Nordic Welfare Centre

Distance spanning solutions in health care and care

Climate impacts and sustainability synergies

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Distance spanning solutions in health care and care – Climate impacts and sustainability synergies 70

Foreword

Distance spanning solutions in healthcare and social care are rapidly increasing in all Nordic countries. Healthcare and care are offered in people's homes based on their own needs. Digitalisation and remote service solutions are important prerequisites for maintaining the quality of the Nordic welfare model. But what are the sustainability impacts of these services?

Digitalisation is seen as one way of reducing the negative environmental impacts of healthcare and care production and advancing the green transition. But what other sustainable development goals are impacted?

The Nordic project Integrated Healthcare and Care through distance spanning solutions (iHAC) is one of several projects that form part of Nordic Vision 2030´s action plan and contributes to the Nordic Council of Ministers' goal of being the most sustainable and integrated region in the world by 2030. This publication presents distance spanning solutions through the lens of sustainability with a focus on climate impacts and SDG synergies.

The purpose of this publication is to enhance understanding of the implications of distance spanning solutions on the different dimensions of the United Nation's Sustainable Development Goals (SDGs). The publication comprises two parts: the first part focuses on the environmental impacts of medicine robot services and the second part on the trade-offs and synergies concerning other environmental and socio-economic factors and their contribution to the green transition that is inclusive and sustainable.

The Nordic Welfare Centre would particularly like to thank the Centre for Rural Medicine – Region Västerbotten, Lappeenranta-Lahti University of Technology, Finnish Environment Institute and Stockholm Environment Institute, as well as the organisations in each country that have contributed with stakeholder perspectives.

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Introduction

The Nordic region has set the ambitious goal of becoming the world's most sustainable and integrated region by 2030. Vision 2030 comprises interlinked strategic priorities: a green Nordic region, a competitive Nordic region and a socially sustainable Nordic region. Achieving this vision requires actions to promote a green transition in the Nordic countries, working towards achieving carbon neutrality, fostering green growth based on knowledge, innovation, mobility and digital integration, and enhancing social sustainability by ensuring good, equal and secure health and welfare for all. Distance spanning solutions in Nordic health care and care are closely aligned with this vision and each strategic priority.

Digital solutions in health care and care represent a promising avenue for improving service accessibility for citizens and enhancing sustainability. Environmental sustainability and the green transition are relatively new topics of discussion concerning the digitalisation of health care and care, despite the numerous connections between climate change and challenges in these sectors. It is estimated that the healthcare sector is responsible for over 4 percent of global greenhouse gas emissions, and in some industrialised countries, this figure could be as high as 15 percent. Digitalisation is viewed as one way of mitigating the negative environmental impacts of health care and care production. However, practical tools are needed in order to comprehensively assess the impacts of digitalisation in this field.

The purpose of this publication is to enhance understanding of the implications of digitalised health care and care on the different dimensions of the Sustainable Development Goals (SDGs). The publication comprises two parts that are presented below. Five model Nordic regions were presented in the iHAC publication from 2022, Integrated Healthcare and Care through distance spanning solutions – for increased service accessibility, and four of these regions – Päijät-Häme wellbeing services county, Finland, Fjallabyggd municipality, North East region, Iceland, Agder, Norway and Tiohundra Norrtälje, Sweden – have participated in and contributed to this publication. Päijät-Häme wellbeing services county is the focus of the first part and all four regions have contributed to the second part through workshops and interviews.

Part 1: Assessing the environmental impacts of medicine robot services

This part introduces a novel methodology to assess the environmental – especially the climate impacts and social impacts of digital healthcare and care services. Digitalisation, such as distance spanning solutions, is seen as one way of reducing the negative environmental impacts of healthcare and care production and advancing the green transition. However, negative climate impacts result from every digitalisation action due to the equipment and energy that are needed. Concrete practical tools are required in order to assess the impacts of digitalisation in the field of health care and care.

In this part, authors from Lappeenranta-Lahti University of Technology (LUT) and the Finnish Environment Institute present the study results of a combined quantitative and qualitative assessment on the impacts of distance spanning solutions in home care services in Päijät-Häme, Finland, focusing on medicine robot services for older people. The study shows how such distance spanning solutions in health care and care can contribute to the green transition. Practical guidance for future impact assessments is also given.

Part 2: Using the SDG Synergies Tool to broaden the perspective on digitalisation

While the reduction in greenhouse gas emissions and the saving of productive time are well-documented benefits, focusing on these metrics alone will not be enough to achieve a sustainable transformation in the sector. A broader perspective is essential to understand the implications of digital healthcare solutions on other environmental and socio-economic factors and their contribution to a green transition that is inclusive and sustainable. This includes ensuring sustainable livelihoods and access to health care services for vulnerable and disadvantaged communities.

The Stockholm Environment Institute's (SEI) compilation of insights from multi-stakeholder workshops across the four Nordic model regions indicates there is a solid understanding among the stakeholders of what sustainability means in their respective contexts. The SDG Synergies tool of the SEI was used in one of the workshops. The tool is open source and freely available and allows for a deeper analysis and pathway design towards realising the Nordic Vision 2030. The SDG Synergies exercise revealed trade-offs and synergies concerning economic development, biodiversity, resource rights, consumption and production, as well as gender equality.

The aim of this chapter is to broaden the perspective on the potential impact of digitalisation in the Nordic welfare sector, from focus on climate impacts and carbon footprints to include social, economic and other environmental dimensions. A broadened scope reflects the 17 Sustainable Development Goals (SDGs) and the United Nation's 2030 Agenda. This is also in line with the Nordic Council of Ministers' Vision 2030 of the Nordic region becoming the most sustainable and integrated region in the world by 2030.

PART 1

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Medicine robot services in health care and care: Contribution to the green transition

Digitalisation, such as distance spanning solutions, is seen as one way of reducing the negative environmental impacts of healthcare and care production and advancing the green transition. Digitalisation is generally considered a positive measure for the environment. However, at least some negative climate impacts result from every digitalisation action due to the equipment and energy that are needed. Concrete practical tools are required in order to assess the impacts of digitalisation in the field of health care and care.

This part of the publication introduces a novel methodology to assess the environmental, especially the climate impacts and social impacts of digital healthcare and care services. We also present the results of our combined quantitative and qualitative assessment concerning the impacts of distance spanning home care services in Finland, focusing on medicine robot services for older people. The study shows how such distance spanning solutions in health care and care can contribute to the green transition. Practical guidance for future impact assessments is also given.

Introduction – Sustainable digitalisation in health care and care

Distance spanning solutions in health care and care are one example of digital services that aim to improve the availability of services for citizens and increase sustainability.

Environmental sustainability and the green transition are relatively new topics in discussions concerning the digitalisation of health care and care (Pereno & Eriksson, 2020), despite the many connections between climate change and healthcare and care challenges. It has been estimated that the healthcare sector is responsible for over 4 percent of greenhouse gas emissions globally (Andreae, 2022; see also Lenzen et al., 2020) and for up to 15 percent of emissions in industrialised countries (WHO, 2015). Digitalisation is seen as one way of reducing the negative environmental impacts of healthcare and care production (e.g. Fragão-Marques & Ozben, 2023), but concrete tools are needed to address the impacts of digitalisation in this field. This part introduces a novel methodology to assess the environmental, especially the climate impacts and social impacts of digital healthcare and care services. The results of a combined quantitative and qualitative assessment concerning the impacts of digital home care services in Finland are also presented.

The Nordic region aims to become the world's most sustainable and integrated region by 2030. This ambitious Vision 2030 (Nordic Council of Ministers, 2020) comprises interlinked strategic priorities: a green Nordic region, a competitive Nordic region, and a socially sustainable Nordic region. Its implementation requires taking measures to promote a green transition in the Nordic countries and work towards achieving carbon neutrality, promoting green growth in the Nordic region based on knowledge, innovation, mobility and digital integration, and working towards social sustainability, such as contributing to good, equal and secure health and welfare for all, as well as involving everyone living in the Nordic region in digital development. In many ways, distance spanning solutions in Nordic health care and care are intertwined with this vision and each strategic priority and their interfaces. The Vision's Objective no. 10, for example, focuses on involving people in the green transition and digital development, utilising the potential of this transition, and counteracting the widening gaps in society as a result of it. In particular, Objective 10 states that the green transition in health care and care involves taking advantage of digital solutions, offering healthcare and care services remotely, promoting innovation, and reducing their climate impact.

The United Nations (UN) Sustainable Development Goals (SDGs) also provide guidelines for the path towards achieving the sustainable digitalisation of healthcare and care services. As emphasised by Carson et al. (2021), SDGs are considered indivisible, and the pursuit of specific goals (e.g. improved access to healthcare and care services) needs to be undertaken while taking into account both the positive and negative spillover impacts on the other goals. Understanding that all SDGs interact as a system is essential to help guide the prioritisation of interventions, leverage synergies and avoid goal conflicts during implementation (Carson et al., 2021).

Limited research on environmental impacts

While the many positive expectations concerning the impacts of digital healthcare and care services are warranted, research is still limited, including research into and the development of usable and robust assessment methods for detecting environmental impacts, as well as other impacts (e.g. European Commission, 2019, mainly on evaluation). Digitalisation is not automatically positive from an environmental perspective, and new knowledge is needed to be able to make informed choices concerning digital healthcare and care services in the Nordic region (Carson et al., 2021). According to Andersen et al., 2021), it is unclear whether the increased use of electricity and rare materials due to digitalisation will be compensated for by efficiency gains and sustainable behaviours. In general, the sustainability of digital innovations depends on whether their integration is conducted in a way that supports their long-term stability (European Commission, 2019; Fragão-Marques & Ozben, 2023).

Healthcare and care services are a challenging field from the perspective of digitalisation. Such services are typically related to citizens' fragile life situations. Diverse ethical issues, data protection and privacy are at stake here (Lerzynski, 2021). Despite the challenges, the enabling role of digitalisation is intriguing in Nordic healthcare and care services due to the broad scope and societal significance of these services, as well as the potential of digitalisation to reduce the need for human labour (e.g. Faggini et al., 2019) in the event of staff shortages. However, the different elements of sustainability require careful attention in any digitalisation project. The need for comprehensive impact assessments has been emphasised by both Nordic decision-makers and healthcare and care organisations and their personnel (Melkas et al., 2025).

This part introduces a novel methodology to assess the environmental, especially the climate impacts and social impacts of digital healthcare and care services. We also present the results of our quantitative and qualitative assessment concerning the impacts of digital home care services in Finland.

Our focus is on medicine robot services for home care clients (older people). The chapter shows how – and under what conditions – distance spanning solutions in health care and care can contribute to the green transition. We also give practical guidance for future impact assessments.

Background and context: Distance spanning solutions and environmental sustainability

Views on sustainable (digital) health care and care

There is no consensus on the definition of sustainable health care and care despite increasing global interest in them (Pereno & Eriksson, 2020; see endnote 1). Any attempts to define them are complicated by the diversity of services and patient/client groups, technologies and systems, programmes and infrastructure, and the fact that services are offered and used in different ways and in different circumstances and environments, ranging from homes to various institutional settings. However, the Nordic countries form a relatively homogeneous region in this regard. According to Nordic Innovation (2019), sustainable healthcare covers

- sustainable service environments,
- sustainable technologies, and
- sustainable behaviour and practices.

Knowledge is also needed on what sustainable *digital* healthcare and care services, such as distance spanning solutions, are like and how they are defined (e.g. Faggini et al., 2019). There are both challenges and opportunities in the way in which digital technologies are integrated into existing healthcare and care services and systems – or how new services are initiated. Contextual factors such as funding, organisational support and people's individual abilities, capacity and education affect integration (e.g. Jungwirth & Haluza, 2019; Stanford et al., 2023).

The digitalisation of health care and care-related processes and improved cooperation between, for example, hospitals and product suppliers can help to reduce the carbon footprint. Improved availability of data may make decision-making in hospitals and healthcare centres more effective. There must also be focus on the sustainability of materials used in buildings and materials of the technology to be utilised, which emphasises the need for procurement expertise. (Nordic Innovation, 2019) However, sustainable healthcare and care should not only be seen in the context of situations in which a person has already become ill and is a care receiver; the early introduction of proactive digital services in home environments could make it possible to benefit more from the positive potential of digitalisation (Melkas et al., 2020).

