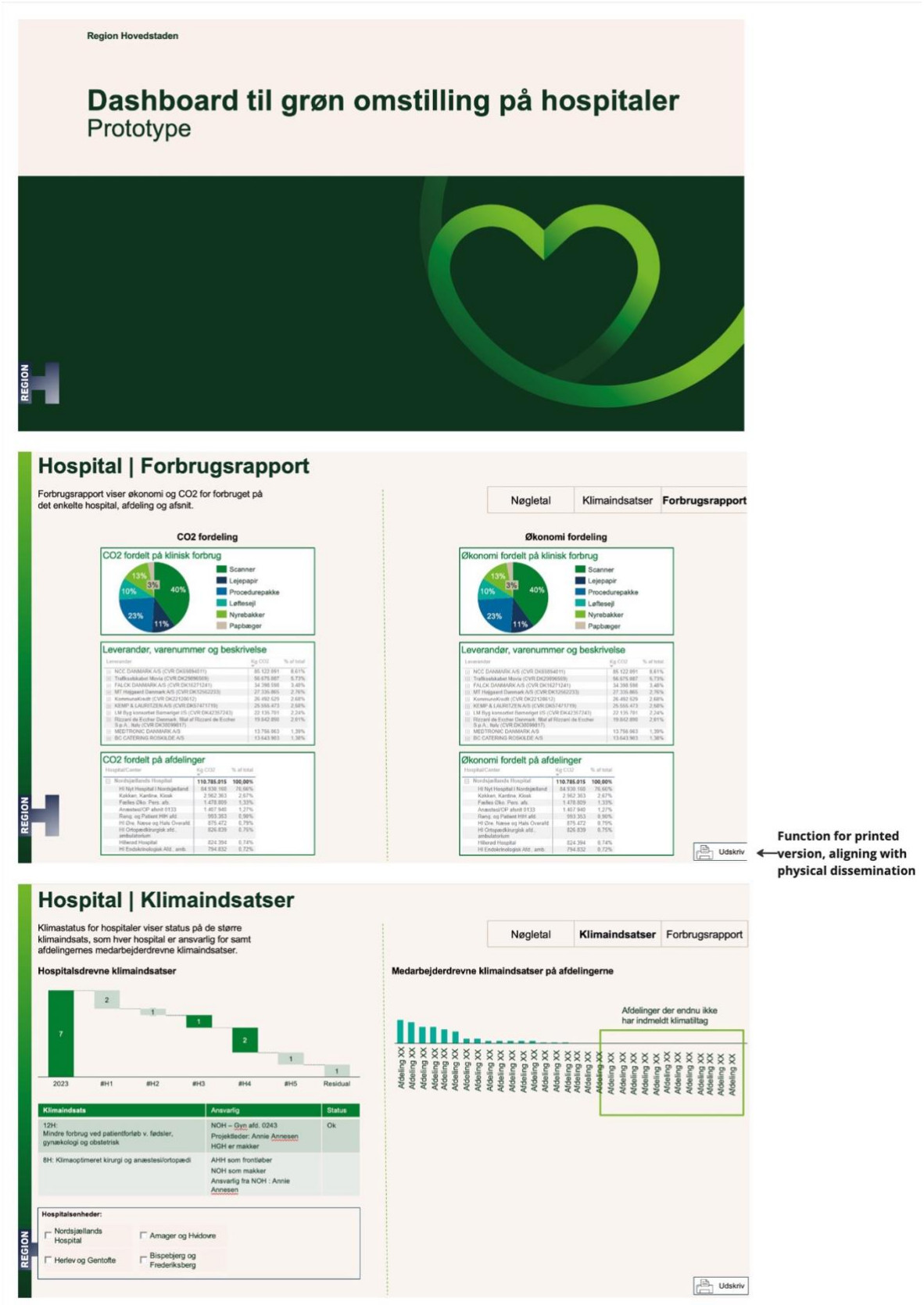

Figure 13 Prototype with integrated design recommendations.

This section outlines key design features, such as institutional scope, user support contacts, unit comparison capabilities, CO_2 impact visualization, an intuitive user interface with contextual colours and navigation guidelines, and a print function. Each of these features is supported by empirical data, ensuring they effectively address the diverse needs of healthcare professionals.

In the next section of the study, I introduced the prototype to the healthcare professionals at two hospitals. This investigation examined how the dashboard influences existing practices, perceptions, and values (Table 3.1). By analysing the negative and positive value experiences from these interactions, new mediations of values, were formulated (Table 3.2), providing a foundation for anticipating its future impact.

Anticipating the impact

This section aims to address the first research question *Which values, practices, and norms do healthcare professionals consider important in their daily work, and how are these impacted by the introduction of Green IS?*

In line with the question, the focus here is to investigate how the dashboard influences healthcare professionals' norms. As outlined in the theoretical framework section (see p.30.), the anticipation phase aims to understand the soft mediating impacts a technology have on its users' values. The impact of the dashboard is therefore tested through prototype tests, probe exercises, interviews, and participant observation, investigating the impact on the previously identified values of the healthcare professionals (See table 3.1). Values are prone to change, and might be *challenged, strengthened,* or even *transformed,* in the interaction with new technology (Smits et al., 2019). The dynamic interplay between technology and values reflects how users' perceptions and priorities can shift based on their experiences and interactions with the technology. The current value framework (See Table 3.1), comprising the latter mentioned values (comprehensibility, patient care, informed competencies, recognition, institutional support and inclusion) is used as a reference to understand the mediating effects of the dashboard.

The introduction of the prototype fostered what Van de Poel & Kudina call "new indeterminate situations" (2022) which triggers new interpretative inquiries that can lead to a value change. As these new situations arise for the healthcare professionals, they lead to "new valuing's" or value judgments, that might differ from the generalized values previously held (van de Poel & Kudina, 2022). As the professionals interact with the prototype, they might emphasize different aspects of the values, prompting discussions that guide the design to better align with their values.

The findings summarized in Table 3.2, reveal both positive and negative impact on these values, providing a basis for redefining the value framework (See p.71), encompassing adapted features for the design and implementation.

Table 3.2 – The prototypes' impact on the first value framework

This section analyses which values were adequately met, the new mediations that emerged, and how perceptions of these values shifted. Following Smits et al. (2019), negative value experiences necessitate the introduction of design features aimed at mitigating these issues. The accompanying table first lists the original values from the initial framework (Table 3.1) in the left column, followed by the newly mediated norms, then the positive and negative value experiences introduced by the dashboard, and finally, a proposed design feature to address the negative and positive experience.

Values	**New emphasized norms**	**Positive value experiences**	**Negative value experiences**	**Design features**
Institutional support	Access	Foster dialogue with the management.	Lack of access to the dashboard for the nurses.	Ensure democratic communication and participation.
	Autonomy	Individual choices in the dashboard.	Lack of autonomy and authority from the nurses. Dependency on institutional approval, limiting individual usage.	Integrate tailored decision-making functions in the dashboard, also for the nurses. Communicate institutional approval of use.
	Financial resources		Measuring initiatives against financial consequences.	Allocate time for nurses and unit managers.
	Accountability	Accountability from the management.	No awareness of the management's efforts (responsibility).	Visualize the management's efforts of green purchasing in the dashboard and their accountability.

Inclusion	Access to the dashboard	Improves dialogue and engagement with the management.	Lack of access discourages responsibility.	Ensure democratic communication and participation.
	Innovation	Facilitates innovative exploring of new initiatives.	Not being able to integrate ideas due to lack of access.	Function for accepting new ideas, fostering shared ownership.
	Personalization	Supports individualized analysis and interpretation of the dashboard.	Not having formal access to the dashboard. The need for institutional approval and authority.	Integration of pick and choose function related to the initiatives on the dashboard (personalization). Voluntary adoption.

Recognition	Validation	Visualizes a clear effect of the initiatives. Measurable data to support changes. Seeing positive eco-feedback and a future impact.	Unclear visualization and acknowledgement of impact. Fear of validation only in numbers and graphs. Technological uncertainty.	Use of colour coding to visualize positive/negative impact. Validate through other elements than numbers, such as figures, text etc. Visualize effect of completed actions/initiatives.
	Comparability	Motivation from comparison (historic, local/regional). Sharing of knowledge and responsibility.	Discouragement due to uneven comparisons. Fear of financial costs for sustainable choices. Lacking individual responsibility.	Integrate historical comparative measures. Employ local and regional contests. Integrate benchmark functionality (externally and internally).
	Professional and patient safety	Maintains safety measures.	Challenges professional perceptions of safety.	Visualize hygiene regulation approval. Display evidence-based justification.
	New tasks and responsibility	Individual responsibilities for carbon mitigation.	New environmental responsibilities. Problems with new task assignment.	Incremental implementation and voluntary adoption. Display the positive quality benefits the initiatives entail.

Informed competencies	Requirements		Afraid of "damaging" the dashboard when using it. Lack of technological experience in the FLIS system. Lack of practical product knowledge.	Technical training in the FLIS program. Guides/Manuals on how to use and find the dashboard. Task assignment clarification.
	Credibility	Openness for new scientific orientations in relation to PPE and technology use.	Permission uncertainty.	Scientific evidence-based knowledge, supporting the initiatives. Knowledge of the products involved in the dashboard initiatives.
	Comprehensible interpretation	Clear guidance and understandable visualizations and GUI.	Contradicting information flows from the management. Complex to navigate in and confusing CO2 concept. Confusion over target audience.	Clear assignment of work roles and responsibilities. Integration of text boxes, guiding the dashboard. Focus on percentages instead of abstract numbers.

Table 3.2: Impact framework of the healthcare professionals, containing new mediations of the values.

Mediation of values

Kudina & Van de Poel (2022) provide insights into how values can change over time as new situations and technologies emerge. Introducing a prototype can bring attention to values that may have been previously overlooked, leading to a reassessment of what is considered important. This process can result in broader changes, where values are changed and adjusted to better address new technological challenges. This analysis explores how the introduction of the prototype creates new situations that lead to the revaluation of previously underexposed values. These changes are captured in the new value framework (see page 70) outlining the emphasized values and the encompassing design features.

