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RESEARCH

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Sustainability in the care sector in Germany: introducing the MORE model for ESG and digitalisation

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Abstract
The use of digital technologies plays a pivotal role in enhancing sustainability performance in the care sector. However, their application in advancing ESG (Environmental, Social, and Governance) criteria remains underexplored. This is particularly true in relation to environmental sustainability, labour conditions, and governance structures. In addition, the wide range of possible combinations between digitalisation, care settings, and sustainability dimensions makes systematic analysis difficult.

This study addresses this gap by conducting a structured literature-based analysis and developing a new model for practical application. It examines how digital technologies influence ESG aspects within care institutions, focusing on their impact on environmental performance, social working conditions, and governance frameworks.

Findings reveal that the use of digital systems in care entails both opportunities and risks. Technological solutions may support resource efficiency, improve transparency, and alleviate workforce burdens, but may also generate environmental costs, raise surveillance concerns, or exacerbate social inequalities. A balanced and context-sensitive approach is essential for responsible implementation.

To support systematic analysis and practical decision-making, the study introduces the MORE model (Monitoring, Optimising, Rebalancing, Embedding)–a novel visual and analytical framework. The model allows for evaluating and guiding how digital solutions interact with ESG dimensions across various care settings, offering a flexible tool to promote sustainable innovation in the care sector.

Keywords Care sector, Digitalisation, ESG, Governance, Robotics, Social sustainability, Sustainability

JEL Classification I19, I15, J24, J28

1 Introduction

The use of digital technologies, robotics, and artificial intelligence (AI) in the care sector is the subject of ongoing political, social, and public debate [10, 29, 45]. However, digitalisation is seen as an opportunity to overcome the challenges in the care sector, which include the general challenges of climate change, demographic change, an ageing society, staff shortages and the increasing number of people in need of care, [27]. The term digitalisation encompasses the broad field of robotics, technical assistance systems, wearables, tracking systems as well as electronic documentation and planning. AI, in the form of automated machine learning, can support various systems [68].

The different segments of the German care system are all affected by the challenges. The care sector in Germany is part of the healthcare system and comprises inpatient, day-care, and outpatient services [65]. Each area includes both short-term and long-term care. The outpatient sector is also subdivided into professional care and relative carers [65]. The care setting, regardless of whether inpatient or outpatient, long-term or short-term, is directly related to or dependent on other areas of the healthcare system, such as the medical sector, pharmacies and suppliers [7].

For the general healthcare sector, ESG criteria and current technological developments are already in use to achieve sustainability [61]. Environmental (E) sustainability, social (S) responsibility, and effective corporate governance (G) are essential components of sustainable development in care [30]. From an economic perspective, it is also necessary to address the challenges of sustainable management in the care sector [46, 62].

1.1 Background

The areas of application for the use of modern technologies in care can be divided into the categories of digitalisation, artificial intelligence, technical assistance systems, telecare and (social) robots [17].

Digitalisation is defined by the automated conversion of analogue data in whole or in part into a digital model of reality and the term 'digitisation' is used when analogue service provision is replaced in whole or in part by service provision in a digital, computer-manageable model [71].

Artificial intelligence (AI) can, to a certain extent, act independently of human intervention [25].One characteristic of AI is the ability to derive models, algorithms or both from input or data [25]. AI is typically based on neural networks, including machine learning and supervised machine learning [70]. It is also machine-based and is either physically integrated into a product or serves the function of the product without being integrated into it [25].

Technical assistance systems in care are support systems such as sensor mats, lifters, intelligent floors and electronic pill dispensers and can be used to support nursing care [33].

Telecare offers the opportunity to visit patients in their familiar setting via networked tele-robots, smartphones or tablets and to provide them with nursing advice and support [31].

Robots are designed to take over human labour and facilitate work processes [3]. They can also change their location and move three-dimensionally in space. They are called care robots when they support or take over care services [6]. Social robots are characterised by the fact that they interact with humans and react to human behaviour. These robots are offered in animal, mythical creature or anthropomorphic form and are designed to promote interaction, communication, community and connection [43].

1.2 Objectives and research questions

The aim of this thesis is to present the effects of digitalisation on the sustainability of care, the future technical possibilities for supporting care through digitalisation and the opportunities and risks involved.

2 Research questions:

- What impact does the use of modern technologies have on the sustainability of care in terms of the ESG?
- What opportunities and risks related to ESG can be expected in the care sector as a result of digitalisation?

3 Method

To answer the research question, a comparative analysis was chosen as the method for the theoretical work. This analysis compares the areas of ESG, digitalisation, and care settings with all its supply variations, and develops a theoretical model [20]. A systematic literature search was carried out in advance of the comparative analysis to form the basis for the theoretical work. The search strategy was aiming to retrieve as many relevant results as possible [37]. The literature search (Table 1), which was carried out in advance of this work, using the identified keywords 'artificial intelligence', 'digitalisation', 'robotics', 'care', 'health', 'sustainability', and 'ESG' in various combinations and synonyms, connected by the Boolean operators AND and OR [13], was conducted in OPAC and concluded in PubMed, SpringerLink and CINAHL databases. In addition, a search was carried out on the Internet using the search engines Google and Google Scholar as well as a manual search.

The study included full-text publications from the last 10 years, comprising scientific articles and reports by organisations in the field of care and technology. The exclusion criteria were publications unrelated to care or sustainability and purely technical studies

Table 1 Literature research

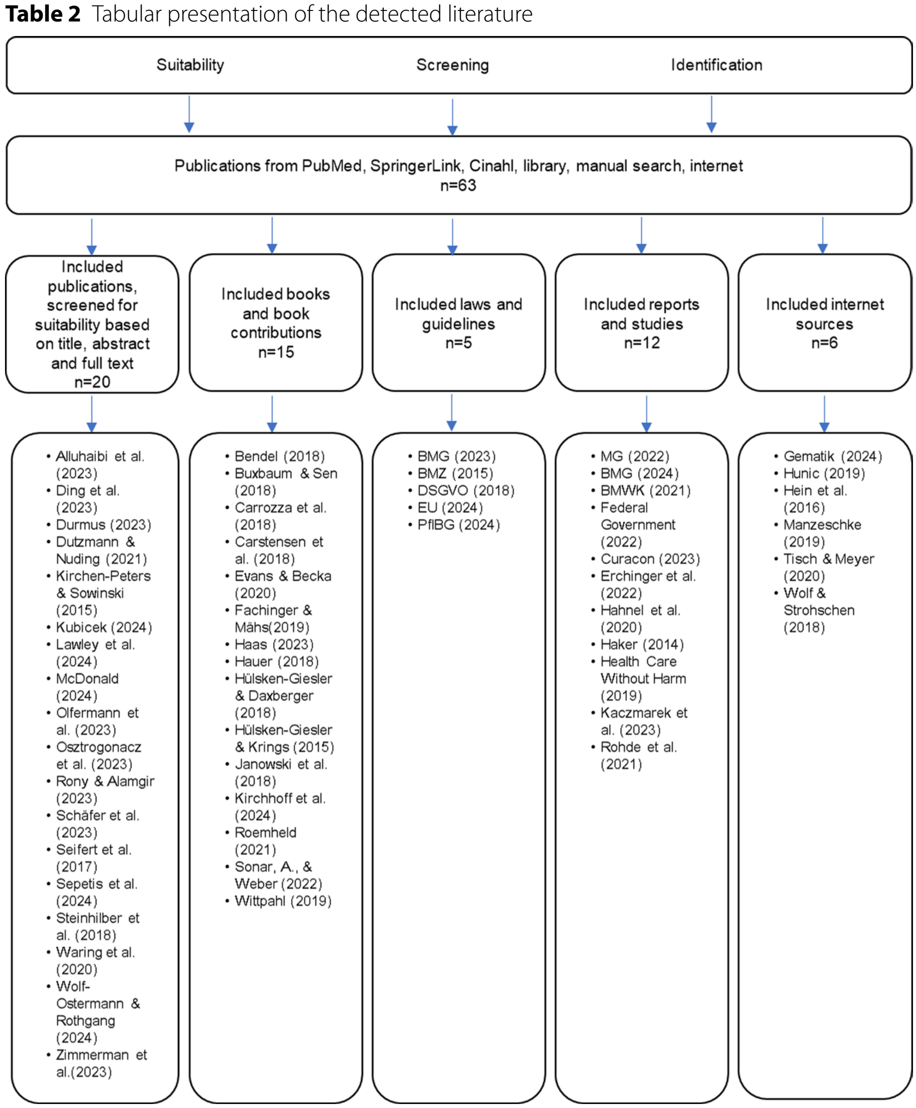
Date of search 12.11.24
Via OPAC: full text only, last 10 years, languages German and English
Sustainability 329.760
sustainability OR Nachhaltigkeit 340.654
(sustainability OR Nachhaltigkeit) AND ESG 2.321
((sustainability OR Nachhaltigkeit) AND ESG) AND Health* 107
After abstract reviewing n = 58
After full text reviewing n = 28
artificial intelligence or ai or a.i. or machine learning or deep learning 722.019
artificial intelligence or ai or a.i. or machine learning or deep learning or robotic or digitalisation 725.088
(artificial intelligence or ai or a.i. or machine learning or deep learning or robotic or digitalisation) and ESG 231
((artificial intelligence or ai or a.i. or machine learning or deep learning or or robotic or digitalisation) and ESG) and health* 18
After abstract reviewing: n = 7
After full text reviewing n = 7
Additional:
Internet research:
Laws an guidelines n = 5
Internet, sources n = 18
Manual search:
Books n = 7

