10-3-2024

Piggyback to Green – Digital Transformation for Environmental Sustainability

Anika Schroder
Copenhagen Business School, asc.digi@cbs.dk

PIGGYBACK TO GREEN – DIGITAL TRANSFORMATION FOR ENVIRONMENTAL SUSTAINABILITY

Research full-length paper

Schroder, Anika, Copenhagen Business School, Frederiksberg, Denmark, asc.digi@cbs.dk

Abstract

This paper adopts a multi-level perspective to investigate how the green transformation can "piggyback" on the digital transformation. It delves into the concept of 'green digital transformation' and identifies factors driving this transformation. Through an interpretative case study, the research uncovers driving factors at macro, meso, and micro levels, emphasizing the need for collaboration across the value chain. The study showcases how digital technology, such as artificial intelligence, aids in overcoming challenges, ultimately allowing organizations to lower their environmental footprint. This research enhances our understanding of how the digital transformation can act as a catalyst for green transformation processes, utilizing digital transformation concepts and empirical examples. The concept of piggybacking introduced to showcase how the green transformation can capitalize on pre-existing resources, technologies, and strategies developed for digital transformation to achieve sustainability goals more effectively and efficiently.

Keywords: Digital Transformation, Green Transformation, Environmental Sustainability, Piggyback.

1 Introduction

Digital technologies offer the potential to mitigate environmental impacts (Melville 2010, vom Brocke et al., 2013) and can reduce global carbon emissions by up to 15%, which accounts for approximately a third of the required reduction to achieve the goal of limiting global warming to 1.5° Celsius by 2030 (World Economic Forum, 2019). While it is acknowledged that digital technologies can act as a catalyst for the green transformation of industries, further research is required to investigate how this occurs. To do so, this paper investigates the agri-food industry. The agri-food industry accounts for one-third of greenhouse gas (GHG) emissions worldwide (UN FAO, 2021), while it has the lowest technology adoption compared to other industries (Harvard Business Review, 2016). Unlike other industries, the agri-food industry is not replaceable, as humans need food to survive. Most of the GHG emissions stem from agricultural use, including crop production, which makes it challenging to significantly reduce carbon emissions.

Meaningful change can only occur when steps are taken throughout the entire value chain instead of focusing on single firm practices. Consequently, a multi-level perspective is needed. In the field of Green Information Systems (Green IS), an amplified focus lay on intraorganizational studies, a single-level perspective (Leidner et al., 2022). However, digital transformation literature has shown attempts of interorganizational perspectives. Digital transformation diverges across levels, yet also many studies have viewed the levels separately (e.g. Markus and Robey, 1988; Volkoff et al., 2007). In a context where organizations and society are simultaneously affected by change, a multi-level perspective can be beneficial because it helps unpack and relate these simultaneous changes (Burton-Jones and Galli-

van, 2007). Thus, this study will take on a multi-level perspective by viewing the different levels simultaneously.

Without efficient collaboration of stakeholders in the value chain, there is limited impact on the green transformation. An important step for researchers is, therefore, to identify the factors that drive an industry's green transformation and the role that digital technologies can play. This research identifies how the green transformation can take advantage of the digital transformation capabilities.

This paper specifically introduces the term "piggyback" to capture this phenomenon. This paper thus asks the following research question: *How can the green transformation piggyback on the digital transformation?*

Learnings from the digital transformation literature and empirical cases were used to understand driving factors that trigger, enable, or have other forms of positive impact on green transformation. A central focus is placed on the concept of *piggybacking* where the advancements made in digital transformation are strategically applied to accelerate the green transformation. Using a case study with 41 interviews with agri-food organizations in different stages of the value chain, this study depicts how the driving factors influence the green transformation on the macro, meso (interorganizational), and micro (intraorganizational) levels. The findings contribute to an understanding of how the learnings from digital transformation can be used to catalyze green transformation.

To contextualize these findings, the paper draws on conditions for digital transformation (Hanelt et al., 2021) and insights from Green IS literature. Additionally, it showcases empirical examples that conclude in a categorization of factors supporting the green transformation, all underpinned by the capabilities of digital technology. This approach not only advances scholarly understanding but also provides practical insights into how the agri-food industry can strategically harness digital transformation for sustainable practices.