This section expands the impact framework above in Table 3.2, summarizing how healthcare professionals' interactions with the dashboard mediate new meanings of the values. It

analyses each value and how the prototype affects these values, identifying the norms that are needed to fulfil them.

The value of environmental sustainability is intentionally excluded from the value framework since it is inherently represented by the dashboard itself. Since the thesis focuses on aligning healthcare professionals' values with the dashboard, the value is not represented in the framework. How environmental sustainability can be aligned with healthcare professionals' values will be elaborated in the discussion.

Institutional Support

Democratic accessibility

After engaging directly with the prototype through prototype tests and the probe exercise, it became clear that institutional support for the healthcare professionals goes beyond financial resource allocation and streamlined guidelines. Crucially, it underscores the need for democratic accessibility and participation to the dashboard. This mediation was notably influenced by the negative experiences reported by the nurses, who did not have formal and practical access to the dashboard, unlike their unit managers: "It's great, but are we allowed to use it (dashboard)? And how do we do it?" (Nurse: Pers.comm, April, 2024). The statement reflects clear doubts about their access to and competencies in using the dashboard. During a visit to a hospital unit involved in the dashboard testing, I interviewed a nurse participating in the dashboard project. When I asked her opinion on the dashboard, she stated:

> My unit manager has never showed it to me, so this is the first time I have seen it. It's really nice that you show it to me, so I can explain it to my co-workers (Nurse: Pers.comm, April, 2024).

The lack of access to the dashboard presents a great challenge for the nurses, particularly those who are eager to use the dashboard to make a meaningful impact. How the lack of access can affect their motivation, perception and practices, will be elaborated in the discussion.

Agency and autonomy

In contrast to the negative value experiences stemming from the lack of access, several unit managers observed how the dashboard can serve as a tool to engage the management and provide data-based credibility for facilitating changes:

> It could be used to start a dialogue with the management, acting as a stepping stone towards making new changes. Having the data to say this and that.
> (Unit manager: Pers.comm, May, 2024).

The quote demonstrates how the dashboard mediates new practices and provide the professionals with more agency by enabling them to engage the management for desired changes (Kudina & Verbeek, 2019).

The need for financial resource allocation and awareness of institutional responsibility is maintained throughout the interactions and remains a constant consideration when interacting with the dashboard, emphasizing the ongoing necessity for time and resource allocation to effectively use the dashboard.

The value of *institutional support* is therefore fulfilled by integrating the following norms:

- Ensuring democratic accessibility.
- Illustrating institutional responsibility and approval of use.
- Financial resource allocation and flexibility.

Patient Care

Personal and patient safety

An area wherein the dashboard has a special mediating impact is on the core value of patient care. The prototype tests reveal that the dashboard challenges the value by promoting environmental sustainability at the perceived expense of safety. Besides challenging the core norm of patient safety, the dashboard also introduces new time-demanding tasks that could implicitly impact their patient-centred responsibilities:

> Just because the new initiatives are better in terms of the environment does not mean that there are no considerations that needs to be taken (Unit manager: Pers.comm, February, 2024).

While patient care in the first value framework centered on the well-being of the patient, the testing of the dashboard highlighted the necessity of prioritizing personal safety for the healthcare professionals, especially due to the initiatives focus on removing protective equipment. As one unit manager noted: "It's a balance, that's also why we use gloves – it's to protect ourselves, so one does not compromise with your own safety, cause I don't want to do that" (Unit manager: Pers.comm, May, 2024).

These concerns illustrate how the dashboard introduces new evaluative dimensions of the Green IS, as meanings and priorities evolve in response to user concerns. This challenge on personal and patient safety will be further elaborated in the discussion.

New moral responsibilities

The concept of *moral framework* from Kudina & Verbeek (2019) helps explain how new ethical responsibilities are mediated, requiring healthcare professionals to balance environmental sustainability with patient care and safety. For instance, a nurse expressed concerns about the new moral burdens introduced by the dashboard:

> Washing reusable items will fall on us. Which shift should do it? This worries me and my colleagues a lot, especially from a hygiene perspective. Also regarding whether or not its responsible to use (multiple-use products).
> (Nurse: Pers.comm, May, 2024).

The introduction of new tasks has led to concerns about who should handle them, creating practical challenges. These concerns illustrate how new practices mediated by the dashboard create ethical and operational dilemmas, affecting existing workflows and responsibilities. A unit manager further emphasized the value conflict between safety and sustainability, in relation to financial costs, by assessing the situation from a cost-benefit perspective: "Its way more expensive for an employee to get infected than for us to wear personal protection equipment" (Nurse: Pers.comm, February, 2024).

These statements underscore the moral conflict mediated by the dashboard, challenging core perceptions of safety. By fostering time-demanding and sustainability-oriented tasks, the dashboard also entails new environmental responsibilities, potentially hindering their patient focus. These significant value conflicts will be further elaborated in the discussion.

Emancipation

However, the dashboard also positively increases awareness of environmental impacts among professionals, as reflected in this statement:

> What about isolation clothing, its literally one-time outfits. We wear it for 5 minutes then throw it out (Nurse: Pers.comm, May, 2024).

In my observations during the prototype test interviews, I noted that several professionals felt empowered and acknowledged by the dashboard, fostering a sense of innovation, as they identified more goals and targets that could be incorporated in the dashboard. This illustrates how the dashboard also shapes new positive perceptions of themselves, potentially redefining their roles as sustainable agents.

Patient care needs to be fulfilled by ensuring that the following norms are integrated:

- Personal and patient safety when using the dashboard and implementing initiatives.
- Voluntary task assignment and avoidance of excessive workload.

Inclusion

Healthcare professionals as co-participants

It became evident that the meaning of *inclusion* described in the first value framework (Table 3.1) had evolved through iterative engagements with the dashboard. Both the nurses and the unit managers now articulated a clear need for more meaningful responsibility and inclusion in relation to the dashboard and the sustainability agenda, progressing more towards the concept co-participation instead of a mere tokenistic involvement, highlighting a positive perception of sustainability mediated by the dashboard: […] after looking at the dashboard the first time we talked about how many more things we can do at the unit (Unit manager: Pers.comm, March, 2024).

Personalization

Contrary to the positive mediations reflected in the quote above, all but one of the unit managers noted that the current design of the dashboard is only for the few, which significantly challenges the value of inclusion:

> Who is it made for? Is it made for someone in the management then it's interesting. For a green ambassador or a nurse, it's too complicated (Unit manager: Pers.comm, May, 2024).

This statement further reveals that while the dashboard has potential for broad application, its current design does not fully support the inclusivity required for everyday use by both the unit mangers and the nurses. Their perception of inclusion goes beyond design process involvement, emphasizing a dashboard that meets local units needs through personalization:

> This allows me to sit and play with it, to see how big a carbon emission each initia tive entails. This allows me to reflect on which initiatives would matter the most to work with (Unit manager: Pers.comm, May, 2024).

This need for personalization not only reflects the value of inclusion, but also autonomy and emancipation in its use, promoting innovative sustainable behaviour.

For the value of inclusion to be supported by the design of the dashboard the following norms needs to be fulfilled:

- Enable personalization functions in the dashboard, fostering autonomy to affect change.
- Involve the nurses and unit managers as co-participants in the design and implementation process.

Informed competencies

Technical Requirements

Observing the professionals' interactions with the dashboard, the value of informed competencies transformed to emphasize not only circular economy competencies, but actual requirements needed to meaningfully use and interpret the dashboard. These requirements include acquiring technical competencies in the FLIS program, the system into which the dashboard is to be integrated:

> It requires proper introduction to the dashboard and proper knowledge in FLIS. Maybe also physical meetings and or posts on intra.
> (Nurse: Pers.comm, April, 2024).

The integration of the dashboard into the FLIS system, reflects a challenge to the practical use of the prototype, potentially fostering exclusivity, if the competencies are not provided. A unit manager further emphasizes the challenge: "It's a system you only become aware of when you are a part of the management. Personally, I think it's too employee distant" (Unit manager: Pers.comm, May, 2024). During a day of participant observation among the professionals, I further reflected on the lack of technological requirements for both the nurses and the unit managers, reflecting a significant gap in the practical usability of the dashboard:

> Many of them haven't even heard of the FLIS system, and those who have seem rather new to it. A potential problem could definitely centre the integration of the dashboard in this system and the lack of competencies navigating it (Field notes: Pers.comm, May, 2024).

Practical and scientific knowledge

The use of the dashboard also reveals a need for competencies involving practical knowledge of the products/equipment measured in the dashboard. These requirements are essential for meaningful interpretation and effective use of the dashboard, as they impact the ability to implement new initiatives. The value of informed competencies also encompasses came the need for scientific credibility concerning environmental sustainability and safety. A lot of the healthcare professionals expressed the need for a credible, factual basis to justify changes in their practices, illustrated by one of the nurses:

> If new science and new facts says otherwise, I would be more open to change. It could be anything from using gloves, but I think it would be a bit too much of a change for some (Nurse: Pers.comm, May, 2024).

This need for scientific and credible information to justify changes in practice also stem from previous negative experiences with conflicting information from the management:

> After changing to another product, following an initiative in the dashboard, a guy from the administration came and told us that we couldn't sort it the way we were actually told to (Nurse: Pers.comm, May, 2024).

A unit manager further elaborated on the practical requirements needed to meaningfully use the dashboard: " […] you need an awareness of the different products, which I don't have today. Our product catalogue is very comprehensive, and price and availability need to be visible" (Unit manager: Pers.comm, April, 2024). Needing both technological, scientific, and practical competencies to successfully adopt the dashboard highlights a clear obstacle for both unit managers and nurses.

Over the last 20 years, healthcare professionals have shifted from using multiple-use equipment to single-use and back to multiple-use, describing their field as being in a constant state of change. While this reflects an openness to change, it could also substantiate an opposition and uncertainty, as they fear these practices might change again. A quote, illustrated earlier, supports this inherent doubt towards the responsibility of the initiatives:

> Washing reusable items will fall on us. Which shift should do it? This worries me and my colleagues a lot, especially from a hygiene perspective. Also regarding whether or not its responsible to use (multiple-use products).
> (Nurse: Pers.comm, May, 2024).

As the statement shows, an uncertainty still persists following the introduction of new practices, even though the initiatives have been approved by the institution's hygiene unit, illustrating a significant value conflict.