unrelated to ESG. The identified literature was also examined using the snowball method to find additional relevant sources [13]. Studies that were not relevant to the care setting were excluded. The tabular presentation of the detected literature can be seen in Table 2 below.

Studies were included that primarily addressed nursing and care topics or contained a high proportion of caring-related content. Furthermore, the studies had to focus on sustainability and ESG aspects in this context and consider the use of digitalization or technical systems that support nursing practice. A prerequisite for inclusion was the availability of the full text in German or English. Studies whose research design or content did not align with the defined research question were excluded.

In order to capture care as an integral part of the German healthcare system and to illustrate the importance of digital technologies for improving sustainability performance in this cross-sectoral industry, this paper includes the entire care sector in its analysis, including clinical, inpatient, outpatient, rehabilitative and palliative care, as well as preventive services [54]. It examines the opportunities and risks of digitalisation, taking into account the specific effects of climate change, demographic change, the shortage

Table 2 Tabular presentation of the detected literature



of skilled workers and the growing number of people in need of care in the individual areas of care.

In order to comprehensively assess the opportunities and risks of digital technologies in the ESG context, different areas of care were included in the analysis. The selection is based on the particular relevance of these areas to ESG criteria, as they differ in terms of their environmental footprint, social requirements such as working conditions, quality of care and the needs of the target group, as well as their specific regulatory framework with regard to governance, data protection and interoperability.

This methodological approach enables a holistic assessment of the sustainability impacts of digital technologies. By taking industry-specific differences into account, both potentials and risks are precisely identified and systematically classified along the ESG dimensions.

As a result, digital technologies, technical assistance systems, robotics and artificial intelligence (AI) are considered along the ESG criteria [46]. The results are presented graphically in circular models, illustrating the intersections among the three main pillars of sustainability: E, S, and G [24].

In the next step, the results will be discussed according to the topics of digitalisation, AI, technical assistance systems, telecare and robotic systems and translated into a three-dimensional model for assessing the opportunities and risks associated with ESG and digitalisation in the care sector.

4 Results

ESG guidelines, as a framework for companies, define environmental sustainability, social responsibility, and good corporate governance more concretely and are intended to support the development of more sustainable and socially acceptable business models ([46]. The impact effects of digitalisation, AI and robotics on the sustainability of care in terms of the ESG criteria are presented below.

4.1 Impact of digital technologies on environmental sustainability

The aspect of the environment (E) is considered from two directions in the context of digitalisation in care, from the perspective of global warming and climate change and from the perspective of the effects on human health [51, 55]. The health-related effects include stress due to overheating, exhaustion and circulatory stress, increased allergies, but also the increase in infectious diseases new to our latitudes and their transmission routes [50, 52, 55, 58]. Climate change and environmental aspects include greenhouse gas (GHG) emissions, energy and resource consumption, water consumption, waste generated and drug administration [46].

Around 42% of the GHG footprint of the German healthcare system is attributable to the areas in which nursing care is involved. Of this, 36% is attributable to the day-care and inpatient sector and 6% to outpatient care [7]. By incorporating digital technologies, technical assistance systems, robotics and AI, a fundamental transformation of the system is to be driven forward in order to reduce both the negative impact on human health and the climate footprint [12].

The global climate footprint of the care system can be categorised under Scope 1, 2, and 3 [34]. Scope 1 comprises locally burnt solid and fossil fuels, Scope 2 electricity, steam, heating and cooling purchased from energy suppliers and Scope 3 emissions outside the company's sphere of influence, such as via supply chains [7].

4.1.1 Scope 1: Locally burnt solid and fossil fuels

With an average of 7.4 tonnes of CO_2 emissions per care place per year, care facilities alone offer considerable climate protection potential and could save around 15% or 1.1 tonnes of CO_2 per place through energy-saving measures [11]. Comprehensive digital recording of data on energy requirements and the buildings in which care takes place can use AI-supported networking and statistics to identify potential energy savings and help prioritise their implementation. Based on this data, targeted savings could be made by refurbishing buildings and reducing or even eliminating the use of solid and fossil fuels burnt on site [69]. AI-supported temperature control can increase those savings. Since the cost bearers do not currently classify energy refurbishment as an operationally prioritised necessity, there are currently financial obstacles to the necessary investment measures [18]. These measures would be necessary due to the indirect effects on the health of staff and care recipients, such as stress caused by overheating, exhaustion and circulatory strain [46].

In the German healthcare sector, a more climate-friendly nutrition and energy supply as well as efficient travel routes for staff and patients could save over 900,000 tonnes of CO_2 per year [11].

In outpatient care services, the use of telecare to support care via networked technical systems such as robots, social robots, smartphones or tablets can be offered and help to save on travelling distances to care recipients and act independently of location [31]. Care visits and consultations can thus be carried out online and conveniently from home [53]. In addition, even in structurally weak areas with long distances, targeted care contact is possible without long journeys [31].

4.1.2 Scope 2: Power purchased from energy suppliers

Digital and intelligent technical solutions help to save energy locally, regardless of energy-efficient user behaviour. This includes smart electricity grids as well as the installation of energy-saving appliances, automatic heating controllers, energy-saving lighting concepts such as daylight-dependent lighting, the use of LED lighting or motion detectors [18]. Intelligent water supply systems check water pipes for leaks and unnecessary water flows can be detected [18].

The switch to digital documentation saves paper, which has an impact on both production and disposal [18].

AI-optimised waste management and optimisation of recycling are important for the aspect of waste separation, waste incineration and the amount of waste generated in the healthcare system [9].

Intelligent handling of medication orders with a view to expiry as well as reducing the consumption of disinfectants and cleaning agents is necessary for environmental protection reasons [9].