2 Theoretical Background

Extant literature has a broad understanding of digital transformation (e.g. Vial, 2019; Wessel et al., 2021; Kaganer et al., 2023). However, the role of digital technology in enabling green transformation remains unclear. This study uses the existing body of literature about digital transformation and Green IS to identify its main influencing factors for a successful green transformation enabled by digital technologies.

Digital transformation (DT) can be defined as organizational change triggered and shaped by widespread diffusion of digital technologies (Hanelt et al., 2021). DT is the "*process where digital technologies create disruptions triggering strategic responses from organizations that seek to alter their value creation paths while managing the structural changes and organizational barriers that affect the positive and negative outcomes of this process."* (Vial, 2019). DT puts digital technologies in the center of business transformation (Baiyere et al., 2020) as it enables the development of new business models for value creation (Verhoef et al., 2021), and (re)defines an organization's value proposition which may lead to organizational identity changes (Wessel et al., 2021).

DT can encompass intraorganizational and interorganizational processes with a wide scope (Hanelt et al., 2021). Intraorganizational DT research, for instance, focuses on specific organizational adoption due to diffusion of certain digital technologies (e.g. Brynjolfsson et al., 2013); adoption process of the whole organization due to complex changes in the digitalized environment (e.g. Lucas and Goh, 2009); and indirect implication of specific digital technologies on parts of the organization (e.g. Gallaugher and Ransbotham 2010). Interorganizational DT research focuses on shifts in an industry context and implications on the whole organization due to digitalization (e.g. Coile, 2000).

Vial (2019) describes the DT process as where digital technologies play a central role in both the creation and reinforcement of disruptions that take place at societal and industry levels. These disruptions trigger strategic responses from organizations. Organizations use digital technologies to alter the value

creation paths they have previously relied upon to remain competitive. Thus, they must implement structural changes and overcome barriers that hinder their transformation effort. These changes lead to positive impacts or undesirable outcomes for organizations, individuals, and society (Vial, 2019). Researchers propose that digital transformation involves the strategic alteration of organizational operations through the deployment of digital technologies, ultimately leading to improved business outcomes (Wessel et al., 2021). A persistent challenge revolves around delineating the nature of the change and its objects and, notably, discerning the distinctive impact of digital technologies compared to earlier forms of information technology or systems. Nevertheless, DT might indeed be instigating profound changes across multiple levels (Baiyere et al., 2020) of an organization and reshaping both internal and external environments (Chanias et al., 2019). In essence, DT appears to catalyze more fundamental and profound transformations than the deliberate changes reflective of managerial intentions.

DT has been one of the most significant global business trends over the past several years, and so has Sustainability (MITSloan Management Review, 2018). DT and sustainability are twin challenges and cannot succeed without each other (Wade, 2020; Bendig et al., 2023; Graf-Drasch et al., 2023). Thus, a deeper understanding of the IS sustainability literature, so-called Green IS, is needed.

2.1 Green Transformation

Environmental sustainability is one of the grand societal challenges of our time (Watson et al., 2010). Thus, organizations are forced to pursue a green transformation journey by market and consumer pressures. To understand the foundation of green transformation, this paper draws from existing IS research on environmental sustainability (Green IS/Digital Sustainability) which has the objective to strengthen the products, practices, and services deemed critical to decrease the environmental footprint (e.g. GHG reduction) or to consider renewable resources (Melville, 2010).