Seen in the empirical data, the dashboard mediates new specifications towards what informed competencies means for the healthcare professionals, emphasizing the need for scientific justification, technological requirements, and practical knowledge of the products, to meaningfully use the dashboard and employ its initiatives.

Incremental and physical dissemination of use

The value of informed competencies furthermore evolves to include not only the necessary knowledge but also how the knowledge should be disseminated and communicated, emphasizing the need for an incremental approach. During my hospital visits, many professionals highlighted gradual and incremental adoption of technologies and initiatives as the right approach, given previous negative experiences with radical changes (Field notes: Pers.comm, April, 2024).

To support the value of informed competencies in the design and implementation of the dashboard, the following norms needs to be fulfilled:

- Technical training in the program FLIS
- Knowledge on the products involved in the dashboard and of environmental sustainability.
- Evidence based knowledge, justifying the professionals transition.
- Physical and incremental dissemination of use.

Recognition

The norms and meanings ascribed to the value of recognition strengthened significantly after engaging with the prototypes, remaining crucial for working with sustainability measures and with the dashboard:

> To look back and see that we have improved ourselves could be a clear motivational factor to continue doing something, if you can see that the initiative actually has an effect on the dashboard, otherwise it would feel like pointless work.
> (Nurse: Pers.comm, February, 2024).

While recognition still necessitates visual feedback and acknowledgement, the empirical data illustrate how its meaning evolves to emphasize comparisons. The focus shifts particularly toward comparisons over time, allowing the professionals to look back and see how much they have

improved, strengthening their acknowledgement. The need for internal and external comparisons also becomes prominent, reflecting how competition with other units and other hospitals could foster motivation:

> Seeing other hospitals against your own. Oh no we are behind or yes we are in front. This is clearly something that could motivate me, just as it did with the APV. If there is a unit doing exceptionally good, you can ask them for help.
> (Nurse: Pers.comm, May, 2024).

Positively mediating a sense of shared collaboration, the comparison aspects reinforce that hospital units are not alone in their efforts.

While the meaning of recognition is mostly strengthened, challenges also arise due to unclear interpretations of the visualizations in the dashboard, which mitigates feelings of acknowledgement. Similarly, a negative perception emerges through experiences of impersonal interaction with the dashboard, where recognition was only perceived in data and numbers:

> Our work with the dashboard is acknowledged in data and numbers which is fine, but an important parameter is also in terms of acknowledgement from the management, co-workers etc. maybe also some words of appreciation.
> (Unit manager: Pers.comm, May, 2024).

The statement addresses the need for more personalized acknowledgements to fulfil the value of recognition among the professionals. Besides personal acknowledgements the following norms need to be integrated to reach the value of recognition:

- Comparisons over time
- External and internal comparisons
- Integration of knowledge sharing and visualization of shared responsibility
- Understandable acknowledgement of efforts

Part conclusion

The mediation analysis offers insights into how the dashboard impacts the healthcare professionals' values, highlighting new engagements with the dashboard, leading to new interpretations and prioritizing of values. While the Green IS has the potential to positively influence adoption and promote sustainability, the analysis also identifies value tensions that could lead to a reluctance in adopting the dashboard. Specifically, it may affect the primary patient care by imposing new environmental responsibilities that challenge their perceptions of safety. To address these issues, the next section reveals a reframing of the value framework alongside new design and implementation features aimed at reconceptualizing the prototype to accommodate the users value experiences.

New value framework

Within the Values-that-Matter (VtM) framework, how can healthcare professionals' value-experiences be integrated into design features that enhance adoption of Green IS and consequently instigate more sustainable practices?

To address the second research question, a new value framework is introduced, incorporating specific design features to address the negative value experiences reported by the healthcare professionals, while also incorporating the positive aspects. The analysis of the dashboards impacts on the initial value framework, as shown in Table 3.2, reveals new interpretations and shifts in value prioritization and emphasis. Based on this, I argue that, for the dashboard to be effectively adopted and utilized, the following values and encompassing norms are essential in its design and implementation: Emancipation, Autonomy, Comparability, and Competencies. By leveraging the core values embedded in this framework, the framework provides a structured approach to ensuring that Green IS initiatives align with the values of healthcare professionals. Additionally, Van de Poel's concept of *specification* supports translating these values and norms to design features (Van de Poel, 2013). While the new value framework outlines the design concept for the dashboard, the discussion will further elaborate on the value conflicts and potential solutions.

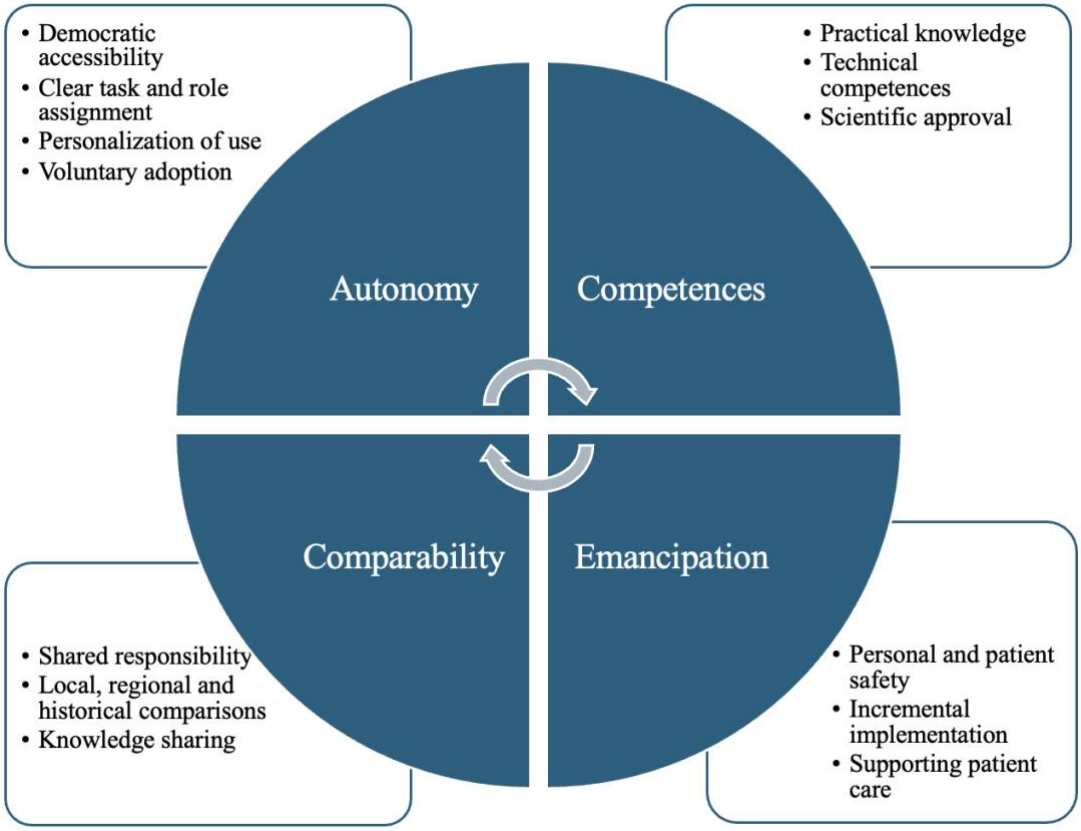

Figure 14 New value framework with encompassing norms

Comparability

Empirical data from the healthcare professionals revealed that comparability features are crucial for engagement and motivation with the dashboard, especially given its voluntary nature. The professionals indicated that understanding their efforts in context of others not only enhances their motivation, but also validates their contributions.

To address these norms, the dashboard should integrate the following comparative features:

- Comparison over time: Visualize the impact of the initiatives over time to track progress and improvements, and to see the effect on their completed actions.
- Internal competitions: Provide comparisons with other hospital units to provide internal context, supporting friendly competition, valued highly by the professionals.
- Local benchmark comparisons: Develop local milestones and goals in the dashboard to demonstrate the progress, enhancing the shared responsibility.

- External comparisons: Integrate benchmarks against other hospitals to foster a sense of community by showing how each hospitals efforts contribute to regional goals.
- CO2 comparisons: To make CO2 emissions more relatable, alternative comparisons such as comparing emissions to the number of trees or household electricity usage could be provided, giving healthcare professionals a clearer and more tangible understanding.
- Knowledge sharing: A resource heavy feature could be the integration of a knowledge sharing module or a communication channel, sharing tips, and tricks. A link could be provided to an external webpage.

Incorporating these comparative features not only helps healthcare professionals see their impact more clearly but also enhances the sense of shared responsibility and motivation by adding local competition. To avoid demotivation from uneven comparisons, ensure that the hospital units used for benchmarking are similar in function and product use. The comparative measures could be integrated into slide 1 on the dashboard, which encompasses the development in price and CO2.

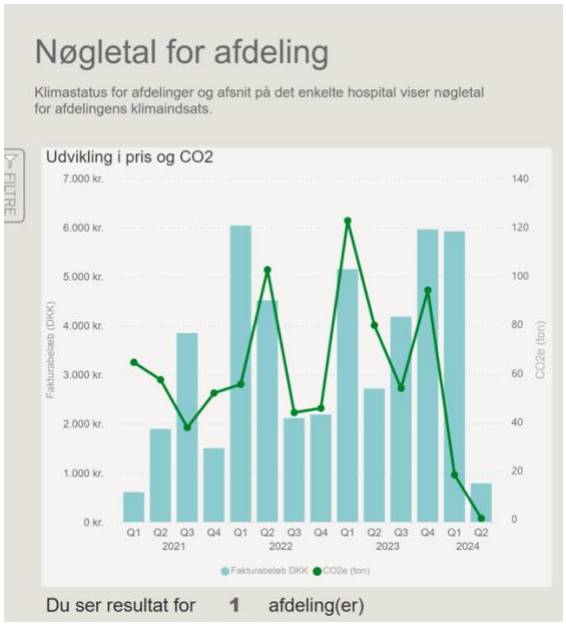

Figure 15 Slide 1 in the dashboard encompassing the development over time in price and CO2.