Carbon footprint in recent studies

In recent years, there have been several studies on the topic of the carbon footprint of telemedicine (e.g. Thiel et al., 2023). The increase in the use of such solutions during the COVID-19 pandemic has affected this recent research (e.g. Ohannessian, Duong & Odone, 2020; Greenhalgh, Koh & Car, 2020). The studies have concerned very different kinds of systems. The researchers have typically focused on benefits, such as avoided patient transfer. Schmitz-Grosz et al. (2023), for example, found that overall, a physician-operated telemedicine centre with a high patient volume showed a negative CO_2 balance with saved CO_2e emissions.

In a systematic review of whether telemedicine reduces the carbon footprint of health care, Purohit, Smith and Hibble (2021) noted the extensive research into the effectiveness, cost and perceptions of telemedicine, while only few studies have assessed the environmental impacts (apart from stating a reduction in travel time). Purohit and colleagues divided the publications into three categories for analysis: telephone synchronous, video synchronous and asynchronous. They compared travel distance saved (average travel saving ranged from about one kilometre to 901 kilometres) with the carbon footprint reduction per telemedicine consultation. Some of the studies also accounted for the carbon footprint of the telemedicine equipment. Purohit et al. (2021) concluded that the reported benefits were primarily travel-associated savings that greatly outweighed the carbon footprint of the telemedicine equipment (see endnote 2). Most of the studies did not include the carbon footprint of the telemedicine service, and Purohit and colleagues also listed several other limitations.

Health care and care are increasingly affected by so-called emerging technologies, such as robotics, artificial intelligence and automated systems. While opportunities have been recognised in healthcare and care services, the use of robots, for instance, is still relatively rare (Pekkarinen & Melkas, 2019; Pekkarinen et al., 2019). The Finnish Ministry of Transport and Communications has assessed that with the help of new solutions implemented using these technologies, such as robotics and their support technologies (e.g. cloud services), the negative environmental impacts of health care and care, and other sectors, could be decreased (LVM, 2020). However, thus far, there have been few impact assessments and it has been noted that the use of AI requires various resources that have negative environmental impacts (OECD, 2022), while recent literature focuses on and emphasises the benefits of AI in climate change adaptation (e.g. Filho et al., 2022).

Distance spanning solutions in Finnish home care

Distance spanning solutions can reduce the workload of home care visits even in situations in which the number of clients increases. In Finland, the development of distance spanning solutions is related to the policies of the Ministry of Social Affairs and Health and ongoing legislative reforms. In 2022, approximately 194,000 clients were receiving home care in Finland. Of the home care clients, 59% of them used home care services regularly and 46% used them often and were clients of the so-called intensive home care.

The need for regular home care increases with age. Of the population in the age group 75–84 years, 8% received regular home care services; in the age group 85–94 years, 30% received regular home care services and in the age group over 95 years, 57% received regular home care services. The share of clients receiving regular home care services varied across wellbeing services counties. In the age group 85–94 years, the share was smallest in the Päijät-Häme wellbeing services county (22%; the context of this study), whereas in some counties, the share was as much as 40%. Over half (59%) of the clients in regular home care received at least one home visit per day, and 17% received three or more home visits per day. (THL, 2023)

One third of staff in elderly care services work in home care (THL, 2021). Almost all (96%) home care contacts in 2022 were visits by a professional caregiver at the client's home. 4% of the contacts were conducted remotely, and most of these were real-time connections using distance spanning solutions (THL, 2023). Medicine robot services are one example of distance spanning solutions used in home care in Finland, the other Nordic countries, and elsewhere.

Distance spanning medicine robots in health care and care

Medication is an important part of healthcare and care systems. Medicine robot services have been developed to assist patients and clients in homes and hospitals or other healthcare and care settings. With the help of a medicine robot, home care clients, for example, receive their regular medication in a timely manner, packed into unit doses.

Typically, an alert sounds when it is time for the client to take their medication, and if they miss a dose during the set period due to forgetfulness, a message stating that they did not take their medication is sent to the relevant persons, such as the client's professional or informal caregivers.

Several commercial products are available, as well as preliminary or working prototypes (Gargioni, Fogli & Baroni, 2024) and the related services are organised in different ways in different national healthcare and care systems (e.g. Iqbal et al., 2021). The management of older people's medication can be particularly challenging due to an increased prevalence of multimorbidity, changes in pharmacokinetics and pharmacodynamics, and clients or patients experiencing problems handling their medication due to a physical disability and/or cognitive impairment (Iqbal et al., 2021). The aim of medicine robot services is to improve medication safety and adherence but also to assist professional caregivers by reducing their workload (e.g. Turjamaa, Kapanen & Kangasniemi, 2020). They can also improve the self-management and independent living of older persons (Tian et al., 2024).

In recent years, medicine robots have gained increasing attention among researchers in different countries, partly because of the special circumstances resulting from the COVID-19 pandemic (e.g. Krishna et al., 2021). Gargioni et al. (2024) recently conducted a systematic review of (what they term) pill and medication dispensers from a human-centred perspective. They concluded that research is often focused on hardware and/or software technology. Human-centred perspectives are overlooked, such as the impacts on the various stakeholders (patients, caregivers, medical doctors, etc.), which they note is crucial to achieve technology acceptance and relevant benefits. They called for comprehensive socio-technical healthcare solutions that involve the use of medicine robots, and showed that several gaps exist in the design, development and deployment of such solutions.

According to Gargioni et al. (2024), the most important open issues and challenges are solution scalability, system integration, authentication and security, dependability and safety, user experience and personalisation. They limited their research to the period from 2013 to 2023, as well as research on Scopus. They did not discuss sustainability or environmental or climate impacts (see also Turjamaa et al., 2020), and a review of the literature suggests that, to date, those have not been the focus of previous research.

Home care-related studies were recently conducted by Suzuki, Takahashi and Tofukuji (2024), and Iqbal et al. (2021). In an experiment conducted in Japan with one older patient with diabetes living in a residential home, Suzuki et al. (2024) found that the medicine robot was effective in facilitating medication adherence. A qualitative case study by Iqbal et al. (2021) adopted a systems thinking approach and explored the implementation and deployment of a robotic system for medication management for municipal home care services in Sweden. They emphasised the need for holistic medication management that requires communication, coordination and effective information sharing among network actors and across different settings, as well as the role of the care personnel and key stakeholders involved in these processes.

Iqbal et al. (2021) also noted that it is challenging for service providers, such as municipalities, to develop and adopt medication management solutions, since additional work procedures need to be in place for care personnel, who also need to adjust to a different type of telepresence relationship with clients or patients. In addition, management and maintenance issues regarding the system and its interface with support services need to be addressed. Another Nordic study on Finnish home care reported the safety profile and usability of medicine robot services and their acceptability to patients and nurses (Rantanen et al., 2017). Turjamaa et al. (2023) also focused on the experiences of Finnish professional caregivers.

In their study on sustainable healthcare systems, Iqbal et al. (2021) referred to the environmental perspective by noting that home visits by nurses to administer medication only should be reduced, as fewer visits to patients' homes would involve less use of vehicles, which is environmentally friendly, sustainable and cost-effective in terms of work/life balance and overall impact on society. Their approach to sustainability was to link medication management robotic systems to the UN's SDGs, of which they had selected 3, 4 and 9 (for other SDG-related perspectives, see Carson et al., 2021).

Assessment of climate and social impacts: the case of Finnish home care services

This part introduces a novel methodology to assess the environmental, especially the climate impacts and social impacts of digital healthcare and care services. We also present the results of our quantitative and qualitative assessment concerning climate and social impacts of digital home care services in Finland, centred on medicine robot services for older clients.

We show how and under what conditions distance spanning solutions in health care and care can contribute to the green transition. We also give practical guidance for future impact assessments.

Case region and services

The empirical data on medicine robot services were collected in the region of Päijät-Häme in Southern Finland (see endnote 3). The region is rather sparsely populated with potentially long distances to services. At the time of the data collection (2022), home care services were provided by Päijät-Häme Joint Authority for Health and Wellbeing (currently called Päijät-Häme wellbeing services county; hereafter the County), the unit for elderly care services and rehabilitation. This regional organisation provides services for the more than 200,000 residents of the region with its 7,000 employees. Päijät-Häme was selected as one of the five model Nordic regions of collaboration in the healthcare and care sector (Nordic Welfare Centre, 2022).

Part of the home care services is provided remotely with the help of distance spanning solutions. The remote care and technology unit, Severi, serves regular home care clients in the region using medicine robot services and other services. Severi's staff comprises both nurses and assistant nurses. The Päijät-Häme region has been a pioneer in remote care in Finland. In 2022, there were 257 medicine robot clients (15.3 percent of all home care clients). Medicine robot services have been provided since 2016 and are therefore not new in the region, although environmental sustainability and climate impacts have not been studied.

Medicine robots are available to the region's home care clients free of charge. Home care professionals generally refill the robots every 1–2 weeks. In the event of potential disturbances, such as power outages, the device sounds an alarm that is directed to a care professional. The device also sounds an alarm if the client does not take the medicine offered or if there is an attempt to break into the device. The medicine robot services function independently or can complement other home care services. The brands used in the region are Evondos (from 2016) and Axitare (from 2020) (see photo 1). A medicine robot requires mains power but not a fixed internet connection, thanks to its built-in mobile modem. To access the backend, as well as the robot itself, employees have a tablet, computer or mobile phone with an internet connection, which the County acquires (itself). Apart from the devices, the County purchases the overall service including maintenance from a technology provider. One of the medicine robots uses medicine bags, while the other uses dose cups. The medicine robot services aim to replace one or more of the care professionals' home visits, though not necessarily all of them.

Photo 1. Medicine robots (photos: Evondos, on the left, and Axitare, on the right).

Data collection

The data collection served the quantitative assessment method, including the development of a calculation model, and the qualitative assessment. The data were collected with the help of interviews with the County staff and the two technology suppliers, as well as documents provided by the County, such as log information related to the use of the services, evaluation reports, planning documents and statistics, plus annual reports on the use and share of services in the region and the development of service usage. The main knowledge needs identified for the data collection were as follows:

- From the perspective of clients, care professionals and the service system:
    - Detailed description of the service (e.g. devices used, architecture of the backend system, daily organising of the service, work environments/spaces)
    - Reasons for introduction/digitalisation of the service (economic and/or related to service quality), impacts (both targeted impacts and other impacts in a broad sense)
    - Information on how the services had been

    - organised in the past and how the digitalisation of the service changed how the various participants operated
    - Information on patient/client satisfaction
- From companies (technology suppliers): description of the service from the company's perspective, matters related to manufacturing materials, production, electricity consumption and materials/parts recycling/life cycle, backend services and network usage.

The interviewees in the case of the medicine robot services:

- 9 interviewees representing the county staff (assistant nurses, a registered nurse, an immediate supervisor, management representatives)
- 2 interviewees representing the technology suppliers

The aim was to collect as broad information as possible on both direct and indirect impacts. The content of the interviews was tailored according to the role of each interviewee. Ethical standards were maintained during the study. All interviewees gave their informed consent for participation and subsequent interviews. The interviewees could leave the interview at any time. A research permit was obtained from the County and the participants' confidentiality was observed. The interviews were conducted from January to March 2022 online as Teams interviews and were recorded and transcribed. Most of the interviews were individual interviews, although a few of them were carried out in pairs. The interviewees were selected in such a way that the most comprehensive information about the impacts was obtained. They represented the management, development and planning, supervision of client service work, employees working in client services, as well as technology trainers and technology suppliers (the companies) (see below).

The material and energy inputs required by both the ICT system and the physical service were investigated based on the interviews, statistics and other documents. For the calculation of climate impacts, quantitative data on direct and indirect factors were collected as comprehensively as possible. The interview data provided a rich basis for the qualitative assessment, including information on how people's actions affected the impacts.