4.1.3 Scope 3: Emissions outside the company's sphere of influence

Disruptions in the global supply chain can delay the delivery of critical raw materials, driving up energy consumption and costs [48]. Such disruptions are often due to ESG regulations rather than geological or spatial scarcity [48]. AI-controlled material procurement, ordering, warehousing and supply chains can save and optimise transport routes and reduce the need for storage [44]. The application of geospatial risk mapping c a central problem with digitalisation in care is data protectionould help care facilities to systematically consider social and environmental standards in procurement to ensure both quality and ethical accountability [48].

Resource planning and internal hospital logistics are key factors for the smooth running of patient care [44]. However, currently used scheduling systems reach their limits, especially in the event of resource bottlenecks or complex, time-critical requirements [44]. Therefore, it is necessary to secure the continuous supply and delivery of medicines and disinfectants [9]. AI will enable flexible and adaptive control through machine learning and data-based decision-making processes and thus shorten transport, waiting and handover times, ensure patient care and relieve the burden on nursing staff [44].

Graphical representation of the impact of digital technologies on environmental sustainability in the care sector in Fig. 1:

4.2 Impact of digital technologies on social conditions

Social (S) sustainability is important the perspectives of different stakeholders and includes the topics of employee orientation and promotion, respecting the interests of stakeholders, promoting diversity and inclusion, ensuring safety in the workplace,

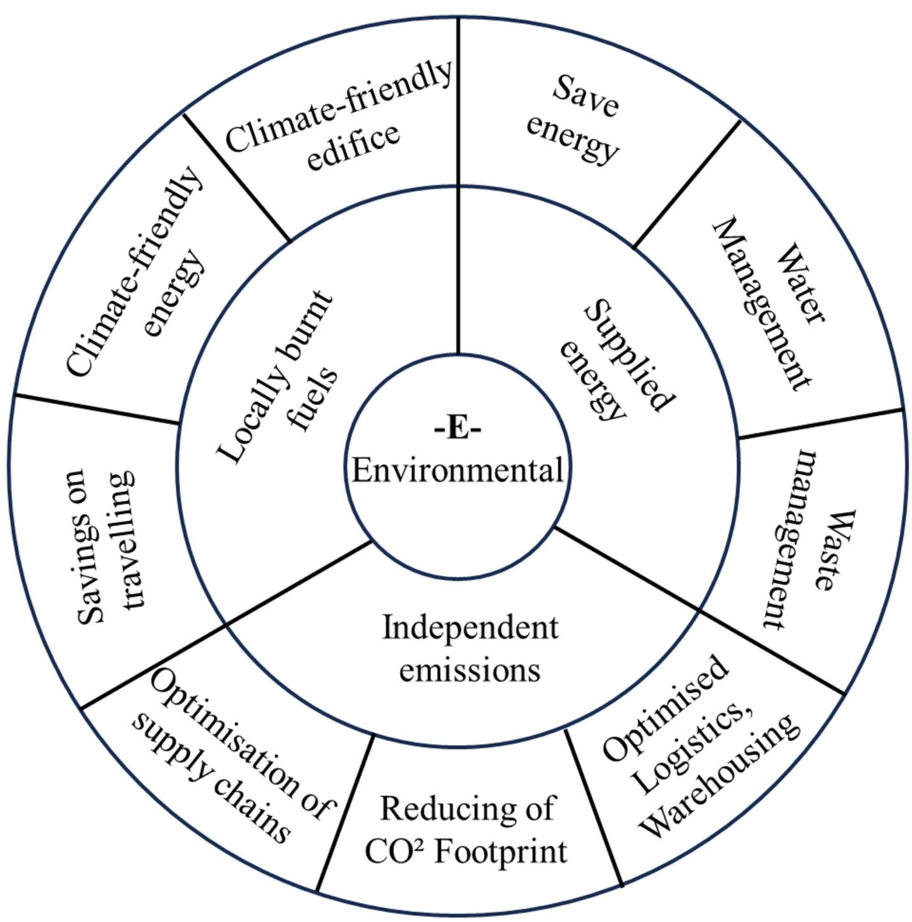


Fig. 1 Impact of digital technologies on environmental sustainability in care (*Source* own presentation)

respecting human rights and promoting positive customer relations [2, 46]. Employees, patients, relatives, suppliers and society are seen as stakeholders for whom digitalisation, robotics and AI offer considerable potential for improving working conditions and care provision [27, 59]. The use of these technical systems is intended to optimise care processes, facilitate documentation, make business practices transparent and ethical, improve the quality of care, increase patient safety and reduce the workload of nursing staff [46].

4.2.1 Sustainable optimisation of care and self-determined life

The targeted use of digitalisation, such as healthcare apps or wearables, tracking or robotic systems, can improve patient care and safety as well as working conditions in the sense of smart organisation or smart home [16, 47, 53]. Health apps, wearables or tracking systems are seen as supportive tools in the care sector due to the possibility of simplified recording of vital parameters, patient data or location, and can serve patient safety by transmitting and documenting the measured data to a health service for remote monitoring [60]. Sensor mats recognise movement patterns, smart floors register and report falls and electronic pill dispensers remind patients to take their medication and administer the correct dosage. Patient-related emergency call bracelets, motion detectors, GPS signals and alarm sensors on doors support mobility, independence and the execution of movements [33]. An alarm can be triggered in the event of danger by pressing an emergency call button or is automatically activated when an area defined as a protective environment is left [60].

4.2.2 Improving working conditions

There are numerous approaches to improving working conditions in the care sector. The often-criticised framework conditions include working hours, shift work, physical and mental stress, unreliability in leisure time planning, unclear responsibilities, and limited opportunities for further development [2, 4].

The targeted use of AI, technical assistance systems, digitalisation and robotics can improve these framework conditions and relieve nursing staff of physically repetitive and administrative tasks [31]. Relief in physically demanding work can be provided by exoskeletons, lifts or transport robots, for example, while administrative, repetitive and interactive tasks can be performed by AI, social robots, or combinations of these. Monitoring activities, in turn, can be handled by technical assistance systems and wearables [32, 42, 43, 60, 64, 67].

Digital technologies and AI offer opportunities for information processing, documentation, organisation and communication in nursing [44]. They can increase efficiency, effectiveness and quality by sorting, coordinating and improving workflows as well as creating synergy effects [27]. With networked documentation and verified access to patient data, time can be used for patient care instead of multiple documentation. This increase in efficiency can be achieved through electronic patient records and AI-supported tools if they ensure fast, complete and secure availability of patient data [27].

4.2.3 Transparent procedures, quality of care and ethical perspective

Synergy effects through information transparency and changes to work processes and organisation can lead to more efficient workflows. Digital technologies, which can be used in information processing, documentation, organisation, networking and communication in care in a variety of contexts to increase efficiency, effectiveness and quality, influence the professional image and self-image of nursing staff [27]. When using these technologies, the focus must be on high-quality care, which is based on complex, situational decisions based on the individual life situation and personal needs of those in need of care. Digitalisation should support care professionals without replacing them [72]. The use of technical systems also requires technical expertise and continuous training in order to ensure patient safety and high-quality, patient-centred care [19, 27]. An ethically reflected and structured implementation of the new technology is also important in order to discuss possible undesirable consequences in advance in a solution-oriented manner [49].

Graphical representation of the impact of digital technologies on social conditions in the care sector in Fig. 2:

4.3 Influence of digitalisation on governance structures

Governance (G) ensures accountability and integrity and helps to meet legal requirements, mitigate reputational risks and recognize changing consumer preferences at an early stage [46]. Governance in the sense of good leadership in nursing strengthens the independence of the professional group and places emphasis on nursing-specific organisational, control, regulatory and financing logics when using digital technologies [26].