Emancipation

From the empirical data, it became evident that the healthcare professionals prioritize time for patient care and personal and patient safety, underscoring the importance of emancipation in the dashboard's design. Emancipation involves empowering users by removing perceived constraints, in this case,

ensuring that patient and professional safety are central to the design. To effectively address these needs, the following recommendations should be integrated:

To address the norm of ensuring patient and personal safety:

- Visualize safety approvals: Clearly display the hygiene unit's safety approval for the initiatives within the dashboard using logos, illustrations, or figures. Include a link to detailed documentation to ensure transparency and reassure users.

To manage the potential increase in workload and environmental responsibilities:

- Offer voluntary adoption: Position the dashboard as a voluntary tool while clearly communicating its benefits to encourage use without adding uncalled pressure.
- Education in safety measures: Implement local workshops, staff education, and onboarding procedures to discuss the benefits of reducing or removing unnecessary PPE for both safety and sustainability.

To address the perceived threat to patient care:

- Highlight the positive contributions of the initiatives in the dashboard: Visualize the positive aspects surrounding operational quality, air pollution, plastic waste, labour rights and population health in the dashboard, using a logo/visualization (see page 89).

To align the dashboard design with healthcare professionals value sets:

- Visualize the healthcare connection: Integrate a tool in the dashboard that shows population health improvements caused by the reduction in CO2, highlighting the impact of sustainability efforts on public health. Furthermore, integrate this link in the introductory text.
- Facilitate acknowledgment: Integrate pop-up messages or automated emails within the dashboard to acknowledge and celebrate when the professionals achieve goals or milestones. This recognition should go beyond numbers and graphs, as these formats don't fully capture the value of their efforts.
- Emphasize empowerment aspects: Demonstrate how the data from the dashboard can be used as a tool to engage the management and facilitate local changes. This could be emphasized during its implementation.

- Innovation integration: Integrate a function which welcomes new innovative initiatives from the professionals aimed at mitigating carbon emission, thereby supporting self-actualization and institutional acknowledgement.

By integrating these aspects into the dashboard, healthcare professionals can see how their contributions to sustainability are not only environmentally beneficial but also resonate with their core values of patient care, operationally enhancing their practices while supporting population health.

Autonomy

When healthcare professionals lack autonomy and the ability to affect change, it can lead to feelings of frustration and disengagement. Not being able to influence decisions or seeing the direct impact of their actions can further diminish their motivation and commitment to sustainability and the use of the dashboard. As not to feel discouraged by the new responsibilities of the dashboard, implicitly affecting their safety perceptions, the autonomy of voluntary adoption accommodates the users' individual needs.

To address this, the design should emphasize the importance of autonomy by:

- Providing democratic access to the dashboard: Granting the healthcare professionals, especially the nurses, direct access to the dashboard, empowers them to actively participate in decision-making processes. Furthermore, it enables innovative contribution power and a sense of ownership.

Ambiguity surrounding the use of the dashboard, as highlighted in the empirical data, can further restrict autonomy by creating uncertainty about roles and responsibilities. To address this issue and enhance user autonomy, I recommend:

- Developing a detailed handbook: Create a comprehensive manual/guide that clearly outlines how both nurses and unit managers should use the dashboard. This manual should detail specific tasks and responsibilities, thereby reducing confusion regarding task assignment. By

clarifying roles and expectations, the manual will help users feel more confident in utilizing the dashboard effectively and taking full advantage of its features.

Facilitating autonomy also requires institutional support, as reflected already in the first value framework. By integrating the contributions or efforts of the "green team" within the dashboard, coupled with the task assignments, the design reinforces shared responsibility and institutional approval, norms, deeply valued by the professionals. I recommend including this in the introduction page of the dashboard, so the users are immediately aware of these efforts. This will also provide clearer guidance on how to use the dashboard effectively.

To further support autonomy, I recommend providing the ability to personalize the dashboard by:

- Choosing how data is represented (e.g. CO2 emissions, waste per kg, financial costs): This feature allows users to tailor the graphs to their preferences and needs, making them feel more in control and more engaged.
- Including personalized to-do lists: Highlighting the next steps or milestones, ensures that the professionals have the freedom to make decisions, but also having support and guidance towards the overall goals. A feature that is technically resource intensive.

Competencies

To facilitate a meaningful usage and adoption of the dashboard, it's essential to focus on empowering the healthcare professionals by improving their competencies, as reflected in the data. This involves addressing mistrust of safety procedures, providing clear guidance towards its use, and ensuring a manageable learning process. Here's how this can be achieved:

Evidence-based justification:

- Visualize scientific evidence: Clearly present scientific evidence-based safety justifications for the dashboard's initiatives. This will help build trust and provide the professionals with the necessary information to confidently adopt and advocate for safety changes.
- Practical product information: Develop a knowledge guide about the products in the dashboard, enhancing their skills and ability to make informed decisions and future changes.

These elements should not be included in the dashboard, but communicated externally, as to be as comprehensible as possible.

Step-by-step technological guidance:

- Develop a usage manual: Create a detailed step-by-step guide for navigating the FLIS program and dashboard, along with its features. This should include a walkthrough for first-time users, ticking off key tasks to help them become familiar with the system. This feature is different from the guide recommended earlier, since this focuses on getting to know the dashboard itself, whereas the handbook is oriented to responsibilities and tasks.

Design process recommendations

Drawing on empirical data and field experiences, several conflicts have emerged concerning the implementation and design of the dashboard. Observations in the field, alongside the norms highlighted in the initial value framework, reveal significant implementation difficulties, such as lack of access and communication challenges. While the design of the dashboard is crucial due to its mediating effects, effective implementation is equally vital for ensuring meaningful adoption. To address these issues and strengthen the adoption process, the following recommendations focus on key implementation features:

Identify target users	To accommodate the target group confusion, start by determining which actors (e.g., nurses, unit managers) will use the technology and how, grasping a thorough understand of their specific needs and contexts. Detailing how the dashboard could fit into existing tasks.
Contextual analysis	Addressing a methodological limitation of the thesis, a proper analysis of the users' contexts is crucial to tailor design features to their daily practices and workflows.
Iterative testing	Implement future iterative testing and involve more stakeholders throughout the design process. Gather feedback, make necessary adjustments, and refine the design based on real-world use and experiences.
Users as co-designers	Grasping the perspectives of the users while making decisions, mitigating the designer and expert bias. Involve the healthcare professionals as

	decision makers in the design process instead of a mere tokenistic involvement.
Meaningful communication	To address the lack of awareness of the dashboard and to prevent potential misuse, a comprehensive and streamlined communication initiative should be implemented, using local dissemination.
Eco-Feedback on info-screens	For those healthcare professionals who do not have the interest or time to use the dashboard, a visualization of the most important graphs could be visualized at local info screens, providing them with live- eco-feedback of their behaviour
Incremental implementation	Implement the dashboard incrementally to avoid overwhelming users. Introduce features gradually and focus on one task at a time. This approach helps users adjust without feeling overloaded and makes the transition smoother.

Graphical user-interface features

Empirical data, particularly from the probe exercises, highlighted several clear GUI design recommendations to enhance the comprehensibility of the dashboard.

Use percentages instead of abstract numbers	Replace abstract numbers with percentages to make data more relatable and easier to understand. This helps users grasp the significance of the information quickly.
Apply analytical colour coding	Integrate colour coding to differentiate data types and highlight key information (see an example in figure 15).
Avoid information overload	Minimize clustering and overload of information on each slide. Present data in a clear, organized manner to prevent users from feeling overwhelmed.
Add subtitles	Incorporate descriptive subtitles in the dashboard to clarify what each section illustrates. This helps users navigate the dashboard more effectively and understand the context of the data.

Include a tip box function	Implement a tip box that appears when users hover over certain elements. Provide brief explanations or instructions on how to use each section or feature, enhancing usability and guidance.

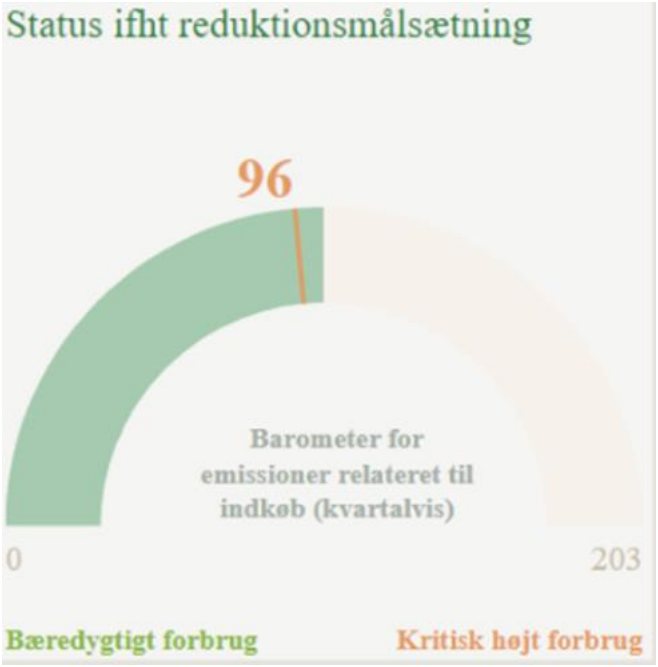

Figure 15 Example of color analysis according to reduction goals

The new value framework aims to refine the sustainability dashboard by aligning its design and implementation with healthcare professionals' core values of: Emancipation, Autonomy, Comparability, and Competencies, along with their underlined norms. The framework offers a structured approach to ensure that the dashboard meets the professionals' needs and values, supporting its meaningful adoption. However, as the analysis also indicates, certain value conflicts stand in the way for a meaningful adoption. The discussion therefore intends to delve into these tensions, looking for new perspectives and understandings that could promote its adoption.

Analytical reflections

Methodological and theoretical

Since the dashboard wasn't employed in the healthcare professionals day-to-day, but only presented during prototype sessions, I needed a method that would allow me to grasp a more concrete perception of the dashboard in daily practices, without it being implemented. The probe exercise allowed me to formulate scenarios and task assignments gaining insights towards how it could affect their practices and perceptions.

The use of Kudina & Verbeeks mediation theory (2019) furthermore provided the analysis with theoretical competencies to investigate how Green IS mediates new perceptions and practices, enabling post phenomenological insights of value experiences.