During the study it became clear that the data needed for the quantitative assessment of climate impacts were not publicly available. Data needed in such assessments tend to be private or confidential and therefore need to be collected by service owners or through good cooperation with all the related parties, such as in this study.

Principles of the impact assessments

Quantitative assessment of climate impacts

The novel methodology that was developed for assessing the climate impacts of digital services comprises an assessment framework and a calculation model.

The assessment framework is based on life cycle assessment methodology (LCA). LCA is an ISO standardised method to study complex value chains in order to understand potential environmental impacts (International Organization for Standardization (ISO), 2006). LCA enables quantification of the potential environmental impacts of the whole product system, including upstream impacts. This is important when studying systems that are global in nature. An LCA-based approach allows for the assessment of multiple environmental impact categories but for now, the availability of data typically limits the assessment to climate impacts with an indicator of Global Warming Potential (kg CO_2e), which is a standard unit for measuring carbon footprints. In addition to standardised methods, further industry-specific rules or even case-specific refinements are often needed.

Digital services typically comprise such a high number of components that an exact assessment of each component is virtually impossible. For example, the network component of a service alone may utilise hundreds of connections and processing units. Another challenge to estimating the impacts of digitalisation is that the process of digitalisation is typically gradual. It can take years to fully digitalise a service and the service itself also develops over time. Thus, achieving a clear before-and-after comparison is a rare occurrence.

Figure 1 illustrates our framework for the quantitative assessment of the climate impacts of digital services. This is the most simplified framework that still adequately describes all the digital components of the service. The production of a digital service requires user IT equipment, internet connection and servers. The consumption of a digital service requires an internet connection and an access device. The access device can be dedicated to the service (e.g. medicine robot or dedicated tablet) or not (PC, smartphone, personal tablet also used for other purposes).

This simplified framework allowed for an assessment based on the collected data. Calculations based on detailed solution architecture would have been virtually impossible. In LCA, impacts are calculated per defined functional unit. It is a measure of the performance of the product system that is studied. It provides a reference to which all inputs and outputs in the system can be related. The functional unit of a one-year service use of one client/patient was selected to facilitate comparison of the climate impacts of digital services with the climate impacts of potentially saved travel.

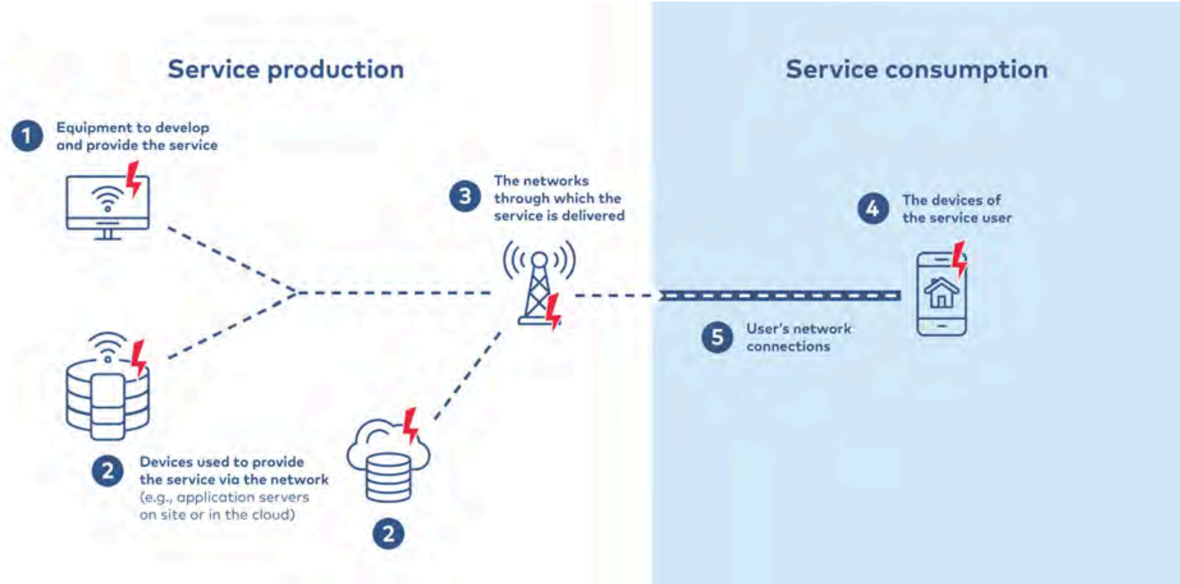

Figure 1. The framework for the assessment of the climate impacts of digital services (source: Melkas et al., forthcoming; adapted from Tuominen-Thuesen et al., 2022).

The assessment framework was tested using real-life cases to detect any potential shortcomings and the limits of its use. We also wanted to know what a roadmap for future assessments should look like and whether it is correct to calculate the impacts in this work in this way. The services of two case regions were chosen as the test environment for the framework in order to identify the applicability of the framework and the calculation model for assessing the climate impacts of the studied digital services. We also gained information on the further development of the framework and the calculation model. This part only focuses on one of the regions and the medicine robot services.

Qualitative assessment

The method developed in this study for qualitatively assessing social and climate impacts is based on the principles of human impact assessment (HuIA, e.g. Melkas et al., 2020; Nelimarkka & Kauppinen, 2007). An assessment of human impacts can be used to structure new perspectives and describe solution options. Impacts assessed using HuIA can be planned or unintended and can be the result of long chains or networks of impacts (Nelimarkka & Kauppinen, 2007). Thus, HuIA is comprehensive by nature: impacts are not limited beforehand, but efforts are made to comprehensively identify them and make them visible. In this study, assessing the impacts on people entails, for example, examining the chains of impacts of digitalisation that can be related to well-being, relationships between people, and changes at care work, inter alia. This approach has been used in studies of the digitalisation of healthcare and care services, which have concerned traditional technology such as safety alarm systems (e.g. Melkas, 2011), and emerging technologies, such as care robots (Melkas et al., 2020). The essence of this approach is to holistically identify the positive, negative and neutral impacts on the different people and groups of people involved.

For the qualitative assessment in this study, the interviews were analysed using content analysis. We searched for both climate impacts and social impacts. An inductive thematic analysis (Braun & Clarke, 2006) of the data was conducted. The transcribed text and notes were then thoroughly reviewed to capture all aspects of the research topic. In this study, the impacts were grouped into positive and negative climate impacts and social impacts. The positive and negative social impacts were further grouped into impacts on clients/patients, impacts on care professionals and impacts on service organisations and society (Figure 2).

Environmental, especially climate impacts:
Positive and negative

Social impacts:
Positive and negative

- Impacts on clients/patients
- Impacts on care professionals
- Impacts on service organisatsociety

Figure 2. Categorisation of the qualitative results (source: Melkas et al., forthcoming; adapted from Tuominen-Thuesen et al., 2022).

Assessment of climate and social impacts: results

Quantitative assessment of climate impacts

The climate impacts of medicine robot services were calculated for a functional unit based on annual use of a medicine robot by a client who takes medication three times a day. Figure 3 describes the basic components of the service. These are the same components as in the framework (Figure 1) with the addition of physical visits to refill the medicine robot.

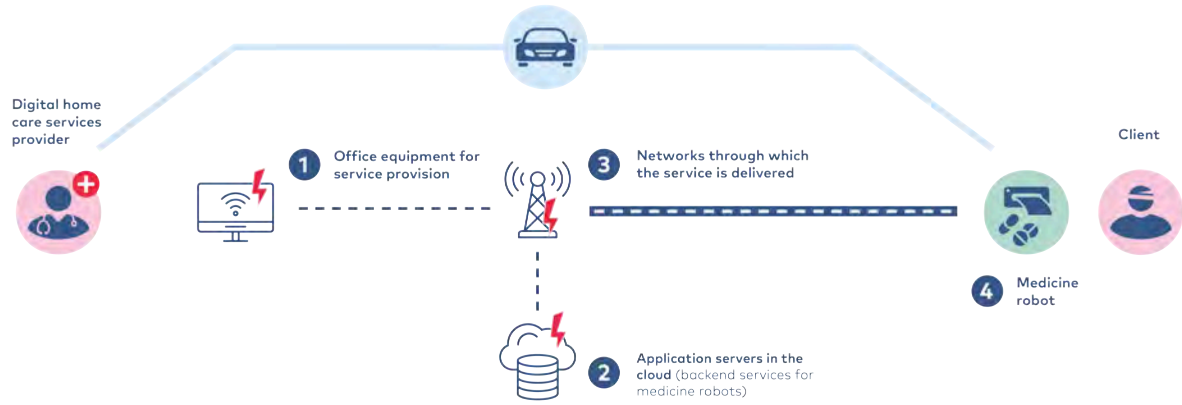

Figure 3. Medicine robot service components for the impact assessment (source: Melkas et al., forthcoming; adapted from Tuominen-Thuesen et al., 2022).

The climate impacts were calculated for both types of medicine robot. The overall results were quite similar. An illustration of the aggregated results can be found in Figure 4. Manufacturing of the robot dominates the climate impacts. Refilling and energy used by the robot together represent less than half of the climate impacts compared to the climate impacts of manufacturing. The backend and mobile data made only a small contribution to the overall climate impacts. Medicine cups – used in one of the robots – were responsible for more climate impacts than the energy used by the robot.

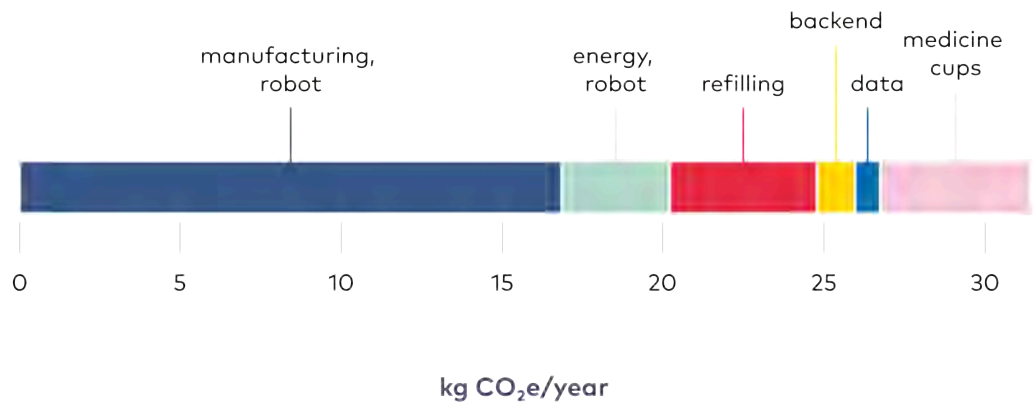

Figure 4. Climate impacts of a medicine robot (aggregated) (source: Melkas et al., forthcoming; adapted from Tuominen-Thuesen et al., 2022).

A medicine robot replaces travel. Clients without a robot typically need two visits per day, while the studied robots need to be refilled every two weeks. Figure 5 compares the climate impacts of the medicine robot services to alternative means of transport to fulfil daily medication needs.

In short, the studied medicine robots are a climate-friendly option when the distance to a client by car (even an electric car) is more than one kilometre (two kilometres by bike).