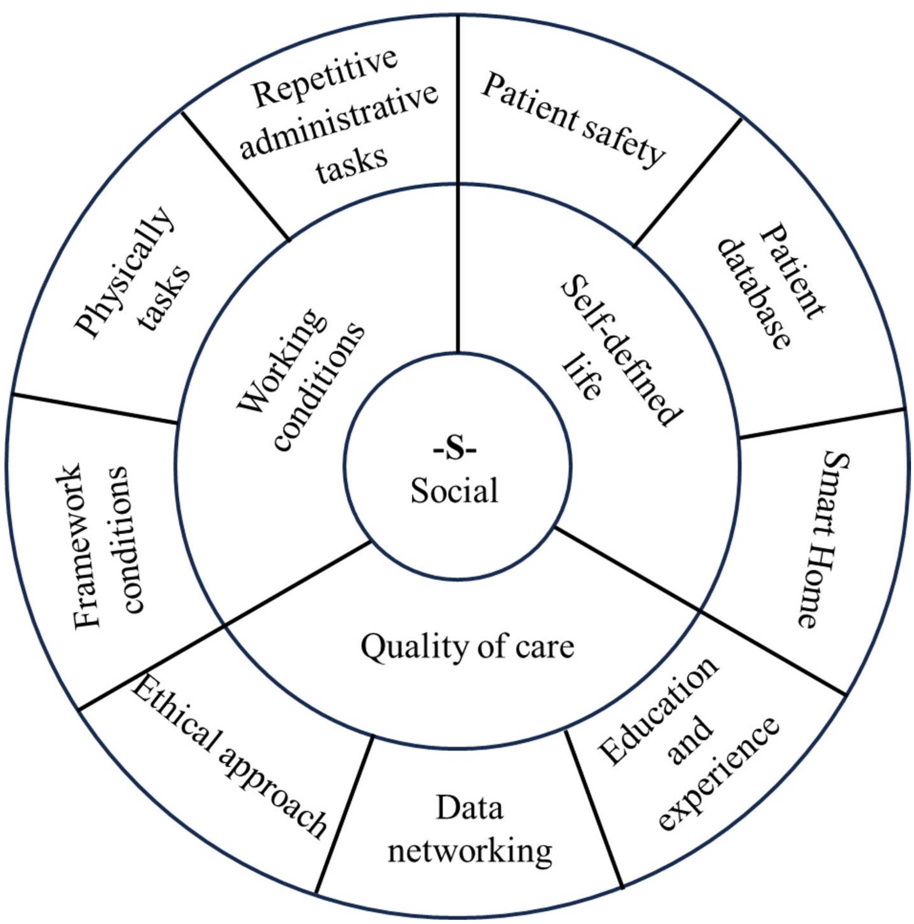


Fig. 2 Impact of digital technologies on social working conditions in care (*Source* own presentation)

The use of digital technology can support management in improving the working and framework conditions for nursing staff by using technology to reduce workload, counteract stress and reduce bureaucracy [38]. In combination with AI, adapted to the needs of nursing practice, the performance of human experts can be supported, possibly even surpassed, and processes can be made more efficient [68].

4.3.1 Organisational processes and more efficient planning at the strategic level

Technical support for the care of an ageing society requires, among other things, constant or reliable legal and institutional framework conditions as well as technical and structural prerequisites such as the implementation of standards and norms to improve interoperability and the expansion of powerful and secure broadband connections as well as the training and further education of nursing staff in digitalisation skills [27]. In order to implement future-oriented and sustainable solutions in the healthcare sector in relation to functioning digitalisation, innovative management must be open to digitalisation and drive forward the infrastructure and database for efficient application.

In the organisational area, AI can optimise the organisation of work, the creation of duty rosters and the planning of bed occupancy and thus both save costs and relieve management by supporting planning and decision-making [56]. Transparent data management and better traceability of workflows improve the transparency of processes and decisions [44]. Digital technologies open up enormous potential by increasing the efficiency of administrative processes, supporting their documentation and helping to reduce the consumption of resources, with the possibility of reducing CO_2 emissions [11].

The integrity of the organisation is linked to data protection, which is considered a central element of a digital healthcare organisation. Careful handling of sensitive data must be guaranteed. In Germany, compliance with the GDPR (General Data Protection Regulation) and other guidelines ensure the confidentiality and security of healthcare data [21]. Both employees and patients must be able to rely on this.

4.3.2 Support of care documentation at the operational level

The documentation of nursing actions, which is the responsibility of operational staff, is listed in the Nursing Professions Act as a professional obligation. It serves to ensure the seamless transfer of information in the sense of high-quality, safe, comprehensible and controllable patient care by recording as completely as possible in writing which measures of the nursing process, including the individual steps as well as observations, special features and changes, were planned and carried out [54]. The German Social Code (SGB V) also requires this quality assurance in the form of documentation in Section 137 [5]. A standardised, networked, easy-to-use and data protection-compliant documentation system can relieve the burden on staff.

Electronic documentation serves to ensure the seamless transfer of information during the creation and implementation of care planning, thereby guaranteeing patient safety through high-quality care [66]. AI can help to increase efficiency and reduce the workload of nursing staff by using dictation software or speech recognition to support the planning of nursing tasks, increase the efficiency and quality of documentation and ensure the traceability of nursing actions [17]. In addition to avoiding duplicate documentation, patient safety is also ensured by seamless nursing documentation, as weak points in the supply chain can be recognised more quickly [44].

4.3.3 Effective discharge management for the user level

Effective personalised information and data transfer is necessary to ensure that care recipients continue to receive good care when they change facilities. Effective discharge management is mandatory for hospitals in accordance with Section 39 (1a) of the fifth Book of the German Social Code (SGB V) in order to ensure the transition to follow-up care and avoid gaps in care due to missing or uncoordinated follow-up treatment [5]. When changing care facility, the targeted use of AI and digitalisation can support compliance with this legal requirement [44].

Successful transition and discharge management, in which health-related data is networked and seamless care is ensured, can counteract re-hospitalisation also referred to as 'the revolving door effect' and thus ensure safety and continuity of care for care recipients, avoid unnecessary hospital stays and thus save costs for the healthcare system [17].

Graphical representation of the impact of digital technologies on governance structures in the care sector in Fig. 3:

For a summary overview of the results, Figs. 1–3 are summarised in the Table 3 below.