Developers' and users

During the prototype tests I observed a noticeable divide between the developers from the capital region and the users. While the function of the prototype test was to grasp the users' perspectives and understandings, it quickly became heavily focused on the technical functionalities, prone to using a tech-oriented buzzwords, far from the nurse's vocabulary. One of the nurses from the prototype test stated, "maybe this is a word which is very normal for you, but I have no idea what benchmark means" (Nurse: Pers.comm, May, 2024). The developer's approach was oftentimes more deductive than inductive, seeking simple yes or no answers about whether integrated features functioned as intended. This narrow focus on technological performance, however, did not foster an environment for more open-ended feedback or deeper exploration of user experiences. In contrast, users were primarily concerned with how well the technology aligned with their needs and how their perspectives were integrated into the design. The data and technology-oriented instrumentalist approach from the developers clearly outlined the divergence in value frameworks between those two groups, underlining the necessity for involving the users in the design phase.

This misalignment highlights the crucial need for a mediator like myself. Techno-anthropologist aim to bridge the gap between developers and users, ensuring that technological

solutions not only function effectively but also fit users' real-world contexts. The predominant focus on technical functionality often results in technological instrumentalism, where the technology is assessed mainly on efficiency rather than its broader impact on users. My role is essential in countering this limitation, advocating for a more comprehensive approach that integrates users' qualitative feedback into not only the design of the dashboard but also the implementation process.

Chapter 7

Discussion

This section addresses the key value conflicts identified in the analysis, with a focus on the tensions between safety, responsibility, and the dashboard's core value of sustainability. Building on the main research question, the aim of this discussion is to explore how value conflicts might impact the adoption of Green IS and to introduce new perspectives that instead could foster a meaningful adoption.

First, the discussion will outline the value conflicts using Friedman's concept of *value tension* (2021), demonstrating that while sustainability is a central value of the dashboard, it should not overshadow other essential values. Instead, the thesis will seek solutions that integrate and uphold the values held by healthcare professionals, drawing on literature and empirical data from the fieldwork. The insights will not encompass new design features but will act as an extension and validation to the design features outlined in the new value framework (see 70).

The discussion will then apply the Triple Bottom Line (TBL) framework to evaluate how and if different sustainability pillars are represented in the dashboard's design, with a particular focus on integrating the social sustainability pillar. The section will furthermore incorporate insights from motivation theory to emphasize the importance of aligning the Green IS with values from healthcare professionals.

Finally, the discussion will address the main limitations of the thesis, providing guidance for managing these limitations in a post-implementation study. Directions for future research will also be proposed to ensure that the Green IS evolves ethically and remains responsive to the changing values of healthcare professionals.

Value conflicts and value tensions

Value conflicts occur when two or more values are in opposition, making it challenging to satisfy all simultaneously (Kozlovski, 2022). Traditionally, solutions like *value hierarchies* and *trade-offs*, as introduced by Friedman and Van de Poel (2009 & 2021), have been used to address and solve these conflicts. The methods typically prioritize one value over others, either by ranking values in a hierarchy or making design decisions that favour one value at the expense of others. However, these approaches how often been critiqued, noting the difficulty of comparing or measuring values due to their differing metrics (Kozlovski, 2022). This complexity makes cost-benefit analyses and trade-offs less applicable, particularly in the context of this thesis.

Instead, this thesis adopts the concept of *value tensions* - a more nuanced approach that encourages designers to find solutions that simultaneously accommodate and promote all relevant values. This perspective broadens the range of design possibilities, allowing for a balance rather than a sacrifice of competing values (Friedman et al., 2021).

Practically, this thesis addresses value conflicts through iterative anticipation testing as outlined in the VtM framework (Smits et al., 2019). This involves continuously testing and reconceptualizing the design to solve the value tensions in the concept. As Verbeek suggests, "The testing phase allows for testing value conflicts as an input for conceptualization and helps in understanding how the anticipated values become appreciated subjectively in real life." (Smits et al., 2019). This iterative process helps in balancing different competing values, testing how they can be solved through phases of reconceptualization.

Value conflict: Safety and Sustainability

The Green IS aims to promote environmentally sustainable behaviour among healthcare professionals in the Capital Region. However, embedding sustainability as a core value in the dashboard has introduced significant value conflicts, particularly concerning the healthcare professional's norm of ensuring patient and personal safety (See Figure 10). The dashboards emphasis on reducing the use of safety equipment presents a major challenge, as it raises concerns about whether sustainability might be prioritized over essential safety measures. This perceived misalignment between healthcare objectives and Green IS is captured in one nurses' observation:

> We want to think greener, but first and foremost, we need to ensure our own safety if we are to stay in this profession for many years. It's a balance between prioritizing our safety and adapting new practices (Nurse: Pers.comm, May 2024).

Although the initiatives have been approved by the hygiene unit, moral reflections concerning their own safety were still heavily emphasized. The statement underscores the delicate balance between maintaining high safety standards and embracing green initiatives. To facilitate meaningful adoption, the dashboard must effectively reconcile these competing values.

Broadening the interpretation of safety

For many professionals, safety is typically associated with the use of PPE (Personal Protection Equipment), which protects against bacteria, diseases, and other hygienic risks. However, recent research by Dr. Mahmood Bhutta (Bhutta, 2006; Rizan et al., 2020; Rizan & Bhutta, 2022; Stancliffe & Bhutta, 2008) offers an alternative perspective, challenging the conventional belief that more protective equipment automatically leads to greater safety. Bhutta's studies suggest that overusing PPE can lead to unintended consequences such as cross-contamination, a false sense of security and the overlooking of other mundane hygiene practices (Ibid.). He argues that this overreliance has been heavily influenced by the COVID-19 pandemic and lobbying by single-use equipment manufacturers, leading to a perception of safety that may not be entirely justified. As reflected in the thorough literature review on environmental sustainability in healthcare by Sherman et al. (2020), they argue that the present generation of healthcare professionals have been indoctrinated into an excessive safety and quality paradigm:

> Excessive infection control practices are a major driver of avoidable pollution and wasted resources. Many infection control policies and procedures are empirically implemented without evidence of significant risk reduction, noticeably increasing the uptake of single-use medical devices and supplies in healthcare (Sherman et al., 2020).

While the norm of safety presents a significant challenge to the adoption of Green IS, I argue that these norms and needs can be upheld by adopting a holistic approach to safety practices, rather than focusing solely on the quantity of safety equipment.

Redefining safety measures

Resolving the conflict between safety and sustainability requires a rethinking of how safety is defined and communicated in healthcare. To promote this shift, local workshops, staff education and onboarding procedures should be employed to discuss the positive contributions that reducing or removing unnecessary PPE can bring to both safety and sustainability. These initiatives could help the professionals understand the positive contributions that reducing or removing unnecessary PPE can bring to sustainability, population health and pollution (Sherman et al., 2020)

For instance, the Sustainable Hospitals Conference in Aarhus demonstrated how these new perspectives could be integrated into healthcare practices, receiving positive feedback from the participants. This positive reception indicated a growing openness among professionals to rethink traditional safety measures, particularly when they are provided with clear, evidence-based explanations. However, it is important to recognize that presenting the evidence-based explanations in the dashboard, would counterintuitively reduce its comprehensibility. Further structural recommendations could revolve around the revision of infection control standards that emphasize single-use instruments and a better collaboration between hygiene organizations and healthcare professionals.

For successful change, it's crucial to balance these safety measures with the other values from the new value framework (see page 70). Professionals need competencies to justify and facilitate changes in their practice, while comparing with others who adopt these changes can build confidence and motivation. Autonomy is furthermore key to avoiding resistance, allowing professionals to make informed decisions voluntarily, emphasizing the patient perspective. By integrating these values into the design, the redefinition of safety measures can be mediated to enhance both patient care and workplace safety.

Value conflict: Responsibility and Sustainability

Another significant value conflict highlighted in the analysis concerns the impact of the dashboard on healthcare professionals' practices. The introduction of new sustainability tasks risks advocating that environmental sustainability is more important than patient care responsibilities:

> Don’t get me wrong, many things are important, and the green transition is something that should be prioritized, but hygiene is also a matter of life and death.
> (Unit manager: Pers.comm, April, 2024).

Although healthcare professionals resist having their time diverted from patient care, there’s a concern that over time, integrating sustainability into their moral framework could shift their sense of responsibility, leaving less focus on the patient. This is problematic since the Green IS should support, not undermine, patient care.

Furthermore, excluding nurses from accessing the dashboard places additional practical responsibilities on the unit managers, potentially hindering shared decision-making and collaboration between the two stakeholder groups.

Providing locus of control

As highlighted by Quitmann et al. (2023a) in the literature review, healthcare workers often feel a degree of responsibility for their hospital’s CO2 emissions. However, this sense of responsibility is frequently undermined by their perception of influence over these outcomes. Quitmann applies the concept of *locus of control* to explain this phenomenon, distinguishing between an *internal locus of control*—where individuals believe they can effect change through their actions, and an *external locus of control*, where they feel powerless to make a difference (Quitmann et al., 2023a).

To address this challenge, I argue that providing healthcare professionals with direct access to the dashboard, alongside clear task assignments for adopting sustainable practices, can effectively shift their locus of control from external to internal. This shift is crucial, as it enhances their sense of agency and responsibility towards mitigating climate change.

Observed during my participant observation at the hospitals, this change became evident when professionals were introduced to the dashboard prototype. The presence of the dashboard served as a catalyst for new, innovative approaches and fostered a heightened sense of responsibility. One nurse, for instance, eagerly demonstrated the new initiatives she now could implement within her unit, thanks to the authority of the dashboard (Field notes, Pers.comm, May, 2024). She felt that the dashboard not only provided the support needed to make real changes but also empowered her with a new sense of responsibility, giving her the ability to effect change. By equipping professionals with tools that enhance their internal locus of control, the dashboard does

more than facilitate sustainable actions - it redefines their roles as proactive agents in the fight against climate change, fostering a deeper, more personal commitment to sustainability.