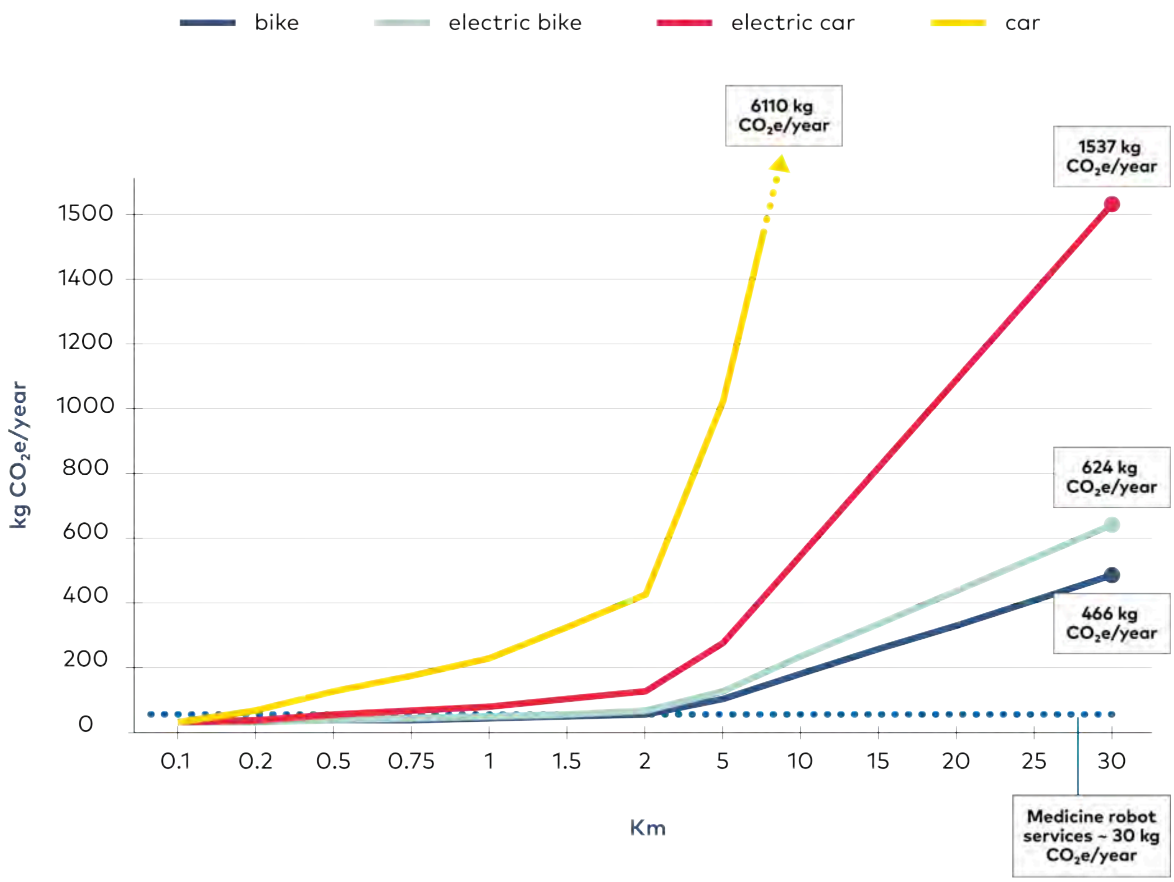

Figure 5. Comparing the climate impacts of medicine robot services to the climate impacts of avoided travel (source: Melkas et al., forthcoming; adapted from Tuominen-Thuesen et al., 2022).

To conclude, a medicine robot has good potential from the perspective of reducing climate impacts. It is particularly beneficial in rural areas and where client visits necessitate the use of a car.

Technology and service providers are key to reducing carbon footprints. The manufacturing phase of the studied medicine robots is responsible for over 50 percent of the assessed climate impacts. The carbon footprint of the manufacturing depends on the design of the robot and the use of materials, as well as on its lifespan. Operational energy and the robot's data usage should also be optimised but have less impact on its carbon footprint. Requiring technology and service providers to submit carbon footprint calculations would be a good way to ensure green services.

Qualitative assessment of climate impacts

Positive climate impacts

The qualitative assessment provided in-depth information about the service context and revealed a number of additional impacts. Medicine robot services enable a reduction in the number of kilometres driven by care professionals, meaning the number of home visits could be reduced from as many as 60 visits per month per client (for administering morning and evening medicine) to just two visits (to refill the robot). Usually, however, only some of the visits are replaced by a robot. One of the aims is to also optimise routes and visits to clients' homes. In the County, the distance from a home care office to a client's home can be tens of kilometres. A care professional noted:

> "I personally find them [medicine robots] useful. They have been well received in the work community. Suitable clients are suggested from the field [by the care professionals]. It's frustrating to drive 50 minutes just to administer morning medicine."

Medicine robot services provide the opportunity to save on the protective equipment (disinfectants, gloves, masks) used by care professionals, which is beneficial for both the environment and the economy. Also, medicine robot services may reduce medicine waste. When only the correct dose of medicine is dispensed, there is no requirement for large packets of medicine that may expire if the medicine is no longer needed.

The life cycle of medicine robots is quite long: 7–8 years. The robots are considered durable and can be repaired by replacing worn parts. They are passed on from one client to the next, and their components are recycled.

Negative climate impacts

The negative climate impacts of medicine robot services have been previously described. However, the qualitative assessment showed that unnecessary additional driving sometimes occurs and could be avoided with better planning. This is related to the guidance given to the clients. When the client receives the robot for the first time, guidance is always given by a care professional and may need to be given several times in the beginning. The technical expertise of the care professional is essential so that they can help if there are any problems when the client is using the device. It is also essential from a more general perspective, as mentioned by a technology supplier:

> "Thorough training and support produces [positive] environmental impacts by ensuring that the device is not left unused or that there is no need to return to administering the medicine on site."

Even though a medicine robot generally reduces the amount of driving needed, error messages or alarms from the device sometimes mean a home visit by a care professional is necessary. Most of these situations can be dealt with by a care professional over the phone, such as when the device sounds an alarm because medicine has not been taken. The interviewees mentioned that sometimes a technician from the manufacturer needed to be called to repair the device, although this was rare. As to workspaces (offices), medicine robot services do not affect the number of workspaces, as the services were previously provided in the clients' homes.

Qualitative assessment of social impacts

Social impacts were divided into both positive and negative impacts on different levels clients, employees and organisations and society (Table 1). Social impacts may be planned (so that they are in line with the aim of the digitalisation actions, from a social perspective) or unexpected. The importance of including social impacts in comprehensive impact assessments was reinforced by the fact that the study revealed various intertwined and multi-directional impacts.

Positive social impacts

Detailed social impacts always depend on the type of service and technology being offered. Our qualitative assessment of medicine robot services revealed several positive social impacts, such as the preservation of client activity and independence, better regional equality in access to services regardless of place of residence, rationalisation of employees' work, increased work flexibility due to a reduction in the amount of time that employees spent travelling, and better allocation of societal resources (see also Table 1).

Medicine robot services (like the use of home care technologies in general) have led to savings in client care fees. The clients felt that the devices were easy to use; they are relatively automated and reliable and do not require clients to have technical skills.

A care professional noted:

> "The attitude of clients and their relatives varies. Often, they resist using it [the robot] at first, but when they try and learn and then realise how useful it is, their attitude is generally positive and they start using the service."

The use of medicine robots also led to the positive impacts of better-quality medicational care and fewer medication errors. The studied medicine robots will always administer the medicine at the specified time, which improves the accuracy of the medication. If a care professional administers the medicine, timing may differ. The robot also relieves the pressure of having to remember to take the medicine. The robot can also give other reminders. In addition, the service provides a sense of participation and accomplishment. Some clients do not like receiving visits from a care professional, so a medicine robot enables a client to maintain a sense of independence, while ensuring access to care.

Negative social impacts

A number of negative social impacts were also identified, such as issues related to client inequality (digital skills, or the service in question being unsuitable for the client and problems resulting from this), employee workload while learning a new way of working, and the increase in management challenges and level of complexity (see also Table 1).

The use of a medicine robot requires different types of skills, such as refilling the robot. New skills are also required in order to assess whether a client has a need for such a service; care professionals must know how to assess which clients the devices would be suitable for. It takes time for a care professional to process changes in the medication dosage, especially if the change is supposed to take effect immediately. The processing of the change depends on the device. In general, however, it is recommended that the change takes place from the next refilling in order to minimise the number of errors.

Familiarising a client with a device and visits due to alarms have to be conducted together with or in addition to other work, because no time is allocated in the work schedule for such activities. Typical error messages concern a device being unplugged. The client may also turn the medicine robot upside down, causing the medicines to become mixed up. Sometimes the medicines are installed incorrectly, or the bag roll gets stuck. In such cases, a care professional has to visit the client's home in order to rectify the problem. Technical problems are also negative impacts, even though such problems are typically caused by network load issues. However, they are relatively rare.

The perceived unsuitability of the devices in the home environment was described as a negative social impact from the client's perspective. The large size of medicine robots may be a surprise and a client may consider it unattractive and inappropriate for use in their home. Also, a medicine robot does not provide social interaction, unlike a visit or a video call from a care professional. It is important to consider the suitability of the technology to the client, especially in the case of people with memory and/or mental illnesses, as they may have delusions or suspicions, as pointed out by a care professional:

> "Some clients with specific illnesses may be very suspicious of such devices. They may think that the device is being used to spy on them or secretly photograph them. ...We

only try the devices if the client is suitable. But it is also possible to discontinue the service and return to a care professional's visits."

Table 1. Positive and negative social impacts of medicine robot services (source: Melkas et al., forthcoming; adapted from Tuominen-Thuesen et al., 2022).

Impacts on...	Positive impacts	Negative impacts
Clients/patients	Savings on service fees, improved accuracy in the timing of medication and care visits, less medication errors, maintaining a sense of independence and autonomy	Not suitable for everyone (e.g. a client potentially being suspicious); perceived suitability of the devices (size, appearance) in the home environment
Employees	Reduction in the time required for travelling and technical tasks, easier planning of time use (more time for actual care work rather than, for example, changing protective equipment and disinfecting between client visits)	Change of work, new tasks (e.g. responsibility for technology, assessment of service needs) Change requires learning, which can be overwhelming No reduction in total workload because the number of clients keeps increasing; easy visits have decreased, while challenging visits remain
Service organisations and society	More rational allocation of resources (face-to-face visits for those clients who really need them), possible increase in general appreciation and attractiveness of care work	Challenges related to work culture and in incorporating the technology into service processes Management challenges and complexity; new and old ways of working collide (e.g. engaging and assisting care personnel, procurement expertise, support services)

Home care quality may be perceived as worse when technology is used in such services. Thus, the initial reaction of clients and their loved ones to the introduction of technology in home care is often negative. The implementation of the studied medicine robot services always starts with a two-week trial period, after which there is an option to stop using it. Most clients are satisfied after the trial period and want to continue using the device. The clients themselves were not interviewed in this study so their experiences were described by the care professionals.

Although the technology can be useful, the overall workload in home care services has not decreased because the number of clients keeps increasing. The interviewees stated that the easy visits have decreased due to the technology while the challenging visits have remained.

Practical guidance for future impact assessments

Services differ and their impacts need to be assessed in different ways. This part looks at climate impact assessment and introduces a simplified method for calculating climate impacts of digital services.

The starting point for a quantitative climate impact assessment

Climate impacts have typically not been the primary reason for digitalisation or the development of a new digital service. Thus, in most cases, climate impacts have not been assessed. As shown by the case study of the medicine robot services, there is good potential for climate benefits, at least in some healthcare and care services. However, all services differ and many more studies are needed to fully assess the potential for a green transition.

It is not practical to assess all digital services with the same level of detail as the medicine robot services in this study. A full life-cycle assessment is quite a heavy process, although an important part of research is to further our knowledge of climate impacts across multiple fields. Often, the most difficult services to assess are digital services because they comprise multiple products and also have hidden network components. To facilitate the assessment of the climate impacts of digital services, we have created an assessment framework to illustrate how to simplify a digital service for easier yet adequately accurate assessments.

This study has shown that the climate impacts of a digital service can be assessed with a reasonable degree of accuracy. Many services have specific equipment and require an LCA professional to assess the climate impacts of the specific parts, but there are also parts that are more generic and similar for a wider array of services.

Description and phases of the quantitative climate impact assessment

A simple assessment method has been developed that can be used to assess the climate impacts of digital or digitalised services. An online service is also available to illustrate the assessment method. The assessment method is based on both qualitative and quantitative assessments.

The main steps of the assessment method are shown in Figure 6.

1. In the first step, the aim is to use the questions on the checklist to identify whether the digital service has significant negative or positive climate impacts.
2. In the second step, the aim is to estimate the actual climate impacts. For some services, the calculation can be conducted using the simple calculator that has been developed in this context. However, for more complex services, a separate life cycle calculation performed by an expert is still needed.
3. The third step is an assessment of improvement potential, also implemented in the form of a checklist. For the applicable services, the assessment of improvement potential can also be conducted using the online service to compare alternative options.