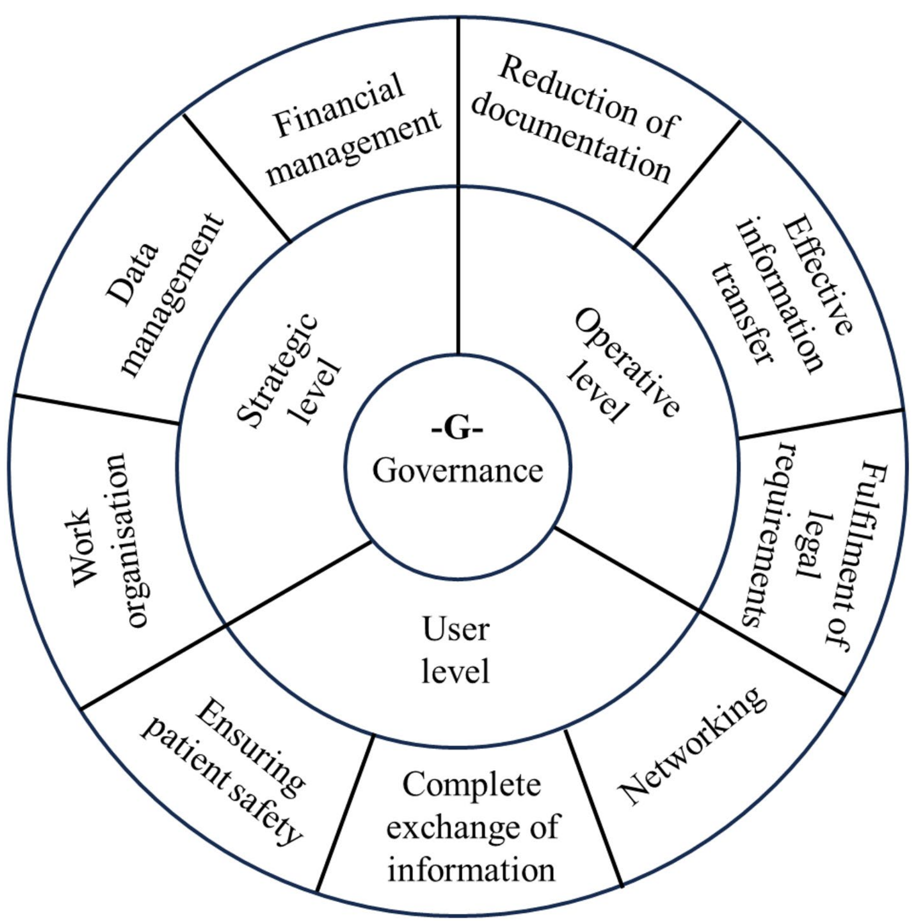


Fig. 3 Influence of digitalisation on governance structures in care (*Source* own presentation)

Table 3 Influence of digitalisation on ESG-structures in care (Source: own presentation)

		Savings on travelling
	Locally burnt fuels	Climate-friendly
		Climate-friendly edifice
-E-		Save energy
Environmental	Supplied energy	Water Management
		Waste management
		Optimisation of supply chains
	Independent emissions	Reducing of CO^2 Footprint
		Optimised Logistics,Warehousing
		Framework conditions
	Working conditions	Physically tasks
		Repetitive administrative tasks
-S-		Patient safety
Social	Self-defined life	Patient database
		Smart Home
		Ethical approach
	Quality of care	Data networking
		Education and experience
		Ensuring patient safety
	User level	Complete exchange of information
		Networking
-G-		Work organisation
Governance	Strategic level	Data management
		Financial management
		Reduction of documentation
	Operative level	Effective information transfer
		Fulfilment of legal requirements

5 Discussion

From 2025, mandatory documentation of organisations will be introduced in accordance with the Corporate Sustainability Reporting Directive—CSRD [41]. In order to meet the content of this obligation, the targeted use of digital technologies can help to improve sustainability in the care sector. Sustainable care based on ESG criteria can be prioritized by employees, care recipients and political decision-makers [22].

Figure 4 below shows the house of sustainability in care with reference to digitalisation. Care with its various areas of hospital care, partial and residential care, prevention and rehabilitation care and outpatient care, is the foundation. Pillars E, S and G support the roof of sustainability with the help of digital technologies and AI.

The opportunities and risks of using ESG are discussed below along the lines of digitalisation, AI, technical assistance systems, and robotics. The roof of the house was supplemented with digitalisation to illustrate the important role that digitalisation plays in the sustainability system.

5.1 Digitalisation and sustainability in care

Digitalisation plays a role in the sustainability of care in all areas of long-term and short-term care and also has an impact on the environment as well as on social and governance-related aspects. Digitalisation in care is based on patient-related data and replaces analogue service provision partially or fully with a with a digitally controlled model [71]. The process of switching from analogue to digital is an ongoing process and was adopted by the Bundestag on December 14, 2023 with the Digital Act [8]. At the same time, the

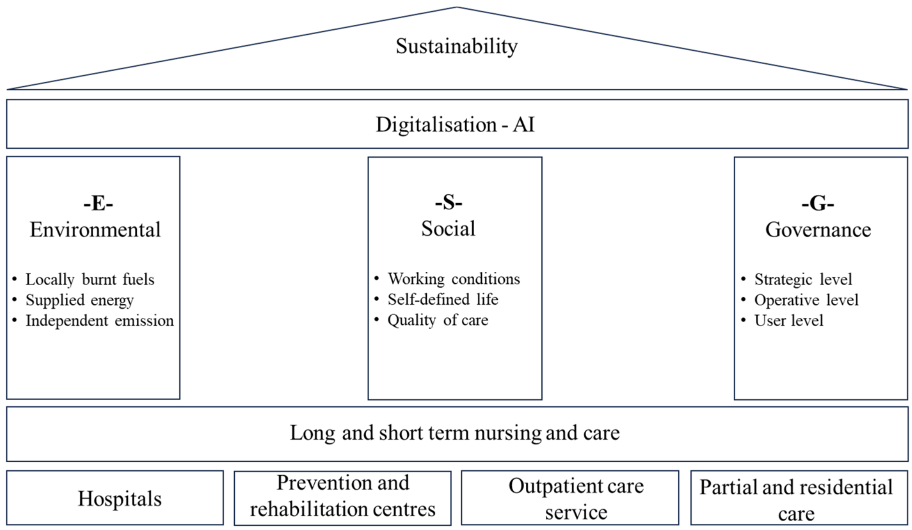


Fig. 4 House of sustainability in care including digitalisation (*Source* own presentation calculated according to Erchinger (2022) based on the structure of sustainable corporate management)

Health Data Utilization Act was also passed with the aim of using digital solutions to improve everyday healthcare and research opportunities in Germany [8]. Nevertheless, a central problem with digitalisation in care is data protection [10]. AI collects, processes and networks data, whereby it must be noted that incorrect training data may lead to inequalities in data-based decisions or that some patient groups may not be taken into account [56]. In environmental terms, telecare offers the opportunity to visit patients.

virtually via networked tele-robots, smartphones or tablets in their home.

environment and to save on travel distances and thus CO_2 The sensitivity of health data requires careful handling and strict compliance with the GDPR [21]. Breaches or security gaps could significantly undermine trust in digital systems.

5.2 AI and sustainability in care

Artificial intelligence (AI) also plays a role in the sustainability of care in all areas of long-term and short-term care and has an impact on the environment as well as on social and governance-related aspects. To a certain extent, it can act independently of human intervention, which can enhance sustainability-related processes [25].

In terms of the environment, AI can serve to reduce the carbon footprint of care independently of human intervention by collecting and aggregating data [34]. Environmental sustainability is seen as important in annual climate conferences and globally [14]. There is a societal expectation that every institution, whether short or long-term care, should do its part to reduce global emissions. The issue is particularly important as Germany, with 5.2% of global CO_2 emissions, is 1.8% above the global average [34]. At 6.1%, the German healthcare sector is also in the high range worldwide. The care sector is active in areas that account for 42% of this 6.1% [7].

There is potential for carbon dioxide ($CO_{2)}$ savings, particularly in energy supply and building refurbishment [18]. AI-supported systems can be used for the sustainability of buildings in care facilities by generating data about them, combining the measured room values and then identifying and proposing improvements. However, the resulting necessary measures such as energy-efficient refurbishments, intelligent waste management or optimised water supply systems are expensive and not refinanced, as these refurbishment measures are not recognized as operationally necessary by the funders [18]. Energy-saving devices required for process optimisation, such as LED lighting, are also unclear in terms of funding [9, 18]. Although the opportunities for improvement are recognized and can be addressed in a targeted manner via the AI-networked data, the unclear refinancing is an obstacle to implementation.

Another aspect related to the environment is the CO_2 impact of supply chains. AI-based logistics can optimise supply chains and transport for care and significantly reduce the resulting emissions [44]. In connection with this, the AI-based solution enables more sustainable material procurement and optimised warehousing. This contributes not only to reducing emissions but also to conserving resources [44]. However, complex logistics solutions can reach their limits when resources are scarce, be it for the delivery of laundry, dressing materials or medicines [23]. From a social perspective, a lack of materials can put care recipients at risk. When resources are scarce, professionally judged decisions must be made after careful consideration of care planning, and responsibility must be assumed for these decisions, which cannot be taken over by an AI.