As reflected in the previous value conflict section, it is crucial to balance the responsibility tensions with the other values from the new value framework. By encouraging autonomy of use, the dashboard could prevent the overburdening of any single group, by allowing them to maintain their core responsibility of patient care. Incorporating features that emphasize comparability and knowledge sharing can help mediate that they are not alone in shouldering the new sustainability responsibilities. This shared commitment ensures that the burden of these new responsibilities is distributed, making it easier to balance sustainability goals with the primary focus on patient care. Design features could revolve around integrating a shared task list, communication channels and comprehensive manuals for the stakeholder groups.

In this section of the discussion, I have aimed to address the value tensions identified in the analysis by incorporating relevant literature, empirical data, and concepts such as value tension and locus of control (Friedman et al., 2021; Quitmann et al., 2023a). The section demonstrates how new perspectives can broaden the interpretation of the Green IS, aligning its design with norms and values from the new value framework. While these insights offer anticipatory solutions to the value tensions, their effectiveness can only be determined through practical application, testing the approaches in real-world settings.

Green IS and the Triple Bottom Line Framework

To ensure the dashboard's long-term sustainable integration and development, the discussion incorporates the TBL framework, evaluating the dashboard from a holistic sustainability perspective. By examining how the three pillars - economic, social, and environmental - are represented in its current design, the discussion will explore opportunities for integrating new perspectives that could enhance its long-term integration (Alhaddi, 2015).

The economic line addresses how organizational practices contribute to growth and long-term viability, creating value for future generations. The social line emphasizes fair practices for employees and the community, supporting long-term success through positive societal impact. The environmental line focuses on responsible practices that conserve resources and reduce ecological impact, ensuring planetary sustainability (Ibid.).

Environmental

The dashboard promotes more responsible and sustainable practices by focusing on reducing CO2 and waste emissions, primarily through the elimination or reduction of carbon-intensive products or practices. By utilizing Life Cycle Assessments (LCAs) to analyse the environmental impact of these products, the dashboard provides a strong foundation for minimizing the healthcare sector's environmental footprint. These efforts are visualized in the primary bars and graphs in the dashboard.

Economic

The dashboard promotes the substitution of single-use products with recyclable and reusable alternatives, thereby integrating favourable circular economy principles. By reducing consumption and minimizing equipment needs, the initiatives prove proves circular solutions more than linear, while adding economic value to support the Green IS. However, the current challenge lies in the transition, as the upfront costs of multiple-use products are higher. Professor Mahmood Bhutta highlights the existing financial structures, which favour the linear economy, and lobbying efforts as significant barriers to this shift (Rizan & Bhutta, 2022).

Already integrated into the dashboard's design, monetary measurements of the initiatives illustrate how switching to economically sustainable products can reduce the units' costs. As one unit manager noted, the financial gains can improve patient care by freeing up resources to hire additional staff. This financial perspective underscores the broader benefits of sustainable practices, linking economic savings directly to enhanced care quality and staffing improvements.

Social

John Elkington, the father of the TBL framework, referred to the social line as conducting fair business practices to the labour, human capital and to the community, providing value to society and giving back to the community (Alhaddi, 2015). At first glance, the sustainability dashboard might seem to only encapsulate one line of the TBL framework i.e. the environmental, reducing the healthcare sectors overall carbon footprint. However, through fieldwork and literature analysis, new positive impacts were discovered.

Environmental care is healthcare

As articulated by the WHO, healthcare and climate change are inextricably linked. The changes entailing carbon emission has been named the number one public health issue of the 21st century,

resulting in a rising number of cardiac disorders, respiratory diseases, infectious diseases, and cancer (Sherman et al., 2020). The public health outcomes, stemming from the healthcare sectors carbon emissions, reflects a paradox, given the many healthcare service needs, it fosters. As observed during my fieldwork, this connection is very difficult to comprehend when you are working in a high paced care unit.

To effectively communicate the health benefits associated with reducing CO2 emissions, the dashboard could incorporate features that both calculate and visualize these benefits, even though the calculations might be difficult to generate. Ideally, a tool could be integrated that demonstrates the health improvements per kilogram of CO2 reduced, using interactive graphics to clearly illustrate the impact of sustainability efforts on public health.

Additionally, the introductory text within the dashboard should address this vital link between environmental actions and health outcomes, emphasizing how the healthcare sector can reduce its own environmental impact while enhancing human health outcomes (Jørgensen, 2023). This contextual information could help users understand how their efforts in reducing CO2 emissions contribute to better population health, reinforcing the connection between environmental practices and patient care. Integrating this link between climate care and healthcare, could further motivate the professionals to adopt the dashboard and implement sustainable initiatives.

Environmental care as labour care

Insights from Mahmood Bhutta demonstrates how environmental care, such as replacing single-use plastics with sustainable, reusable products, can also improve labour rights globally. The $300 billion industry often relies on free market economics, leading to widespread outsourcing of products, resulting in issues of modern slavery, as seen in Malaysia - a major provider of NHS plastic gloves (Bhutta, 2006).

To address these concerns, structural solutions to secure the supply chain could include incorporating labour rights requirements into procurement tenders. Additionally, by promoting locally produced products (Ibid.).

Integrating these insights into the dashboard or initiatives could further motivate professionals to adopt more sustainable practices. By highlighting the ethical implications of single-use equipment and illustrating the positive impact of switching to reusable alternatives, the dashboard can hopefully encourage users to reconsider their choices of PPE. While labour rights are a critical

concern, the goal is not to induce guilt among professionals but to encourage reflection on their product choices.

Environmental care and operational quality

The transition to sustainable products has shown a significant positive impact on both patient and staff experiences, primarily due to the superior quality of these products compared to traditional plastic alternatives. This was a key theme at the Sustainable Hospitals Conference in Aarhus, where healthcare professionals highlighted how sustainable products not only enhanced their own work experience but also improved patient satisfaction, ultimately leading to better quality of care.

However, to fully integrate these products, certain precautions must be observed, including strict adherence to safety regulations and necessary infrastructural adjustments to support the use of reusable products. I propose integrating a visualization on the dashboards front page that highlights all the positive elements of its initiatives. The visualization could look like this:

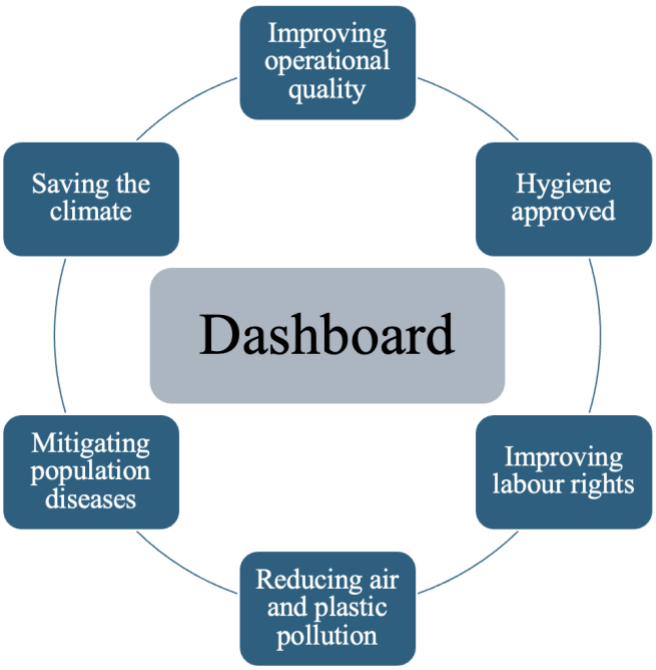

Figure 16 Draft of contribution visualization in the dashboard

While the section emphasizes the importance of social sustainability in fostering a meaningful adoption of Green IS, achieving this integration will require iterative processes and proactive adjustments to ensure that the values are embedded and aligned with evolving needs.

Motivation and a meaningful adoption of the Green IS

In discussing the meaningful adoption of Green IS, it's essential to understand the role of healthcare values. Deci and Ryan's Self-Determination Theory (1991) offers a valuable perspective that aligns with the new value framework developed in this thesis. The theory asserts that motivation is significantly enhanced when three fundamental psychological needs, autonomy, competencies, and relatedness are fulfilled. Since three of the four values in the new framework correspond to these needs, it further reinforces how the framework can effectively foster motivation for engaging with the dashboard (Deci et al., 1991)

Additionally, Andersen and Pedersen, two Danish researchers, emphasize that if new technologies or practices do not align with healthcare professionals' norms and values, their adoption may be hindered. They identify three types of motivation: Introjected, identified & internalized motivation (Andersen & Pedersen, 2011), arguing that a system that doesn't align with their values may result in introjected motivation, where the use is superficial. Yet, demonstrating how the Green IS aligns with their needs and values fosters more motivation to adopt the system.

Part conclusion

As the discussion reflects, integrating Green IS into healthcare presents both opportunities and challenges. On one hand, it can enhance the environmental and social impact by promoting responsible sustainable practices. On the other, it can negatively impact their perception and practices. Many technological solutions are developed without considering the user's needs, often resulting in systems that lack practical relevance or usability. In contrast, this thesis has strived to design a technology that wouldn't be deemed successful only after being implemented, but instead during its design phases, anticipating its impact through iterative design phases.

Due to the increasing prominence of technology in our society and the influence of technological determinism, there is a growing need to integrate human values across various sectors beyond just healthcare. Expanding the body of knowledge within this area therefore provides valuable insights that hopefully can be applied to other fields.

The discussion reflects how the value conflicts could be elucidated by incorporating and extending insights from the literature along with empirical observations (Quitmann et al., 2023a; Stancliffe & Bhutta, 2008).

The TBL framework enabled new perspectives towards its long-term implementation, while further substantiating the importance of social sustainable elements in the dashboard.

Motivation theory verified the reasoning behind integrating contextual values of the healthcare professionals in the dashboard alongside autonomy, competences and comparability (Alhaddi, 2015; Andersen & Pedersen, 2011; Deci et al., 1991).

Strengths, limitations and future research

While the study provides valuable insights into the adoption of Green IS from the healthcare professionals', it also contains certain limitations.

Lack of focus on external constraints

While the adoption of Green IS focuses on aligning with end-users' needs and values, it is crucial to acknowledge the challenges of external constraints, such as economic, organizational, technological, and regulatory factors in translating values into design features (Sayyadi Tooranloo & Rahimi Ashjerdi, 2018).