The assessment method can be used in both the development phase and for the assessment of established services. The opportunity to influence climate impacts is best when a service is being developed because potential improvements can be made directly, without any significant cost impact.

Figure 6. Simple assessment method (source: Melkas et al., forthcoming; adapted from Tuominen-Thuesen et al., 2022).

Identification of the most significant climate impacts

Digital services differ greatly, although some common factors that typically lead to higher climate impacts have been collected to help identify potential cases for further assessment. These factors have been turned into a series of questions that can be seen in the online tool of the simple assessment method. The questions are used to identify services that have potentially high climate impacts, either as a whole or per use, but also services that could potentially have significant positive climate impacts. A positive answer to any question on the checklist indicates an increased need to assess the climate impacts.

Calculation of climate impacts

If a service has been identified as having a significant climate impact potential, it should be assessed for climate impacts. A case-specific climate impact assessment by an expert produces the most reliable results and is suitable for any service, but this type of assessment takes time and money. Ready-made calculation tools enable a less expensive and faster way to assess climate impacts, but it is not feasible to develop such calculation tools for all services.

The calculation tool for digital services used via networks has been integrated into the online service of the simple assessment method. This tool can be used to estimate the climate impacts for the service or part of the service according to Figure 7. The numbers refer to Table 2, which shows the scope of the calculation for the different parts of the assessed service. The actual calculation can be conducted using the formulas in Table 3. The calculation also requires emission factors, which can be retrieved from emission factor databases or the environmental product declarations (EPDs) of the relevant products. The calculation tool is ready for use since it contains estimates for the emission factors needed in the calculation.

The calculation tool is available online.

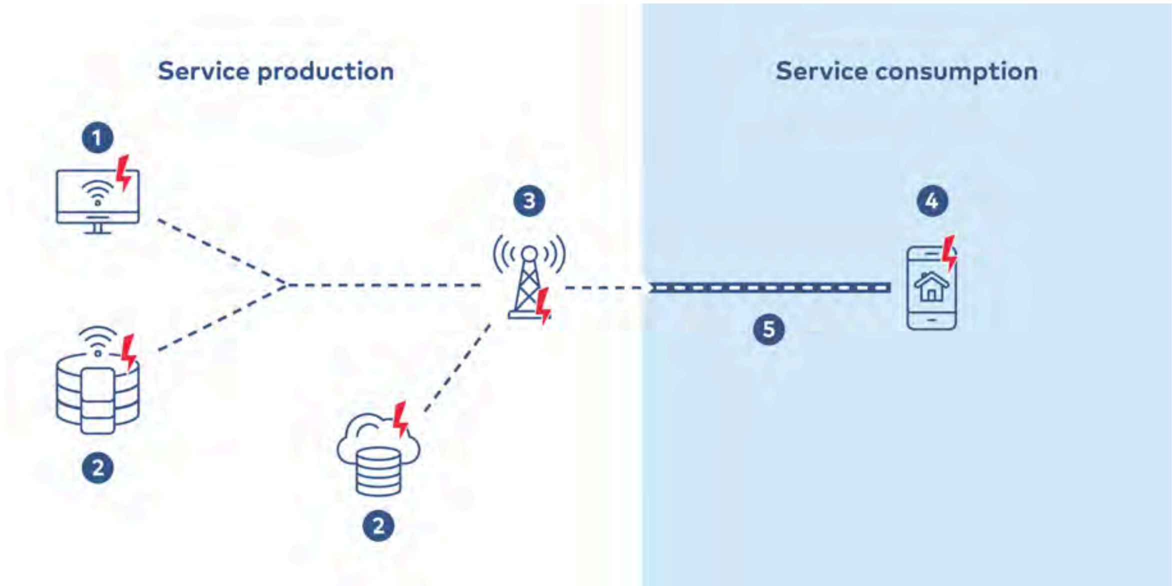

Figure 7. Digital service used via the network (source: Melkas et al., forthcoming; adapted from Tuominen-Thuesen et al., 2022).

Table 2. Scope of the climate impact calculation – digital services used via the network (source: Melkas et al., forthcoming; adapted from Tuominen-Thuesen et al., 2022).

Part of the assessed service	Climate impacts of the use phase	Climate impacts of the manufacturing phase
1) Equipment of the producer, developer and administrator of the service	Calculated Energy consumption or share of energy used to provide the service	Calculated Equipment directly related to service production or allocation of the share used to provide the service
2) Devices used to provide the service via the network (e.g. application servers in the intranet or in the cloud)	Calculated Energy consumption or share of energy used to provide the service	Calculated Equipment directly related to service production or allocation of the share used to provide the service
3) Networks through which the service is delivered and maintained	Calculated Energy consumption for the whole network, estimated per transferred amount of data	Out of scope Networks are mainly built for other uses
4) Equipment of the service user	Calculated Energy consumption during use of the assessed service	Calculated Allocation based on the time used
5) User's network connections	Whole network calculated above (3)	Out of scope Networks are mainly built for other uses

Table 3. Formulas for climate impact calculation – digital services used via the network (source: Melkas et al., forthcoming; adapted from Tuominen-Thuesen et al., 2022).

Part of the assessed service	Climate impacts of the use phase	Climate impacts of the manufacturing phase
1) Equipment of the producer, developer and administrator of the service	Electricity consumption X share of use X electricity emission factor	Emission value X share of use
2) Devices used to provide the service via the network (e.g. application servers in the intranet or in the cloud)	The electricity consumption of a typical server per one core X the number of allocated cores X the share of the capacity allocated to the service in question X power usage effectiveness (PUE) factor of the data centre X electricity emission factor	Separately, emissions of a typical server per one core and disk space emissions per terabyte X number of allocated cores/terabytes X share of capacity allocated to the service in question
3) Networks through which the service is delivered and maintained	In a simplified form, the entire network's energy use per gigabyte X electricity emission factor	-
4) Equipment of the service user	Electricity consumption of typical devices X share of the service in question X electricity emission factor	Emissions of typical devices X share of the use of the service in question
5) User's network connections	Whole network calculated above (3)	-

Assessment of improvement potential

Traditionally, there has been minimal focus on the carbon footprint of digital services. The emissions of most services can be reduced using relatively simple measures. In particular, if significant negative climate impacts have been identified in earlier stages of the assessment method, it is necessary to identify the most relevant factors and the most optimal ways of rectifying the situation.

The simple assessment method involves a set of measures that aim to reduce climate impacts in three relevant areas:

- emissions from the manufacture of the devices
- energy consumption during use
- the amount of data transferred

These proposed measures have been collected into the online service. The identification of the most effective measures cannot be conducted on a general level without there being information on the distribution of the emissions of the service in question. However, once a climate impact assessment has been conducted, the measures can be prioritised. When planning a new service, all the proposed measures should be considered. Implementing these improvements in the planning phase will incur little or no cost.

Integration of the qualitative assessment

The qualitative assessment of climate impacts and social impacts showed the multi-directionality and interconnectedness of the impacts of medicine robot services, as well as the associations of the impacts with people and their actions. This emphasises the need for a contextual understanding that is based on a qualitative assessment when making quantitative impact assessments. For example, the qualitative results showed that it is important to adequately assess the suitability of the distance spanning service, or the technology it uses, for the client/patient before its implementation and to carefully familiarise all parties involved so that it can be safely and successfully used. This, in turn, will contribute to the planning and foresight of the work and thus the functionality of the whole services, thereby increasing the possibility of achieving positive climate impacts (see Figure 8). When planning and implementing distance spanning solutions in health care and care with a view to contributing to the green transition, this kind of systems thinking is vital.

Figure 8. An example of the intertwined and multi-directional impacts in medicine robot services (source: Melkas et al., forthcoming; adapted from Tuominen-Thuesen et al., 2022).

The knowledge provided by the qualitative assessment enables an in-depth contextual understanding and knowledge related to people's ways of working and using services, which the service organisation and system are able to affect (unlike the manufacturing processes of their distance spanning technologies, for example). Thus, the service organisations and systems can also use such knowledge and understanding in their service design and development activities.

Towards a more meaningful, optimised balance of impacts

This part has provided an example of how a qualitative assessment can be conducted and combined with a quantitative assessment, and how a climate impact assessment and a social impact assessment can be combined. Figure 9 illustrates this combination.

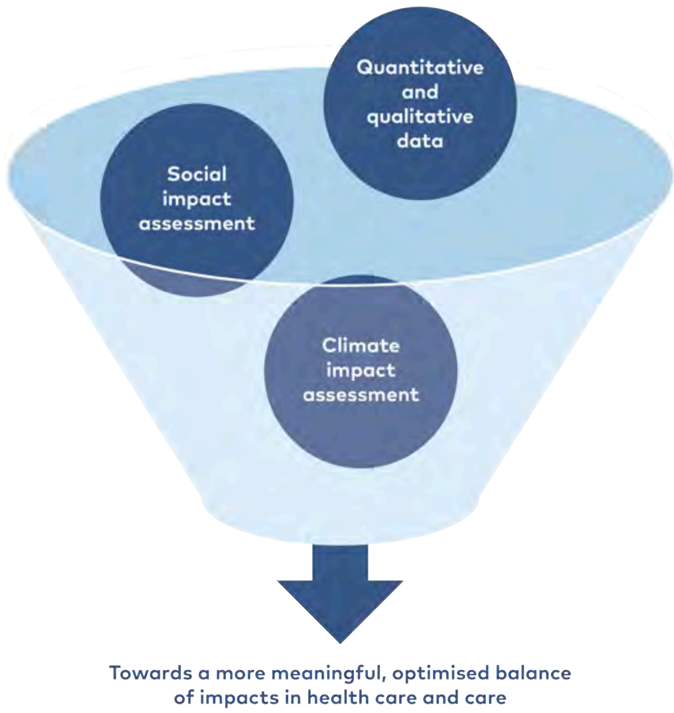

Figure 9. Towards understanding and contributing to a balance of impacts.

Both types of assessment require similar data but – as shown in this part – they make different contributions. The economic impacts – especially the positive impacts – of digital service innovations, such as the use of distance spanning solutions in health care and care, are usually assessed (or at least recognised), but climate and social impact assessments should also be conducted. In health care and care, in particular, it is a question of finding a meaningful and humanely balanced focus on the climate and social impacts – as well as the economic impacts. Achieving positive climate impacts is good, but in health care and care, the main priority must be to provide good health care and care.

Finding the right balance requires careful and informed planning. What is the relative value of the different impacts? In what way are the different impacts intertwined? Optimisation based on one aspect alone is not a viable solution. Holistic climate and social impact assessments will contribute to achieving a more meaningful, optimised balance of the impacts of distance spanning solutions in the future. Nordic policy measures should speed up the proliferation of such impact assessments.

Conclusions of part 1

Healthcare and home care services are undergoing major changes in their operating environment in many countries, such as an increasing number of clients, changing organisational and service structures, challenges in finding enough staff, as well as financial challenges. Digitalisation is expected to play a key role in these services, but the field is also very complex and digitalising it in a meaningful, ethical and effective way will be a challenging task.

The Covid-19 pandemic accelerated the introduction and use of various types of distance spanning solutions in healthcare and home care services, but climate impacts have not been the key driver of the digitalisation of these services. The wider adoption of emerging technologies such as robotics and artificial intelligence will likely increase the challenges of climate impact assessments. Such developments highlight the need for increasingly active assessment activities in the future.

This part introduced a novel methodology to assess environmental, especially climate impacts, and the related social impacts of digital healthcare and care services. We also presented the results of our combined quantitative and qualitative assessments concerning the impacts of distance spanning home care services in Finland, focusing on medicine robot services for older people. The study showed how such distance spanning solutions in health care and care can contribute to the green transition. We also gave practical guidance for future impact assessments.

Digitalisation is generally considered a positive measure for the environment. However, at least some negative climate impacts result from every digitalisation action due to the equipment and energy that are needed. Concrete practical tools are required in order to assess the impacts of digitalisation in the field of health care and care. The key results of the case study on medicine robot services offered a multidimensional picture of the impacts of distance spanning solutions, both climate impacts and the intertwined social impacts on clients/patients, care professionals, service organisations and society.