More climate-friendly commuting by car sharing or car pools can be coordinated and offered in a targeted manner via AI and significantly reduce emissions [9]. At this point, it should also be discussed whether the CO_2 consumption of the computing power of the AI is in proportion to the CO_2 savings [57]. Technology-independent offers such as cost coverage as incentives for public transport must be compared with digital options. In the case of digital options, there is also the fact that employees have to provide data relating to their place of residence and duty roster for this service, which could create new problems through data misuse and security risks such as data leaks.

Overall, the high energy requirements of digital technologies can negate or even exceed the savings achieved [57]. It should also be noted that AI is added to the system and requires energy in the form of computing power for each process [25]. From an ethical point of view, this must be taken into account in terms of intergenerational justice with regard to environmental damage and work efficiency benefits [63].

On a social level, AI can contribute to improving the independence, safety and social contacts of people with disabilities in terms of self-determined living [1]. To this end, AI collects, processes and networks data, whereby it must be noted that incorrect training data may lead to inequalities in data-based decisions or that some patient groups may not be taken into account. AI algorithms are only as good as their programmers [56]. Artificial intelligence (AI) has the potential to transfer the values of its creators, investors or users to society and the people it affects [73]. However, the intentions of developers and investors may diverge from the values of users or society, and users may use technologies unexpectedly or without authorization. Data leaks or cyber-attacks can jeopardize safety and severely impact patient and employee trust. A dynamic process for adapting AI systems is essential to ensure they align with society's safety, values and needs [73]. The transparency of data use, the quality and selection of training data including decision algorithms and the ethical dimensions of participation and equity of access should be transparently presented and ethically considered [49].

At the governance level, the use of AI is possible for nursing staff as users for the complete exchange of patient-related information and networking of professional groups to ensure patient safety [72]. The legal requirements must always be complied with and the use of AI is characterized by restrictions such as limited data access and a lack of data diversity, which can impair the reliability of AI decisions in sensitive care contexts [68]. In Germany, for example, legal regulations in the healthcare sector require parallel data infrastructures to be created, with the result that the health and personal data required for AI is often not available or not available in combination [21, 28, 56]. This legal framework must be reviewed and modified, particularly with regard to the availability of data relevant to nursing care and research, so that the development and operation of a modern, standardised database in the care sector is permitted and practicable.

5.3 Telecare and sustainability in care

In environmental terms, telecare offers the opportunity to visit patients virtually via networked tele-robots, smartphones or tablets in their home environment and to save on travel distances and thus CO_2 [31, 55]. In addition, at the governance level, the telecare offer strategically changes the organization of work and on a social level, it influences the organisation of working hours and the place of work. By saving travel time and working from any location, the shortage of nursing staff can be counteracted at the governance level and patient care can be ensured [31]. On the other hand, there is personal contact with people. Human contact, conversation and professional advice are seen as the basis of nursing work [54]. Therefore, professional consideration in participation with the care recipient is necessary regarding the use of telecare itself as well as the frequency of use. Nurses act in a patient-centred manner in their reserved tasks and they are responsible for care planning [54]. As part of their duties, they consider the use of new technologies, including the positive or negative effects in terms of health, sustainability and human rights [50].

On a social level, over-reliance on technology can reduce personal interaction and empathy in care. Human aspects of care can take a back seat when digital health services and mobile health platforms provide care to patients regardless of their location [31]. The challenges of telecare lie in the inadequate technical infrastructure, the lack of personal contact, the loss of care-relevant data that cannot be obtained online, such as non-verbal signals or smells, and the lack of clarity regarding expectations of caregivers in their role [17]. In addition, not all patients and caregivers have the same access to digital technologies or the same competence in using them. This can lead to a new form of inequality and make access to healthcare services more difficult.

5.4 Technical assistance systems and sustainability in care

At the social level, technical assistance systems can help to ensure that the care provided to care recipients by professional nurses, helpers and informal nurses interact in the best possible way [72]. They serve to prevent, heal and improve people's health and well-being and can be used in the outpatient sector as smart homes or ambient assistant living. Health apps, wearables, tracking systems, support robotics, social robots, emergency call systems, sensor mats, intelligent floors and mirrors or electronic pill dispensers are coordinated to support nursing care [33]. In addition to enabling care recipients to remain at home for as long as possible, technical assistance systems also improve the safety and independence of patients, enable them to lead a self-determined life and relieve the burden on nurses [33]. In addition, relatives can network with the information about care recipients. The systems can also be used in a clinical setting to relieve the burden on staff.

In the social context, technical assistance systems can play an important role in the transition from hospitalization to home or inpatient care. As part of discharge management, it can be clarified which systems should be available at home and how follow-up care can be adapted accordingly [17]. A challenge in the case of acute needs, such as following a hospital stay, is the financing of technical assistance systems, the existing infrastructure in the form of Wi-Fi, Internet access and its quality, as well as the uncertainty of customers regarding security and data protection concerns, but also the difficulties of care recipients in keeping up with technological changes [1].

Holistic and networked documentation in the sense of data networking serves to improve the quality of care in the social sector, make work easier for staff and optimise patient care [65]. By reducing documentation gaps and providing precisely formulated information, well-founded decisions can be made. At the same time, AI-supported tools can provide patient data quickly and reliably. These can support the creation of care diagnoses and be used for secure and quickly accessible detailed documentation, process tracking and transparency or can be linked to the electronic patient record. These systems help to increase the quality of care by ensuring continuity of care and improving the efficiency of documentation. In the long term, such improvements can help to counteract the shortage of specialists by reducing the workload and time spent on documentation. It is considered important for nursing to improve working conditions [4].

From the strategic perspective of governance, digital technologies can optimize work structures and contribute to relieving the burden on caregivers by improving the flow of information, data exchange and interprofessional collaboration. Employee acceptance is a prerequisite for the successful use of digital technologies [1, 65]. This acceptance requires staff to have digital skills, whether through training, education or practical experience. Employees who are not sufficiently trained or informed may be sceptical about the use of AI. They may also suffer from the fear of losing their job as a result of these technical changes [56].

At the operational level of governance, AI-supported systems can support data collection and documentation. Improved and more efficient planning through digitalisation via optimised organisational processes, such as duty scheduling and bed occupancy, saves costs and increases the traceability of decisions. The transparency of processes is increased through structured data management, while data protection remains guaranteed through compliance with the DSGVO and other guidelines [21]. AI-supported systems can also improve the efficiency and quality of care planning by effectively designing and facilitating processes such as staff scheduling, reporting and billing. Electronic documentation ensures a seamless transfer of information and contributes to quality assurance in accordance with legal requirements such as the German Social Code-SGB V [5].

5.5 Robotic systems and sustainability in care

For social working conditions, robots could improve working conditions and transport robots should take over long journeys, lifts or exoskeletons can, for example, counteract the intensification of work and heavy physical labour and increase the well-being and safety of those in need of care [15, 39, 42, 67]. Care professionals are expected to be familiar with the technical possibilities and have the ability to operate digital technology at a high level at all times and to use it in a targeted, safe and thoughtful manner [36]. The use of technology requires, on the one hand, an interest in technology on the part of nursing staff and, on the other hand, the targeted and professional use of all technical systems that come into contact with patients with regard to patient safety [40]. It is crucial to create awareness of the current situation and actively involve employees in the change process in order to avoid resistance and dissatisfaction [38]. At the same time, there is a risk of dependence on technical systems in practice and that the focus on increasing efficiency neglects ethical and social aspects [49, 63].