Many design features in the new value framework extend beyond simple GUI recommendations, requiring additional resources like the development of manuals and training guides. These resources are essential but introduce economic and technical challenges. As observed during the Sustainable Hospitals Conference in Aarhus, the clinicians reflect how financial barriers stand in the way for transitioning to multiple-use products. Furthermore, many hospitals do not have the infrastructure for the desired changes. Moreover, regulatory aspects such as GDPR or Power BI's limited capacity for advanced customization might restrict the integration of features supporting autonomy.

VtM and a lack of resources

The Values-that-Matter (VtM) framework offers a robust foundation for adapting to various stakeholders and their evolving values. However, the framework also requires significant resources for activities such as data collection, analysis, conceptualization, testing, and iterative refinement. For hospital units with limited resources, traditional methods like participant observation, workshops, or interviews may not be feasible. As a resource-efficient alternative, these units could employ probes, as I have done in the thesis. Future research could evolve around developing resource-suitable methods for employing the VtM framework.

Post-evaluation study and future research

While the thesis provides a solid foundation for reconceptualizing the dashboard prior to its implementation, future iterations will be necessary. As reflected in the literature, societal values are dynamic and can evolve, either through the emergence of new values, different prioritization or conceptualization after interacting with technology (van de Poel & Kudina, 2022). As the VtM framework emphasizes iterative cycles of analysis and synthesis, I argue that a post-evaluation iteration should be conducted, to assess the alignment of healthcare values in the Green IS (Smits et al., 2019).

Reframing the value framework with newly identified values from the anticipation phase (see page 70) provides a basis for assessing the Green IS when it has been implemented in their daily practices (van de Poel & Kudina, 2022). This assessment should focus on determining whether the design features align with the norms and values established in the framework. Facilitating a post-evaluation study furthermore enables clearer insights into the practice related challenge of the dashboard.

Contributions

This study makes several significant contributions across practical, methodological, and theoretical dimensions, addressing key knowledge gaps while advancing existing body of knowledge. It builds on knowledge concerning environmental sustainability and technology adoption in healthcare. By examining the design and implementation of Green IS, the thesis has not only incorporated and extended the body of knowledge within these areas but also laid the foundation for future research and development of Green IS in the healthcare sector.

Practical contributions

By leveraging the VtM framework and Van de Poel's expertise within translating values, the study provides practical design contributions into how technology can be designed to align with the values and needs of healthcare professionals. It furthermore advances the knowledge within sustainability adoption in healthcare, illuminating practical challenges and solutions, that could be employed beyond the healthcare sector.

The value framework developed in this study can act as a point of departure for other healthcare technology designs, as well as an assessment device, used deductively to see if the design requirements reflect the values of its users. Values are context dependent, but the approach can be adopted. Additionally, the study addresses the knowledge gap concerning how technology can be

used to foster more sustainable practices, demonstrating how the dashboard can help redefine its users as sustainable actors if the socio-cultural barriers are accommodated.

Methodological contributions

The study demonstrates how techno-anthropological qualitative methods can be used to incorporate value-based user feedback into technology design. By employing the framework of VtM it furthermore provides limitations and future suggestions to its methodological toolbox.

Theoretical Contributions

Theoretically, this study extends the new Values-that-Matter (VtM) framework by applying it to the design of Green IS in healthcare, enriching our understanding of how values can be translated to design features. Aligning technologies with human values is an area of increasing importance, not only in healthcare but also in all other areas of technology development, underlining the importance of the thesis contributions. The thesis furthermore demonstrates how bridging theoretical concepts and frameworks with empirical data, can result in meaningful practical applications.

AALBORG UNIVERSITY
COPENHAGEN

Chapter 8

Conclusion

This thesis aids the capital region of Denmark in the design and implementation of a sustainability dashboard promoting sustainable practices within the healthcare sector. To meet the objectives of the thesis, concrete technological design features were developed based on healthcare professionals' interactions with the dashboard prototype. Additionally, a new value framework was created to align the dashboard design with the needs, norms, and values of the healthcare professionals.

Which values and norms do health care professionals consider important in their daily work, and how are these impacted by the introduction of Green IS?

To answer the first research question, the study developed a framework entailing values of importance for the healthcare professionals (patient care, informed competencies, recognition, inclusion, institutional support, (See Table 3.1). Leading to the development of the dashboard prototype, the study then analysed the prototypes impact on the value framework, investigating the mediations it entailed. New interpretations and prioritizations of values and norms were examined, encompassing both positive and negative experiences (See Table 3.2). Demonstrating how the dashboard can

mediate a more personal commitment to sustainability, it also presents value conflicts, such as the threat to personal and professional safety, additional moral responsibilities, and the exclusion of nurse's access to the dashboard. To answer how these conflicts could be anticipated and integrated as design and implementation features, a new value framework with emphasized norms from the health care professionals was developed.

Within the Values-that-Matter (VtM) framework, how can healthcare professionals' value-experiences be integrated into design features that enhance adoption of Green IS?

To enhance the adoption of Green IS and foster sustainable practices, the VtM framework was employed, integrating the emphasized values of autonomy, competencies, comparability, and emancipation. Using Van de Poel's translation process, these values were translated into norms and design features.

- Autonomy requires that the dashboard is accessible to all users, particularly nurses, with clearly defined roles and responsibilities, as this is unclear in the prototype. Additionally, personalized design features allow the users to adapt the tool to meet their specific needs and preferences, empowering their ability to affect change, while still maintaining focus on their core tasks through voluntary use.
- Competencies emphasize the integration of practical product knowledge and technical guidance in FLIS, while ensuring scientifically validated safety information, to justify change in use of PPE and other sustainable practices.
- Comparability features are furthermore essential in fostering a sense of shared motivation and commitment among the users, ensuring that the burden of the new responsibilities is distributed.
- Emancipation prioritizes the norms of personal and patient safety, entailing the illustration of hygiene approvals, while advocating for an incremental, voluntary adoption, safeguarding their focus on the patients.

Illuminating the identified value conflicts of safety and responsibility required integrating new perspectives from literature and translating them into design features. For instance, addressing the threat to personal and patient safety requires rethinking how safety measures are defined and communicated, visualizing its broader social sustainable contributions to population health, labour rights and operational experience in the dashboard. Addressing the moral responsibility tension

involves distributing the responsibility by opening access to the nurses as well, while providing voluntary personalized adoption.

Ultimately, integrating these values into the dashboard encourages the adoption of sustainable practices, showing how they can go hand-in-hand with high-quality patient care and safety, aligning environmental goals and healthcare objectives.

Implications and future directions

The findings also indicate that while the VtM framework effectively aligns Green IS with healthcare values, the study's small sample size and single-stakeholder focus limit its generalizability. Additionally, the resource-intensive nature of the framework suggests future needs for methods better suited to resource-constrained environments. Further iterations are also needed to effectively accommodate the changing values over time, testing and accommodating potential value conflicts.

The new value framework (see page 70-71) can be adopted and iterated to guide future Green IS projects in the healthcare sector, serving as a foundation for future research. The study also displays the critical need for techno-anthropological intermediaries in the healthcare sector, translating user needs into design solutions, cementing the study's societal relevance.

Concluding, this thesis highlights the importance of aligning technology with healthcare professionals' values in the design and implementation process, enhancing the possibility of a meaningful adoption.

References

Alhaddi, H. (2015). Triple Bottom Line and Sustainability: A Literature Review. Business and Management Studies, 1(2). https://doi.org/10.11114/bms.v1i2.752

Anåker, A., Nilsson, M., Holmner, Å., & Elf, M. (2015). Nurses' perceptions of climate and environmental issues: A qualitative study. Journal of Advanced Nursing, 71(8). https://doi.org/10.1111/jan.12655

Andersen, L. B., & Pedersen, L. H. (2011). Motivation i den offentlige sektor. In Organisering af den offentlige sektor, Grundbog i offentlig forvaltning.

Antoinette Marie van de Vijver Jørgensen. (2023). Sustainability in Danish Healthcare. Denmark Informs - Inspires - Invites.

Ashcroft, R. E., Dawson, A., Draper, H., & McMillan, J. R. (2007). Principles of Health Care Ethics: Second Edition. In Principles of Health Care Ethics: Second Edition. https://doi.org/10.1002/9780470510544

Bhutta, M. F. (2006). Fair trade for surgical instruments. In British Medical Journal (Vol. 333, Issue 7562). https://doi.org/10.1136/bmj.38901.619074.55

Børsen, T. (2020). Bridging critical constructivism and postphenomenology at Techno-anthropology. Techne: Research in Philosophy and Technology, 24(1–2). https://doi.org/10.5840/techne2020320122

Brinkmann, S. (2014). Doing Without Data. Qualitative Inquiry, 20(6). https://doi.org/10.1177/1077800414530254

Casado-Mansilla, D., Irizar-Arrieta, A., Solabarrieta-Roman, M., Manterola-Lasa, A., Kamara-Esteban, O., Tsolakis, A. C., Krinidis, S., Tzovaras, D., Borges, C. E., & Lopez-De-Ipina, D. (2020). Lasting and Spillover Effects of Ambient Eco-Feedback in the Office-based Workplace. 2020 5th International Conference on Smart and Sustainable Technologies, SpliTech 2020. https://doi.org/10.23919/SpliTech49282.2020.9243717

Chalal, M. L., Medjdoub, B., Bezai, N., Bull, R., & Zune, M. (2022). Visualisation in energy eco-feedback systems: A systematic review of good practice. In Renewable and Sustainable Energy Reviews (Vol. 162). https://doi.org/10.1016/j.rser.2022.112447

Christensen, M. (2024). Teknologien ændrer og udfordrer faglige opgaver, roller og ansvar. Det skal vi forholde os til. Sundhedsmonitor.