An important lesson for the field of healthcare and care services is that a well-planned and well-implemented digital service is likely to be a climate-friendly option, but the design, architecture and practical implementation of digital services greatly affect their climate and social impacts.

Based on the results, multi-perspective and multi-method impact assessments should be advocated to advance the green transition. In addition to quantitative assessment - and to help interpret its results - a qualitative understanding of digitalisation and its impacts is needed, especially when access to numerical data is limited. A systemic understanding of a service context in which everything affects everything is essential to properly comprehend and advance the entire sustainability mindset in healthcare and care services.

The differences between services and service contexts can be significant. Appropriate policy measures could speed up the proliferation of impact assessments. Conducting climate and social impact assessments in a holistic way will contribute to reaching a more meaningful, optimised balance of the impacts of distance spanning solutions in the future, thereby achieving the strategic priorities of a green, socially sustainable and competitive Nordic region.

Endnotes

1. The definition (scope) of health care can vary across countries and their different service systems. In most instances, health care and care are used side-by-side in this part to also cover elderly care, such as home care.
2. The savings ranged from 0.70 to 372 kg CO2e per consultation but were noted to be highly context-specific. The mode of transport was usually assumed to be a car, but even air travel scenarios were considered. The most comprehensive LCA was found to be the study by Holmner et al. (2014), where it was estimated that the studied telerehabilitation service became carbon cost-effective if the patient travel distance was over 7.2 km.
3. We also studied video call services for older people as well as remote healthcare appointments in dental care, nutritional care and mental health and substance abuse services for children and youth; see Melkas et al. (forthcoming) and Tuominen-Thuesen et al. (2022) for further information. Subsequent sections of this part are partly based on and adapted from the above-mentioned publications.

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PART 2

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Sustainability in digital health care: A new tool for evaluating impacts

The aim of this part is to broaden the perspective on the potential impacts of digitalisation in the Nordic welfare sector, from a narrow focus on climate impacts and carbon footprints to a broader focus that includes social, economic and other environmental dimensions.

A broadened scope reflects the 17 Sustainable Development Goals (SDGs) and the United Nation's 2030 Agenda. These interconnected goals address the global challenges we face, including those challenges related to poverty, inequality, climate change, environmental degradation, peace and justice. The target is to achieve the SDGs by 2030. They are applicable to all countries and integrate social, environmental and economic aspects in a globally agreed vision for a sustainable world.

This is also in line with the Nordic Council of Ministers' Vision 2030 of the Nordic region becoming the most sustainable and integrated region in the world by 2030.

Introduction: Digitalisation of the welfare sector and the potential impacts of sustainability

What kind of sustainability impacts could result from the digitalisation of the health and welfare sector in the Nordics? The Nordic countries make wide use of digital technologies for communication and the delivery of their respective welfare services. The public sectors are among the world's most digitalised.

The vision of the Nordic region comprises three strategic priorities: a green Nordic region, a competitive Nordic region and a socially sustainable Nordic region. Digitalisation has the potential to contribute to all three aforementioned priority areas. However, the widespread use of digital technologies also presents challenges such as inequality in accessing digital services and the environmental footprints of digital transformation. This is resulting in inequality in terms of who actually benefits from the digitalisation of public services. Inequality is known to erode trust in public authorities and is a danger to healthy democracies. The environmental footprint of such a digital transformation is considerable.

In this respect, in its last report, the Intergovernmental Panel on Climate Change (Working Group III, which focuses on climate change mitigation) states: "At present, the understanding of both the direct and indirect impacts of digitalisation on energy use, carbon emissions and potential mitigation [of carbon emissions] is limited."

In 2019 the UN's Special Rapporteur on Human Rights called for attention on the widening gap between the rich and poor as a result of digitalisation.

Digitalisation is widely recognised as a megatrend shaping economy and society and, as a general purpose technology, has impacts across economic sectors and society through automation, digital platforms, AI and cloud computing.

While the literature primarily focuses on the impacts of digital applications (Horner et al., 2016), as seen through the lens of direct and indirect energy and material footprints, relatively less attention is given to the systemic impacts on society, i.e. in terms of social impacts, for example, norms, social trust, misinformation, the digital divide, social inequality, infrastructure access, and economic impacts, for example, jobs, income inequality, trade, productivity, skills, competitiveness. The way in which digitalisation is used to manage or mitigate these impacts is also important (e.g. how policy or regulation should tackle the dynamics of market power, the digital divide and the intended and unintended consequences of AI) (Creutzig et al., 2022).

The Nordic countries have the technological readiness to support the digital transformation in the welfare sector but this also emphasises the urgent need for key stakeholders to prioritise and identify areas of engagement and develop robust action plans. From a sustainability perspective, the areas of engagement and action plans should reflect the various dimensions of the SDGs. The purpose of this chapter is to enhance the understanding of the potential implications of digitalised health care on the different dimensions of the SDGs. This has been conducted in the project - Integrated Healthcare and Care through Distance spanning solutions (iHAC).

To address the above concerns, this chapter examines the digitalisation of health care in the Nordic countries through the lens of the SDGs in model projects in different regions in the Nordic countries – the Agder region in Norway; the Päijät-Häme wellbeing services county in Finland; Fjallabyggd municipality in Iceland; and Tiohundra in Norrtälje, Sweden. To ensure a scope that is broader than the impacts of climate change alone, we rely on the UN's 17 Sustainable Development Goals (SDGs).

Photo 2. The 17 Sustainable Development Goals.

The objectives of the iHAC project are as follows:

1. Gather stakeholders' perceptions of the sustainability of digital healthcare solutions within their various contexts, and identify opportunities and challenges for introducing digital healthcare and care solutions.
2. Introduce a methodology ("SDG Synergies"- see Box 1) to systematically explore the sustainability implications of digital healthcare solutions
3. Explore and map the interactions between a range of digital healthcare and care solutions and a range of social, economic and environmental goals as defined by the Sustainable Development Goals (SDGs).
4. Initiate learning and knowledge sharing between the projects with reference to the 2030 Agenda and the SDGs.

These objectives have been achieved via two activities: first, multi-stakeholder workshops were organised in the model regions to consult stakeholders and mobilise them to participate in the SDG Synergies workshop. This addressed the first objective; the multi-stakeholder workshops were followed by an SDG Synergies workshop that addressed the remaining objectives.

In the following, the process and outcomes of a participatory exercise to systematically explore the socio-economic and environmental impact of distance spanning solutions in health care are described.

The Nordic project Integrated Healthcare and Care through distance spanning solutions (iHAC)

Integrated health care and care with the citizen's perspective in focus is gaining ground in all Nordic countries. Health care and care are offered in people's homes based on their own needs. However, there are challenges in coordinating the service providers due to silo mentality and different areas of responsibility. Digitalisation and remote services are important prerequisites for maintaining the quality of the Nordic welfare model. In addition, digital service models are a necessary first step to creating efficient integrated health care and care. The iHAC project is part of the Nordic Vision 2030's action plan and aims to contribute to the Nordic Council of Ministers' goal of making the Nordic region the most sustainable and integrated region in the world by 2030. However, from a sustainability point of view, it is important to take into account different perspectives.

As the three pillars of the Nordic Vision place emphasis on a green, competitive and socially sustainable society, the 12 indicators that form part of these pillars provide a granular understanding of what this actually means. In this report we refer to the indicators relating to digitalisation, equity and health as part of a green and socially sustainable Nordic region.

Four Nordic model regions

The model regions included in the iHAC project comprise ongoing and planned distance spanning solutions in four Nordic countries – the Agder region in Norway, Päijät-Häme wellbeing services county in Finland, Fjallabyggd municipality in Iceland and Tiohundra Norrtälje in Sweden. These model regions aim to achieve the provision of integrated healthcare and care services supported by distance spanning solutions.

Since 2013, several telemedicine monitoring services have been introduced in the region of Agder with the aim of creating a common technology platform to facilitate procurement, operation and support. These services have been implemented in close collaboration with the Hospital of Southern Norway. The aim is to provide access to a simple and secure comprehensive digital health and care services for all citizens in the Agder region. This is presented in the report Integrated Healthcare and Care through distance spanning solutions – for increased service accessibility.

The home care services for the elderly in the Päijät-Häme region are based on a centralised and inclusive model in which patients are regarded as clients. The innovations in home care services in the region were undertaken in response to challenges linked to limited nursing resources, decreased well-being of health professionals, and the increasing cost of health care and care.

The TioHundra Norrtälje model in Sweden integrates county-operated health care and municipality-operated social care services. This involves a collaboration between Norrtälje municipality, Region Stockholm and Tiohundra AB. The TioHundra collaboration has been running since 2006 with the aim of providing access to health care and care services for all. The TioHundra model consists of an integrated approach to ensure high quality care for patients.

The Fjallabyggð municipality in Iceland is planning to integrate health and social care services. This is a collaboration between the municipality and the state to support the elderly population and provide citizens with a holistic view of their health and well-being.

The SDG Synergies approach: a methodology to explore the socio-economic and environmental impact of distance spanning solutions in health care

In 2015, the UN member states agreed on an ambitious global agenda for sustainable development: the 2030 Agenda. For the first time, a global development agenda was adopted that integrates social, economic and environmental dimensions. The 2030 Agenda states this in an overarching declaration, 17 Sustainable Development Goals (SDGs) with 169 targets and an indicator framework.

This new approach raised the bar for integrated planning and policy coherence, as many of the goals are interlinked. It is often the case that progress on one of the SDGs makes it easier to achieve other SDGs, although this is not always the case and there are some difficult trade-offs which, if left unmanaged, can slow down or even undo progress. Halfway into the implementation period (which runs between 2015 and 2030) the 2030 Agenda also seems to be influencing how policymakers think and communicate about sustainability; it is broadening their view and understanding of the interactions between social, economic and environmental goals.

With the SDGs, demand grew for scientific methods and practical tools that could help decision-makers to navigate the ways in which the various goals interact, as well as how other goals or agendas interact with the SDGs. Such tools could help to avoid the unintended effects (trade-offs) on other policy areas by planned actions, and capture the co-benefits (synergies), thereby using resources more efficiently and ensuring that the outcomes are equitable.

The SDG Synergies tool, developed by researchers at the Stockholm Environment Institute, is one such tool and has been chosen for the participatory exercise described here. See box 1 for an overview.

Box 1. The SDG Synergies approach and tool.

The SDG Synergies approach and tool – what is it?

SDG Synergies is a practical tool for exploring how goals or policy areas interact. It was originally designed to support governments in implementing the Sustainable Development Goals but will help any user to record, visualise and analyse how multiple targets are likely to interact in a given context. It combines a participatory process in which stakeholders assess interactions in a structured way, as well as network analysis to reveal deeper patterns and relationships between goals that would otherwise not have been observed by merely looking at the interactions between targets in a pairwise manner.

In a participatory, discussion-based scoring process, SDG Synergies users develop a cross-impact matrix of interactions based on a simple question: "how does progress on goal x influence progress on goal y?" (repeated for all matrix elements). The completed matrix immediately gives an overview of the direct synergies and trade-offs and, using intuitive controls, it is then possible to explore different aspects of the system. Using advanced network analysis and visualisation capabilities, SDG Synergies can reveal more complex relationships that are the result of how interactions can ripple through the larger system. For example, visualisations and analyses can inform decisions about how to prioritise or sequence the implementation of different targets based on their systemic impact (what gives the most/least support to achieving progress in all the goals), or where measures may be needed to manage potential trade-offs between them. They can also help to identify what cross-sectoral collaborations would be the most productive by showing groups of strongly linked goals.

The scientific basis of the SDG Synergies approach is described in Weitz et al. (2018).

The basic idea is understanding the impact and importance of a goal in supporting sustainability requires systems analysis.