With regard to the strategic level of governance, the costs for the implementation, maintenance and further development of technical systems are important in the short and long-term care sector. A lack of or inadequate technical infrastructure, insufficient staff training and high costs for new technologies could delay or hinder the implementation of digital solutions [9]. The introduction of digital systems can also lead to resistance within the organisation. Care organisations and their management need to implement innovative solutions and effective change management to meet both internal and external requirements [38]. Employees may feel threatened in their professional role by automation and digitalisation, which reduces the acceptance of such technologies [35].

One obstacle is the lack of acceptance or qualification of those involved [35]. Nursing staff and patients need to be trained in the use of digital and robotic solutions, which requires time and resources to avoid staff being overwhelmed by the technology. Ongoing training is also required to ensure that caregivers can use the technologies effectively and safely. Relief through technology can only work if the motivational and user aspects of older adults and caregivers are taken into account. The care, ethical and social perspectives as well as the cost–benefit ratio are also relevant for future prospects [27].

In the social sphere of self-determined living and the smart home, social robots will take on the role of roommates and companions in care, no longer performing tasks but interacting, entertaining and spending time with people [43]. The risk here is that human contact is reduced due to the assumption that the person is already being entertained. From an environmental perspective, it should also be mentioned that robots and their drive or battery systems are sometimes made from environmentally harmful materials, which means that their manufacture, use with energy supply and disposal have an environmental impact [48]. Their use must therefore be carefully evaluated. Refinancing must also be clarified in advance.

In the context of digitalisation and care, the three ESG dimensions are interrelated. They influence each other, meaning that decisions in one area always have consequences in the other dimensions. They must therefore be considered together in order to gain a holistic understanding of the opportunities and risks in the care sector.

Looking at the mutual impact of digitalisation in care from a social and environmental perspective, one risk would be if, for example, energy-intensive technology were replaced by more economical solutions at the expense of care quality or working conditions. In contrast, digitalisation could help to improve care quality or working conditions, but have a poor energy balance.

Innovative corporate management can use technologies for efficient and structured work. However, a powerful IT infrastructure leads to environmental pollution through energy consumption. At the same time, innovative technical structures could optimise environmental pollution.

Good corporate management can influence the social effects of digitalisation by using technologies to improve working conditions, quality of care and self-determination. Even so, users must be willing to engage with the technology and accept its implementation despite data transfer or possibly also an increased workload.

Figure 5 shows the relationship and interaction between the environmental, social and governance aspects in relation to the opportunities and risks of digitalisation in the care sector and underlines that these three different aspects are not independent of each other.

Figure 6 uses rectangular boxes to illustrate the dependency of the overarching elements of digitalisation, maintenance and sustainability. The subdivisions of the elements are shown in oval shapes. The broken lines represent the path of the subdivision. The continuous arrows place the elements in relation to each other. The arrows pointing in one direction represent the name of the relationship. For a better overview, these ratios are shown as double arrows in the subdivision, i.e. they point in both directions. The bracket summarises the results of the dependencies and leads them over to the practical application. This is shown as a practical framework, based on the SWOT analysis and adapted for the ESG relationship of the opportunities and risks, benefits and harms of digitalisation in the care sector.

For practical application, Fig. 6 was converted into a three-dimensional model, which can be seen in Fig. 7. The model was named MORE-Model for Opportunities and Risks in relation to ESG and digitalisation in the care sector. The central layer contains the

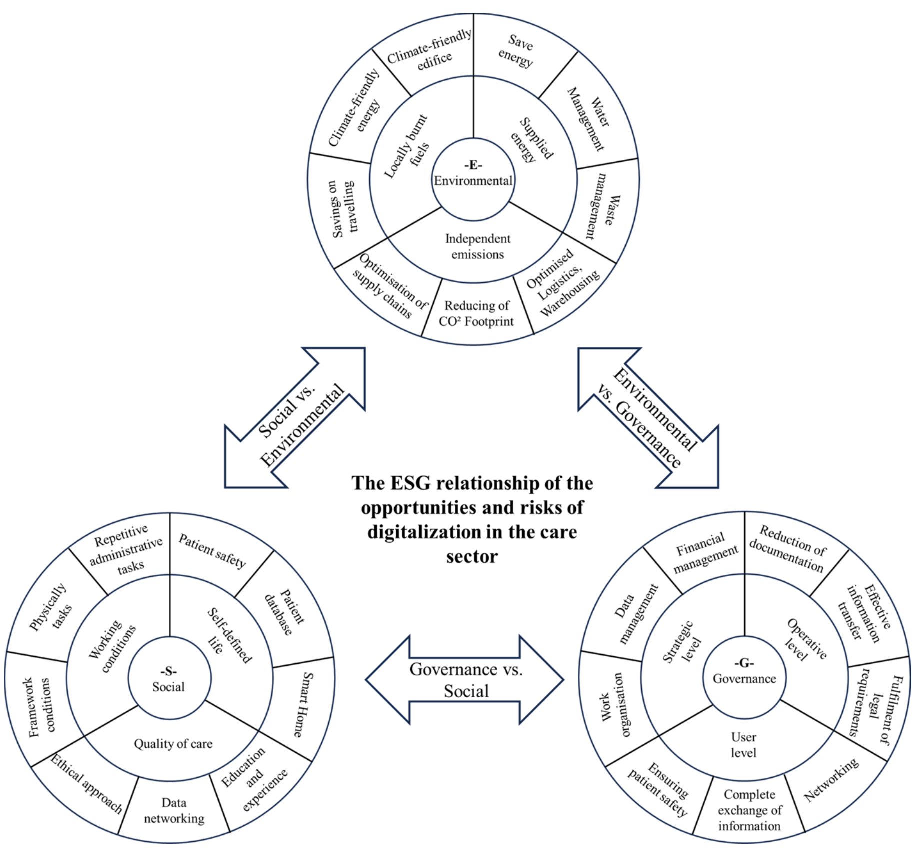


Fig. 5 The ESG relationship of the opportunities and risks of digitalisation in the care sector (*Source* own presentation)

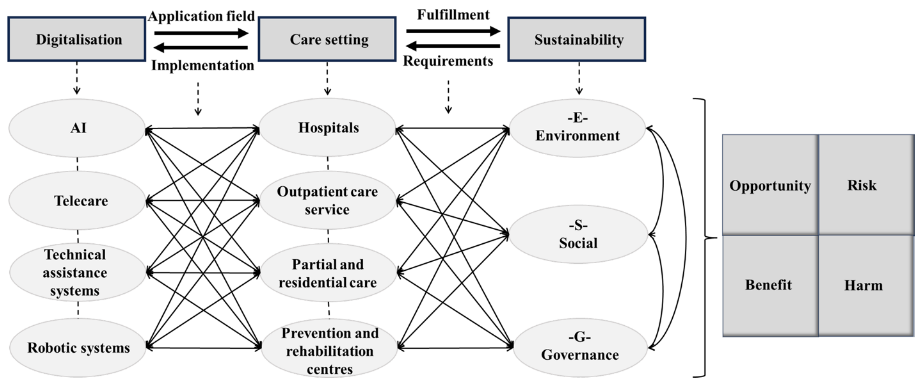


Fig. 6 Relationship between digitalisation, care setting and sustainability (*Source* own presentation)