Davis, J., & Nathan, L. P. (2015). Value sensitive design: Applications, adaptations, and critiques. In Handbook of Ethics, Values, and Technological Design: Sources, Theory, Values and Application Domains. https://doi.org/10.1007/978-94-007-6970-0_3

de Camargo Fiorini, P., & Jabbour, C. J. C. (2017). Information systems and sustainable supply chain management towards a more sustainable society: Where we are and where we are going. In International Journal of Information Management (Vol. 37, Issue 4). https://doi.org/10.1016/j.ijinfomgt.2016.12.004

Deci, E., Vallerand, R., Pelletier, L., & Ryan, R. (1991). Motivation and Education: The Self-Determination Perspective. Educational Psychologist, 26(3). https://doi.org/10.1207/s15326985ep2603&4_6

Ellis, C., & Adams, T. E. (2014). The Purposes, Practices, and Principles of Autoethnographic Research. In The Oxford Handbook of Qualitative Research. https://doi.org/10.1093/oxfordhb/9780199811755.013.004

Flyvbjerg, B. (2006). Five Misunderstandings About Case-Study Research. Qualitative Inquiry. Qualitative Inquiry, 12(2).

Friedman, B., Harbers, M., Hendry, D. G., van den Hoven, J., Jonker, C., & Logler, N. (2021). Eight grand challenges for value sensitive design from the 2016 Lorentz workshop. Ethics and Information Technology, 23(1). https://doi.org/10.1007/s10676-021-09586-y

Friedman, B., Kahn, P. H., & Borning, A. (2009). Value Sensitive Design and Information Systems. In The Handbook of Information and Computer Ethics. https://doi.org/10.1002/9780470281819.ch4

Ghazisaeidi, M., Safdari, R., Torabi, M., Mirzaee, M., Farzi, J., & Goodini, A. (2015). Development of performance dashboards in healthcare sector: Key practical issues. Acta Informatica Medica, 23(5). https://doi.org/10.5455/aim.2015.23.317-321

Hedman, J., & Henningsson, S. (2016). Developing ecological sustainability: A green IS response model. Information Systems Journal, 26(3). https://doi.org/10.1111/isj.12095

Hensher, M., & McGain, F. (2020). Health care sustainability metrics: Building a safer, low-carbon health system. Health Affairs, 39(12). https://doi.org/10.1377/hlthaff.2020.01103

Hillebrand, K., & Johannsen, F. (2021). KlimaKarl – A Chatbot to Promote Employees' Climate-Friendly Behavior in an Office Setting. Lecture Notes in Computer Science (Including Subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics), 12807 LNCS. https://doi.org/10.1007/978-3-030-82405-1_1

Holden, R. J., & Karsh, B. T. (2010). The Technology Acceptance Model: Its past and its future in health care. In Journal of Biomedical Informatics (Vol. 43, Issue 1). https://doi.org/10.1016/j.jbi.2009.07.002

Hovedstaden, R. (n.d.). Region Hovedstadens handlingsplan for FN's verdens mål.

Ihde, D. (2008). The designer fallacy and technological imagination. In Philosophy and Design: From Engineering to Architecture. https://doi.org/10.1007/978-1-4020-6591-0_4

Jaspers, M. W. M., Steen, T., Bos, C. Van Den, & Geenen, M. (2004). The think aloud method: A guide to user interface design. International Journal of Medical Informatics, 73(11–12). https://doi.org/10.1016/j.ijmedinf.2004.08.003

Kalogirou, M. R., Dahlke, S., Davidson, S., & Yamamoto, S. (2021). How the hospital context influences nurses' environmentally responsible practice: A focused ethnography. Journal of Advanced Nursing, 77(9). https://doi.org/10.1111/jan.14936

Kiran, A. H., Oudshoorn, N., & Verbeek, P. P. (2015). Beyond checklists: toward an ethical-constructive technology assessment. Journal of Responsible Innovation, 2(1). https://doi.org/10.1080/23299460.2014.992769

Kirchner-Krath, J., Morschheuser, B., Sicevic, N., Xi, N., von Korflesch, H. F. O., & Hamari, J. (2024). Challenges in the adoption of sustainability information systems: A study on green IS in organizations. International Journal of Information Management. https://doi.org/10.1016/j.ijinfomgt.2024.102754

Kitchin, R., Lauriault, T. P., & McArdle, G. (2015). Knowing and governing cities through urban indicators, city benchmarking and real-time dashboards. Regional Studies, Regional Science, 2(1). https://doi.org/10.1080/21681376.2014.983149

Knott, E., Rao, A. H., Summers, K., & Teeger, C. (2022). Interviews in the social sciences. Nature Reviews Methods Primers, 2(1). https://doi.org/10.1038/s43586-022-00150-6

Kozlovski, A. (2022). Parity and the Resolution of Value Conflicts in Design. Science and Engineering Ethics, 28(2). https://doi.org/10.1007/s11948-022-00375-4

Kudina, O., & Verbeek, P. P. (2019). Ethics from Within: Google Glass, the Collingridge Dilemma, and the Mediated Value of Privacy. Science Technology and Human Values, 44(2). https://doi.org/10.1177/0162243918793711

Kvale, S. (2011). Epistemological Issues of Interviewing. In Doing Interviews. https://doi.org/10.4135/9781849208963.n2

Martin, D., Spink, M. J., & Pereira, P. P. G. (2018). Multiple bodies, political ontologies and the logic of care: An interview with Annemarie Mol. In Interface: Communication, Health, Education (Vol. 22, Issue 64). https://doi.org/10.1590/1807-57622017.0171

Mattelmäki, T. (2005). Applying probes – from inspirational notes to collaborative insights. CoDesign, 1(2). https://doi.org/10.1080/15719880500135821

Moyo, M., Goodyear-Smith, F. A., Weller, J., Robb, G., & Shulruf, B. (2016). Healthcare practitioners' personal and professional values. Advances in Health Sciences Education, 21(2). https://doi.org/10.1007/s10459-015-9626-9

Neyland, D. (2008). Observing and Participating. Organizational Ethnography.

Nielsen, M., & Rapport, N. (2017). On the genealogy of writing anthropology. In The Composition of Anthropology: How Anthropological Texts Are Written. https://doi.org/10.4324/9781315460253

Osinkolu, I., & Pegna, V. (2023). The three Fs of sustainability in surgery: the facts, what is currently feasible and the future. The Bulletin of the Royal College of Surgeons of England, 105(S1). https://doi.org/10.1308/rcsbull.tb2023.4

Quitmann, C., Sauerborn, R., Danquah, I., & Herrmann, A. (2023a). “Climate change mitigation is a hot topic, but not when it comes to hospitals”: a qualitative study on hospital stakeholders’ perception and sense of responsibility for greenhouse gas emissions. Journal of Medical Ethics, 49(3). https://doi.org/10.1136/medethics-2021-107971

Quitmann, C., Sauerborn, R., Danquah, I., & Herrmann, A. (2023b). Reducing the carbon footprint of a German university hospital: Perspectives from hospital stakeholders. Journal of Climate Change and Health, 12. https://doi.org/10.1016/j.joclim.2023.100247

Rizan, C., & Bhutta, M. F. (2022). Environmental impact and life cycle financial cost of hybrid (reusable/single-use) instruments versus single-use equivalents in laparoscopic cholecystectomy. Surgical Endoscopy, 36(6). https://doi.org/10.1007/s00464-021-08728-z

Rizan, C., Mortimer, F., Stancliffe, R., & Bhutta, M. F. (2020). Plastics in healthcare: time for a re-evaluation. In Journal of the Royal Society of Medicine (Vol. 113, Issue 2). https://doi.org/10.1177/0141076819890554

Sayyadi Tooranloo, H., & Rahimi Ashjerdi, S. (2018). Analyzing Effective Factors in Green Information Systems (ISs) Adoption in Health Care Centers Using Interpretive Structural Modeling. International Journal of Industrial Engineering & Production Research, 29(3), 321–341. https://doi.org/10.22068/ijiepr.29

Sherman, J. D., Thiel, C., MacNeill, A., Eckelman, M. J., Dubrow, R., Hopf, H., Lagasse, R., Bialowitz, J., Costello, A., Forbes, M., Stancliffe, R., Anastas, P., Anderko, L., Baratz, M., Barna, S., Bhatnagar, U., Burnham, J., Cai, Y., Cassels-Brown, A., … Bilec, M. M. (2020). The Green Print: Advancement of Environmental Sustainability in Healthcare. In Resources, Conservation and Recycling (Vol. 161). https://doi.org/10.1016/j.resconrec.2020.104882

Simon, D. (1987). Our Common Future: Report of the World Commission on Environment and Development (Book Review). Third World Planning Review, 9(3). https://doi.org/10.3828/twpr.9.3.x4k73r2p72w22402

Smith, C. L., Zurynski, Y., & Braithwaite, J. (2022). We can’t mitigate what we don’t monitor: using informatics to measure and improve healthcare systems’ climate impact and environmental footprint. In Journal of the American Medical Informatics Association (Vol. 29, Issue 12). https://doi.org/10.1093/jamia/ocac113

Smits, M., Bredie, B., Van Goor, H., & Verbeek, P. P. C. C. (2019). Values that Matter: Mediation Theory and Design for Values. Proceedings of Academy of Design Innovation Management Conference.

Smits, M., Ludden, G., Peters, R., Bredie, S. J. H., van Goor, H., & Verbeek, P. P. (2022). Values that Matter: A New Method to Design and Assess Moral Mediation of Technology. In Design Issues (Vol. 38, Issue 1, pp. 39–54). MIT Press Journals. https://doi.org/10.1162/desi_a_00669

Spradley, J. P. (1980). Ethnography for What? In Participant Observation.

Stancliffe, R. C., & Bhutta, M. (2008). Wanted: A green NHS. In BMJ (Vol. 336, Issue 7642). https://doi.org/10.1136/bmj.39500.473669.be

Thiel, C. L., Schehlein, E., Ravilla, T., Ravindran, R. D., Robin, A. L., Saeedi, O. J., Schuman, J. S., & Venkatesh, R. (2017). Cataract surgery and environmental sustainability: Waste and lifecycle assessment of phacoemulsification at a private healthcare facility. Journal of Cataract and Refractive Surgery, 43(11). https://doi.org/10.1016/j.jcrs.2017.08.017

van de Poel, I. (2013). Translating Values into Design Requirements. In Philosophy of Engineering and Technology (Vol. 15). https://doi.org/10.1007/978-94-007-7762-0_20

van de Poel, I., & Kudina, O. (2022). Understanding Technology-Induced Value Change: a Pragmatist Proposal. Philosophy and Technology, 35(2). https://doi.org/10.1007/s13347-022-00520-8