Each application of SDG Synergies is unique. SDG Synergies has been used in a wide range of different settings on a sub-national, national and regional level (EU). The process could involve scientific experts, representatives of different government sectors, and a range of other stakeholders. As well as benefiting from their unique perspectives, this type of inclusiveness can help to build bridges and partnerships between actors and sectors, generating a shared understanding of the challenges and opportunities, highlighting common interests, and building ownership among stakeholders. These outcomes can be just as valuable as the analytical outputs. Showcasing how the approach can be customised, Barquet et al. (2021) summarised three country studies and Carlsen et al. (2022) demonstrated how the SDG Synergies can be used to support systems thinking in the voluntary national review (VNR) process. Helldén et al. (Helldén et al. 2022) showed an application to child health in Cambodia. More examples can be found at www.sdgsynergies.org, where the tool is freely available.

The breadth of the contexts in which SDG Synergies has been applied shows the flexibility of the approach for use in multiple settings. This flexibility is necessary as interactions have been shown to be strongly context-specific; how they play out depends on institutional arrangements, natural resources, economic conditions, governance set-ups, the technological options available, current policies and practices, as well as the prevailing ideologies.

While every application of SDG Synergies is different, tailored to the context, targets and resources available, they all follow the same methodological steps: contextualisation, scoring of interactions and analysis. This was also the case for the applications described in this chapter.

The SDG Synergies approach consists of a three-step process of collaborative analysis:

1. **Contextualisation:** Every application of SDG Synergies is unique, and the way in which the interactions play out depends on the context in terms of institutional arrangements, natural resources, economic conditions, governance set-ups, the technological options available, current policies and practices, as well as the prevailing ideologies. Hence, the goals and targets need to be clearly defined in each application of SDG Synergies.
2. **Scoring interactions:** The selected goals from step 1 are transferred into a cross-impact matrix, in which each matrix element (except the diagonal) is used to score the interactions. The guiding question for the scoring is: "If progress is made towards Target X, how does this influence progress towards Target Y?" In this scoring, a scale is applied ranging from +3: strongly promoting progress towards Target Y, via +2: moderately promoting, +1: weakly promoting, 0: no influence, -1: weakly restricting progress towards Target Y, -2: moderately restricting, to -3: strongly restricting (Weimer-Jehle 2006). In the SDG Synergies tool it is also possible to add text to justify or further explain the selected score. An important feature of this excercise is that stakeholders focus on the direct influence between the targets, whereas the secondary effects are taken care of by the software.
3. **Analysis:** In the third step, network analysis methods are used to relate all interactions in the matrix and analyse how progress towards the different goals could affect the whole system. In this step, catalytic targets are identified, i.e. targets that have a positive effect on the system as a whole. Another useful type of analysis in this step is to identify clusters of positively interacting targets and how they might interact with similar clusters. This could serve as a basis for creating cross-sectoral working groups to enhance the development of joint strategies.

SDG Synergies has been applied to a wide range of different cases on a sub-national level, via national and regional levels to an EU level. Showcasing how the approach can be customised, Barquet et al. (2021) summarised three country studies and Carlsen et al. (2022) demonstrated how SDG Synergies can be used to support systems thinking in a voluntary national review (VNR) process. Helldén et al. (2022) showed the application of SDG Synergies to child health in Cambodia.

More examples can be found at www.sdgsynergies.org, where the tool is freely available. The breadth of contexts in which SDG

Synergies has been applied indicates the flexibility of the approach for use in multiple settings. We describe its application to the iHAC project below.

Multi-stakeholder engagement

In this chapter, multi-stakeholder engagement is described and the insights from the stakeholder workshops are presented. All the model regions also participated in an SDG Synergies workshop in Stockholm.

Multi-stakeholder consultations

Multi-stakeholder workshops were organised in the model regions – Agder, Päijät-Häme, Fjallabyggd and Tiohundra. The aim of these workshops was to understand the baseline of health care and care services including the opportunities and challenges in introducing digital healthcare solutions in the model regions and elaborate on the shared understanding of the sustainability impacts connected to these solutions. The Tandem framework was used to plan these workshops and structure the discussions. The Tandem framework is a tool for co-exploration and co-production (Daniels et al., 2019). The framework offers guidance for achieving the following goals:

- Improve the ways in which all participants work together to purposefully design transdisciplinary knowledge integration processes
- Co-explore the relevant needs, priorities and preferences for the co-production of integrated climate information (i.e. decision-relevant climate and non-climate data)
- Increase individual and institutional capacities, collaboration, communication and networks that can translate this data into climate-resilient decision-making and action

The insights from the multi-stakeholder workshops are varied, as shown in Table 1. However, there are some common aspects reported by most of the model regions.

In terms of opportunities for digitalised healthcare solutions, a reduction in travel distance and therefore also in greenhouse gas emissions was the issue that was raised the most. Access to information and the internet, the ability to manage new technological systems and concerns about privacy and data security were some of the most reported challenges for digitalised healthcare solutions. In terms of the needs and priorities of the model regions, the perspectives of different stakeholders, particularly users or clients, were emphasised by most of the model regions. Environmental, economic, social aspects were evident in what the participants from the model regions generally reported in terms of what sustainability means in their various projects and regions.

Table 4: Insights from multi-stakeholder workshops in the model regions

Model regions	**Opportunities and challenges for distance health and care solutions**		**Project needs and priorities**	**What does sustainability look like in this landscape?**
	Opportunities	**Challenges**		
Agder region, Norway (in person, 17 January 2023)	- Reduced travel distance to hospitals and health centres. - Generous sharing culture. - Trust and high-quality standards.	- Difficulties investing in new technologies. - Information about the services is not adequately disseminated. - Staff in care centres/homes are required to have know-ledge of a wide range of areas. - Concerns regarding privacy and data security.	- Perspectives of users/patients are needed. - Perspectives of politicians and other high-level govern-ment actors are needed. - Perspectives of technology designers are needed.	- Reduction in travel distance and greenhouse gas emissions. - Cost effec-tiveness of technologies. - Engagement of multiple stakeholders.

Päijät-Häme wellbeing services county, Finland (online, 14 February 2023)	- Reduced workload (physical) connected with e-services. - Good communication between service providers and certain client groups. - Reduced travel distance to hospitals and health centres. - A digital leap is possible. - E-services are often more cost-effective than face-to-face services. - With e-services, clients can be more independent and serve themselves.	- Clients need guidance. - Increased requests for services from various clients lead to queuing and overcrowding. - The quality of the digital services provided varies. - Face to face meetings are needed to ascertain the overall well-being of clients. - Costs connected with equipment and connectivity may be a barrier for some clients. - The technical skills of some professionals and clients are a barrier.	- Different types of services are needed for different groups of clients.	- Occupational safety, health and general well-being of staff. - Attractiveness of workforce in home care services.
Fjallabyggð Municipality, Iceland (online, 5 June 2023)	- New technology is being tried out to serve as a model for other municipalities. - Emphasis is on the integration of existing services rather than the creation of new services.	- There is a disconnect between the state and the municipality in the provision of healthcare and care services.	- Strengthen collaboration, sharing and learning between the healthcare and care sectors.	- Emphasis is on sustainable funding and consideration of the vulnerable segments of society e.g. the elderly.

TioHundra Norrtälje, Sweden (in person, 17 May 2023)	- Reduced travel and the production of greenhouse gases. - Increased opportunity to serve more clients. - Reduced stress among service providers. - Opportunity to conduct several checks on patients at night. - Some patients, for example, those with dementia, feel safer with digital surveill-ance during the nighttime.	- Access to electricity and internet connectivity need to be reliable. - Shared responsibility in operating and managing the system – between patients or clients and service providers. - Surveillance cameras are currently only operational during the nighttime.	- Explore the possibilities of providing 24/7 monitoring of patients. - Gathering of good data during supervision is key to the continuous improvement of services. - Ensure that users in rural and urban settings have the same possibilities and experience of the system.	- Avoid unnece-ssary travel (reduce green-house gas emissions). - Create good working conditions. - Avoid accidents linked to driving. - Create good working conditions and retain staff. - Introduce and maintain cost-effective supervision of patients.

SDG Synergies workshop

Following the multi-stakeholder workshop, the SDG Synergies workshop was held at the Stockholm Environment Institute (SEI) with representatives from all the model regions. The objective was to let the participants test the SDG Synergies approach, familiarise themselves with the type of insights it can generate and start to broaden their perspectives on the sustainability impacts of distance spanning healthcare solutions.

Photo 3. Instructions to the participants at the iHAC workshop at Stockholm Environment Institute.

The workshop followed the three standard steps of the SDG Synergies approach referred to in Box 1:

Step 1 - Contextualisation: The goals and targets (whether or not they are related to the 2030 Agenda) are selected and defined in order to set the boundary for the exercise in terms of its scope and identify the relevant stakeholders. This step was conducted ahead of the workshop.

For our exercise, the following distance spanning health solutions were included and presented to the participants:

1. **Use of medicine robot services:** Medicine robot services can ensure that the user receives the correct medication at the right dose and at the right time. The user is notified via audio and light signals, as well as by information on the robot's display, when it is time for them to take their medication. It can allow the user to become more independent with their medication, increase compliance with their medication and can also mean fewer staff journeys. The robot can also help to reduce problems regarding skills provision and streamline home care activities.
2. **Use of digital night monitoring:** Digital night monitoring can replace potentially disruptive visits by night patrols to supervise elderly people. A surveillance camera and a mobile router are installed in the user's home and allow for better matching to their unique needs compared to pre-scheduled visits. An assistant nurse at a central unit in the municipality performs online checks at specific times of night. The time required to conduct online checks is considerably less than physical visits.
3. **Use of smart video technology:** Smart video technology is used as a tool to move care closer to the patient - from the hospital to the health centre and from the hospital/-health centre to self-care. For example, it enables residents living in sparsely populated areas to meet a doctor remotely at their local health centre. A nurse examines the patient, takes samples, where applicable, and can contact the hospital's on-call doctor who then talks with and examines the patient via a video link.

The following 7 SDGs were selected:

- SDG 3. Good health and well-being
- SDG 5. Gender equality
- SDG 6. Clean water and sanitation
- SDG 8. Decent work and economic growth
- SDG 10. Reduced inequalities
- SDG 12. Responsible consumption and production
- SDG 15. Life on land

19 experts participated in the workshop, representing all four regions and stakeholders as citizens, staff in health care and social services, researchers, digital service experts, change management consultants and managers.

Step 2 - Scoring interactions: The selected goals and solutions from step 1 had been transferred into a cross-impact matrix in the online SDG Synergies tool. The participants were divided into five groups in which they worked to assess a part of the matrix.

The tool guides participants through the matrix, asking them the guiding question for each interaction: "If progress is made towards Target X, how does this influence progress towards Target Y?" Participants referred to a scale ranging from +3: strongly promoting progress towards Target Y, via +2: moderately promoting, +1: weakly promoting, 0: no influence, -1: weakly restricting progress towards Target Y, -2: moderately restricting, to -3: strongly restricting (Weimer-Jehle 2006), and select a score based on their discussions. They were encouraged to add text to justify or further explain their selected score. An important feature of this step was that the participants focus on the direct influence between targets only, whereas the secondary effects are taken care of by the software of the SDG synergies tool. The SEI team was available throughout the group discussion to clarify questions and provide technical support.

Step 3 - Analysis: Following the scoring, the SEI team ran the network analysis to relate all interactions in the matrix and show the participants how progress towards the different goals could affect the whole system. Following the scoring, the participants had a joint discussion on the preliminary findings. Figure 10 shows the complete matrix with inputs from each group.