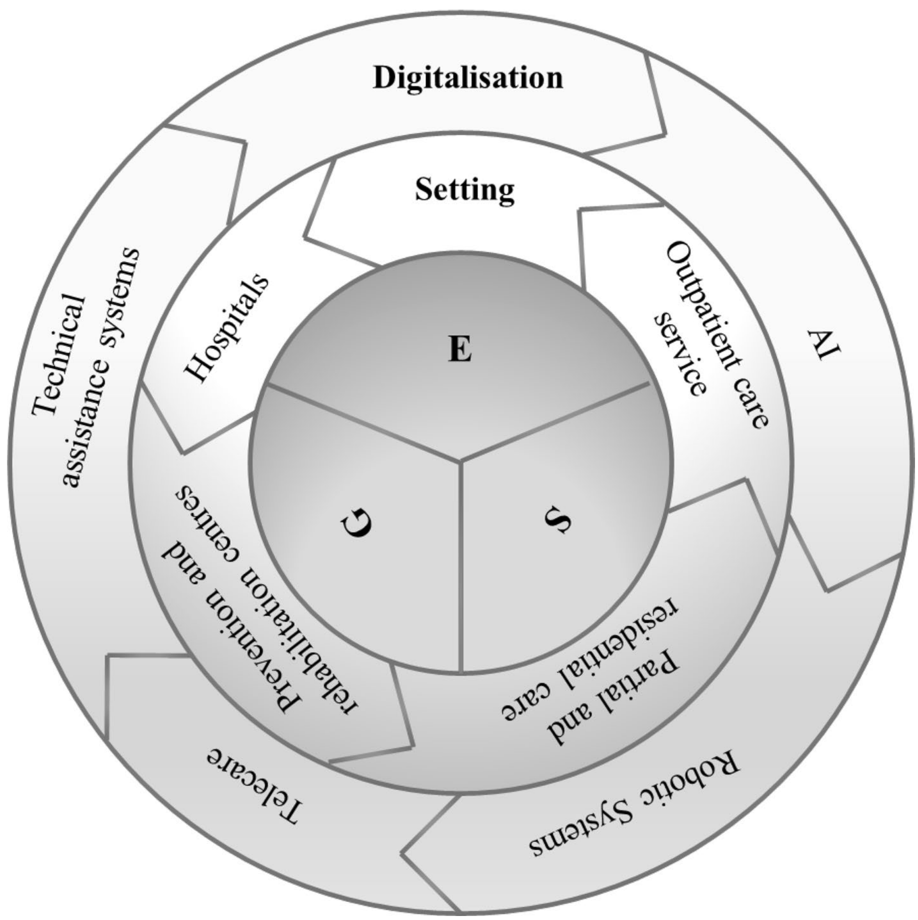


Fig. 7 MORE–Model for Opportunities and Risks in relation to ESG and digitalisation in the care sector (*Source* own presentation)

ESG sustainability criteria. The second layer represents the care sector settings, which includes hospitals, outpatient care, partial and residential care as well as prevention an rehabilitation centres, and the third layer includes the elements of digitalisation like AI, telecare, technical assistance an robotic systems. The three superimposed areas create a three-dimensional model in which the areas can be rotated against each other as required. In this way, the individual sustainability criteria can be combined with the respective care setting and the selected digitalisation system and examined for opportunities, risks, benefits and harms.

This serves to systematise the numerous possible combinations of ESG, digitalisation and care. Within the individual areas, the sub-items can be compared with each other in the same way.

6 Summary and conclusion

The ESG dimensions are closely interrelated in the digital care sector. Environmental impacts, social effects and forms of corporate governance influence each other and therefore cannot be viewed in isolation. Digital technologies can reduce environmental burdens, but at the same time create new ones. They can improve the quality of care, but cause social risks if introduced without appropriate governance. Responsible corporate governance acts as a connecting element that balances ecological and social goals and translates them into sustainable digitalisation strategies. It is therefore essential to consider the three dimensions together in order to realistically assess the opportunities offered by digitalisation in the care sector and systematically manage its risks.

In the healthcare system, regardless of whether it involves long-term or short-term, inpatient or outpatient care, in addition to the CO_2 debate, the availability of staff, time, the best possible patient care and innovative management are also of great importance for the future of patient care. In order to explore the application of technologies to promote ESG criteria in healthcare, particularly in the areas of environmental sustainability, working conditions and management structures, it is necessary to consider and examine the healthcare system with regard to these criteria and digitalisation as a separate area within the healthcare system. In this way, data on sustainable performance can be collected in a targeted manner in line with ESG criteria and forward-looking recommendations for action can be derived.

From an environmental perspective, it is recommended that digital technologies be used to optimise processes and make them more efficient, save resources and optimise their consumption, optimise warehousing and goods management, save on consumables and delivery routes and reduce costs. In addition, the required computing power and the resulting environmental impact must be taken into account, especially when using AI. Overall, energy consumption, energy dependency and data transmission must be taken into account and the digital infrastructure, including network security, must be guaranteed.

In the social sector, digital technologies can help to improve working conditions, automate processes and relieve care workers of administrative tasks. New and flexible working models such as telecare must be promoted. However, it must be considered important that digitalisation has its limits where people need people. Humans and their decisions should not be replaced by digitalisation but rather supported. In-depth knowledge is generally necessary in order to avoid becoming dependent on technology when making decisions. It is important that the aspects of digitalisation are integrated into the basic, advanced and further training of nursing staff on a mandatory basis.

Governance structures require the use of digitalisation to improve accountability, transparency and traceability in decision-making. AI-based tools should be used to optimise documentation, personnel planning and compliance with legal requirements. A strict data protection concept must be adhered to in this context. For digitalisation to be successful at the governance level, technological, ethical and human factors must be integrated into a coherent system. In order to secure the future of care, the infrastructure for digitalisation must be expanded and technical offerings must be critically evaluated in terms of patient orientation, safety and cost–benefit ratio. Changing practices and implementing and using these systems requires innovative management and the political will to finance or refinance their use and technology.

The MORE model (Model for Opportunities and Risks in relation to ESG, or Monitoring, Optimising, Rebalancing, Embedding) is a novel visual and analytical framework developed for practical application. The model can serve as a framework for integration between digitalisation, care facilities and sustainability dimensions. As a flexible tool, it can be used to systematise possible combinations of digitalisation in relation to ESG criteria in the care sector. To promote sustainable innovation in the care sector, it serves to manage the interactions between digital solutions and ESG dimensions in various care facilities.

The MORE model offers a structured method for assessing the opportunities and risks associated with digital systems in care to ensure a balanced and context-sensitive approach to responsible implementation.

7 Limitations and future research directions

The study has several limitations that should be considered. Potential publication bias could influence the results, as primarily studies with significant or positive findings are available. The number of included studies is limited, which restricts the generalizability of the results. The study focuses primarily on the care sector in Germany, particularly long-term care, thus limiting its applicability to other countries or care sectors. Finally, technological solutions and sustainability approaches are developing very rapidly in the care sector, meaning the findings represent only a snapshot of the current situation. These limitations also outline clear directions for future research and practical development.

The MORE model, as a theoretical tool, is useful for practical application. Decision-makers could use it to systematically plan and prioritize sustainability measures in the care sector, for example, regarding resource allocation or the implementation of new processes. Future research should conduct pilot projects in real-world care facilities to test its practical applicability and perform empirical validation to verify the model's effectiveness and efficiency. Furthermore, long-term studies could investigate how technological developments and organizational changes complement or adapt the model. Building on these directions, forthcoming research can contribute to developing robust, scalable and forward-looking digital solutions that strengthen sustainability in the care sector and support the continuous advancement of ESG oriented healthcare.

Author contributions

Conceptualization: R.Z., Z.Sz. Methodology: R.Z., Z.Sz. Formal analysis: R.Z. Investigation: R.Z. Writing – original draft: R.Z. Writing – review & editing: R.Z., Á.P-V., Z.Sz. Visualization: R.Z. Supervision: Z.Sz., Á.P-V. Project administration: R.Z, Á.P-V. Funding acquisition: None.

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Data availability

All data generated or analysed during this study are included in this published article.

Declarations

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