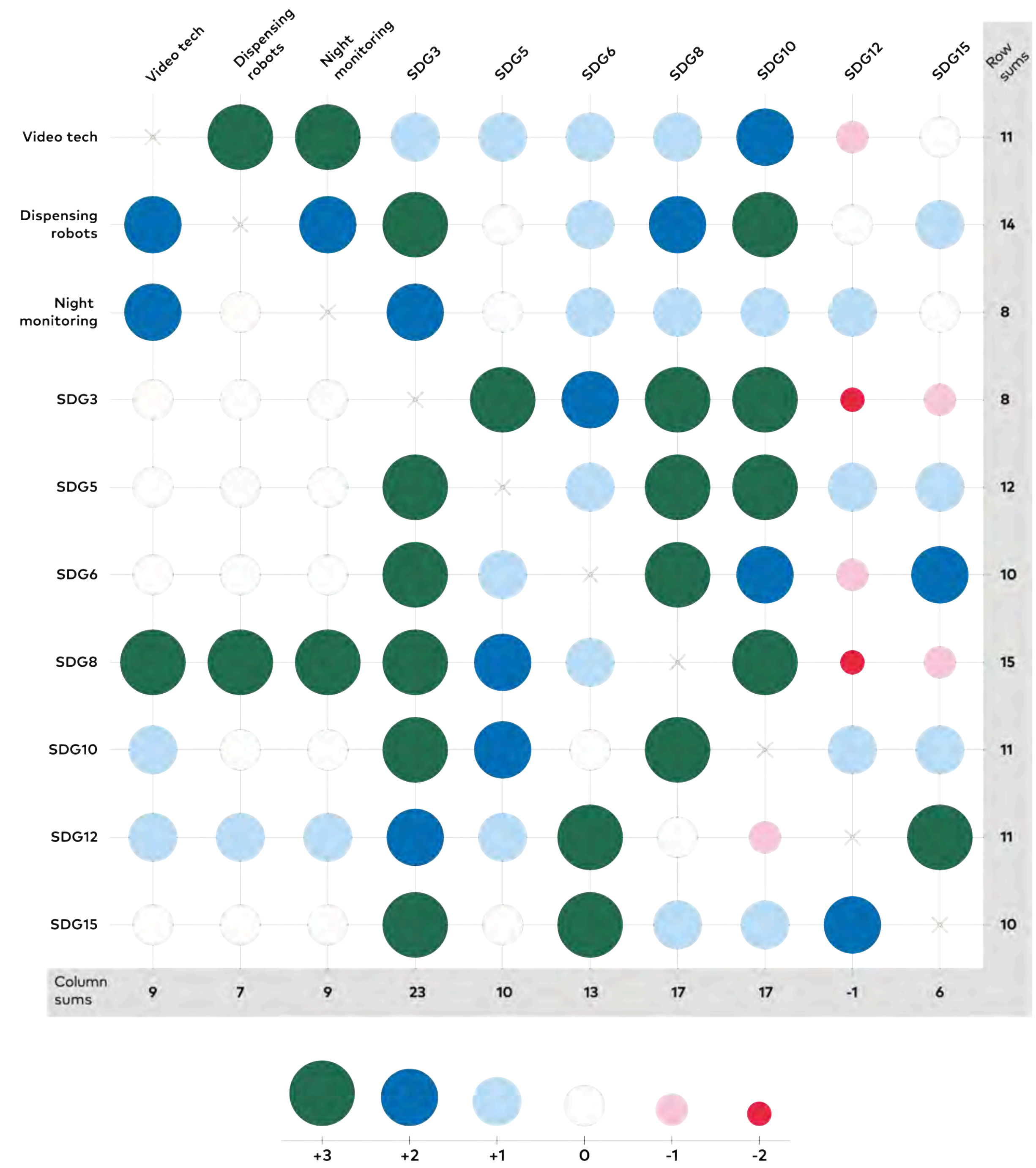

Figure 10: The cross-impact matrix collecting all scores. The colour codes are as follows (cf. Step 2 above in the process description): Red: -2, Pink: -1, White: 0, Light blue: +1, Blue: +2 and Green: +3. The row sums (11, 14, 8, etc.) show the first order influence of each goal on all other goals. The column sums (9, 7, 9, etc.) show how each goal is influenced by progress on all other goals (first order).

The participants discussed their respective strategies within their regions and with the other regions represented at the workshop. The task was to score how these strategies impacted the progress of the SDGs and to see where the interactions, synergies and trade-offs occur.

At first glance, the matrix shows more blue (positive) elements than red or yellow (negative) elements, suggesting that there were more synergies than trade-offs between the matrix elements. We can also see where critical trade-offs and strong synergies sit. Only seven trade-offs were identified but these merit discussion We also note that the matrix is relatively dense, i.e. there are few interactions that were assessed as non-existent (grey).

The numbers to the right of and below the matrix show the row sums and column sums, respectively. The row sums can be interpreted as an indication of a goal's influence on all other goals. The column sums can be interpreted as an indication of how each goal is influenced by all other goals. For example, SDG 8 has the strongest positive influence overall, but also shows trade-offs with some goals.

Importantly, the row and column sums only include the direct effects between the goals, and to understand the impact of a goal we need to look more deeply into the network and include the secondary effects. For example, a goal that positively influences another goal which, in turn, has many and/or strong positive connections, can have significant systemic impact, whereas in contrast, the positive influence on a goal which, in turn, has a negative influence on many other goals, can be negative. A high number of strong positive connections to other goals with the same characteristics generate a high and positive multiplier effect, while a strong positive connection to a goal which, in turn, exerts a negative influence on other goals, generates a negative systemic impact. On the other hand, if the affected goal has few and/or weak positive connections, the positive effect quickly diminishes without having much systemic effect. Below we present the five highest ranking goals from three different perspectives.

Systemic impact. This ranking shows the five goals with the strongest positive systemic impact (secondary effects included). These goals can be seen as catalytic because promoting progress in them would have positive effects on the system as a whole.

1. Decent work and economic growth (SDG 8)
2. Dispensing robots
3. Gender equality (SDG 5)
4. Reduced inequalities (SDG 10)
5. Video tech

Most supported goals. This ranking shows the goals that are most positively influenced by the progress made in other goals (secondary effects included). These goals may need less direct support to enable progress, as they benefit from the progress made in other goals.

1. Good health and well-being (SDG 3)
2. Decent work and economic growth (SDG 8)
3. Reduced inequalities (SDG 10)
4. Gender equality (SDG 5)
5. Clean water and sanitation (SDG 6)

Least supported goals. This ranking shows the goals which are the least positively influenced by the overall progress. They may need extra support to enable progress, as they are not influenced by the progress made in other goals and can even be restricted as other goals progress.

1. Responsible consumption and production (SDG 12)
2. Life on land (SDG 15)
3. Dispensing robots
4. Night monitoring
5. Video tech

Finally, the SDG Synergies tool can identify clusters of goals that are strongly interconnected. These clusters can be used to set up cross-sectoral (cross-goal) collaborations as they comprise goals that promote each other and therefore enable overall progress.

Conclusions of part 2 and recommendations based on the SDG Synergies Tool assessment

The Nordic countries are committed to transforming healthcare and care services to address the major challenges they are facing within this sector. Digitalised health care and care is currently being promoted as part of the solution to reach people wherever they live and, most importantly, in remote locations.

The Nordic countries are poised to be at the forefront of innovations in the transformation of the healthcare sector due to the high level of digital maturity in these countries. However, as this chapter shows, to build and support digitally enabled, data-driven, integrated and sustainable health systems, emphasis needs to be placed on understanding the environmental, social and economic implications of digitalised healthcare and care solutions on society. The implications in terms of a reduction in CO2 emissions, as well as the productive time saved, have been well recorded. However, this narrow perspective is not sufficient to enable the sustainable transformation of the sector.

As this chapter shows, a broader perspective is needed to ascertain the implications of digital healthcare solutions on other environmental and socio-economic factors, and how these solutions contribute to a green transition that is inclusive and sustainable. This includes a sustainable livelihood and access to health care services for vulnerable and disadvantaged communities. The insights from the multi-stakeholder workshops in the various model regions reveal that there is a good understanding among the stakeholders about what sustainability entails in the contexts of the model regions. Apart from a reduction in the impacts of climate change, the stakeholders highlighted issues related to safe work conditions, cost effectiveness, stakeholder engagement and inclusion and equality. The SDG Synergies exercise identified both trade-offs and synergies with respect to issues such as economic development, biodiversity and resource rights, consumption and production, and gender equality.

Identifying trade-offs and synergies

From a conceptual perspective, the SDG Synergies exercise shows how trade-offs and synergies between the goals can be identified to inform planning and design. The results of the exercise reveal that to achieve systemic impact, decent work and economic growth (SDG 8), gender equality (SDG 5) and reducing inequality (SDG 10) can be considered catalytic since promoting them would have positive effects on the system as a whole. Other goals such as good health and well-being (SDG 3), decent work and economic growth (SDG 8), reduced inequalities (SDG 10), gender equality (SDG 5) and clean water and sanitation (SDG 6) are most positively influenced by progress in other goals. Above mentioned goals may need less direct support to achieve progress, as they benefit from the progress made in other goals. Lastly, goals such as responsible consumption and production (SDG 12) and life on land (SDG 15) are least positively influenced by the overall progress as they are not influenced by the progress made in other goals. Consequently, these goals require specific emphasis to enable progress. From a research point of view, the trade-offs and synergies between the SDGs in relation to digitalised healthcare solutions need to be empirically examined. This area has not been explored and warrants further research.

Our findings tie in with the 12 indicators of the Nordic Vision 2030, linking specifically with the recommendations on a digital economy and society – allowing for a competitive Nordic region in which inequity does not hold back any demographic segment or region, as well as including indicators on social trust and societal exclusion. This was highlighted in our synergies workshop, which explored the interactions between these variables. As it is open source and freely available to all organisations, the SDG Synergies tool allows for further investigation into the design of pathways towards the realisation of the Nordic Vision 2030. We recommend that the multi-stakeholder engagements on the interactions of the SDGs be taken forward with all the stakeholders identified across the Nordic regions.

Afterword

The Nordic region has the ambitious goal of become the world's most sustainable and integrated region by 2030. This calls for action to fulfil the established goals of becoming a socially sustainable Nordic region based on good health and well-being, gender equality and reduced inequality, in combination with a green Nordic region based on sustainable consumption and production, and combating climate change.

Achieving the Nordic Vision 2030 requires measures to promote a green transition in the Nordic countries, working towards achieving carbon neutrality, fostering green growth based on knowledge, innovation, mobility and digital integration, and enhancing social sustainability by ensuring good, equal and secure health and welfare for all. Distance spanning solutions in Nordic health care and care are closely aligned with this vision and each strategic priority.

The Nordic countries' initiative to transform the healthcare and care services is a testament to their commitment to addressing the significant challenges in the sector. The ongoing promotion of digitalised health care aims to ensure accessibility for all, especially those living in remote areas. The Nordic region's high level of digital maturity positions it as a leader in healthcare innovation. However, building and supporting digitally enabled, data-driven, integrated and sustainable health systems require a comprehensive understanding of the environmental, social and economic implications of digital healthcare solutions on society.

Stakeholders need a broad perspective on sustainability

While a reduction in CO_2 emissions and the saving of productive time are well-documented benefits, a narrow focus on these metrics alone will not be enough to achieve a sustainable transformation of the sector. A broader perspective is essential to understanding the implications of digital healthcare solutions on other environmental and socio-economic factors and their contributions to a green transition that is inclusive and sustainable. This includes ensuring sustainable livelihoods and access to health care services for vulnerable and disadvantaged communities.

The insights from the multi-stakeholder workshops that were held across the various model regions indicate a solid understanding among stakeholders of what sustainability means in their respective contexts. Beyond reducing the impacts of climate change, the stakeholders emphasised safe working conditions, cost-effectiveness, stakeholder engagement, inclusion and equality.

The SDG Synergies exercise revealed trade-offs and synergies concerning economic development, biodiversity, resource rights, consumption and production, and gender equality.

A holistic approach is needed

In conclusion, the Nordic Welfare Centre and its collaboration partners – the Centre for Rural Medicine – Region Västerbotten, Lappeenranta-Lahti University of Technology, the Finnish Environment Institute and the Stockholm Environment Institute – posit that distance spanning solutions could have a positive impact on CO2 emissions but also that transforming the healthcare sector in the Nordic countries through digitalisation requires a holistic approach that considers the environmental, social and economic dimensions.

The collaborative efforts and insights gained from the stakeholders across the region highlight the potential for digital healthcare solutions to make a significant contribution to the sustainable development goals, provided that trade-offs and synergies are carefully managed and addressed.

Continued research and stakeholder engagement will be crucial in advancing the objective of fostering a holistic perspective that considers the environmental, social and economic dimensions and ensuring that the benefits of digital health innovations are equitably distributed.

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