A body of literature is emerging on digital and sustainability as synergistic components of organizational activity (Pan and Zhang, 2020; George and Schillebeeckx, 2021; George et al., 2021; Mair and Gegegnhuber, 2021). Digital sustainability activities are business activities that are guided by implementing DT and sustainability as core synergetic components (George et al., 2021). Digital sustainability is a contemporary concept reflecting how digital technologies are closely related to practice and are increasingly shaping our world and society (Kotlarsky et al., 2023). Digital sustainability is *"the development and deployment of digital resources and artifacts toward improving the environment, society, and economic welfare"* (Kotlarsky et al., 2023). Thus, digital sustainability adopts the principles of the "triple bottom line" which highlights the importance of considering economic, social, and environmental dimensions (Elkington, 1997). Long before the term digital sustainability was coined in 2020 (George et al., 2020), IS research had been focused on different applications for environmental sustainability (Green IT/IS) (e.g. Loeser et al., 2017) and social sustainability (ICT4D/digital social innovation) (e.g. Tim et al., 2021). While social sustainability is an equally important research area, this article zeroes in on the understanding of the environmental aspects of digital sustainability. Green IT/IS is recognized as a specific theme under the broader umbrella of digital sustainability, which encompasses the use of digital technologies to create and shape the physical world (Kotlarsky et al., 2023). Research within Green IT focuses on the direct environmental impacts of IS use with an emphasis on issues at an organizational level (e.g. Nishant et al., 2017). Research within Green IS focuses on IS use to promote sustainability in business and society with a wider area of focus on issues at the micro, meso and macro levels (e.g. Melville 2010; Seidel et al., 2017; Tim et al., 2018).

Research within the Green IS domain has focused on three key themes: (1) drivers for the adoption, (2) use of IS, and (3) approaches for implementation (Kotlarsky et al., 2023). Most of these studies have focused on intraorganizational studies (e.g. Cooper and Moller 2017; Hanelt et al., 2017; Loeser et al., 2017; Seidel et al., 2013), focusing on the individual (Corbett, 2013; Loock et al., 2013) or organizational level (Seidel et al., 2013). Intraorganizational studies on the drivers for adoption are con-

cerned with topics such as the impacts of IT on the environment, recognizing sustainability trends and ensuring leadership commitment to Green IT (Coffey et al., 2013; Hu et al., 2016). Intraorganizational studies about the use of IS focus on topics such as transforming physical into virtual processes for both IT infrastructure and business operations. For example, IT reporting systems track sustainability indicators that make the impact of sustainable technology striking (e.g. Bengtsson and Ågerfalk, 2011); decision support systems (e.g. Aubert et al., 2012) to provide timely information for the management of various sustainability risks; and business intelligence systems (Petrini and Pozzebon, 2009), like managing biodiversity and human well-being (Pan et al., 2020). The intraorganizational studies about the implementation of IS studies offer various tools to managers for assessing and evaluating the environmental cost of their activities and the benefits of long-term investment in Green IT/IS. These studies focus on design principles for sensemaking support systems and management analytics systems (Seidel et al., 2018; Pan et al., 2020), design requirements for sustainable business processes (Zhang et al., 2011) and green data centers (Bai and Sarkis, 2013); and simulation modeling to assist managers in designing a sustainable production system (Kurkalova and Carter, 2017).

The interorganizational perspective is scarce. However, Leidner et al., (2022) examined the implementation of IS by investigating interorganizational green IS. In their paper, they extend Melville's (2010) belief-action-outcome framework, which focuses on the role of IS in establishing sustainable processes and practices in organizations. By researching a digital platform encouraging organizations within a supply chain to undertake environmental sustainability initiatives, Leidner et al., (2022) empirically derive the concept of interorganizational green IS. Interorganizational IS enables knowledge sharing between firms along the supply chain (Dong et al., 2017). Interorganizational green IS brings organizations together with existing client-supplier relationships and may also bring competing or independent organizations together. The purpose of interorganizational green IS lies in sharing information about environmental sustainability without notable benefits of participating organizations. Interorganizational green IS creates a distinctive set of motivational and contextual factors that may have significant effects on green IS use and effectiveness (Leidner et al., 2022). Interorganizational research for the green transformation is thus needed, as meaningful change can only occur when steps are taken throughout the entire supply chain.

This study focuses on the factors that influence green DT. Theoretically, it focuses on the contextual conditions that trigger and shape DT and derive empirically the factors for green DT.

DT research can be divided into (1) contextual conditions that trigger and shape DT, (2) mechanisms that link contextual conditions with outcomes, and (3) outcomes that refer to the consequences of DT on an organizational, economic and spill over level (Hanelt et al., 2021). Contextual conditions define the emergence of DT where material, organizational and environmental factors trigger and shape the DT (Hanelt et al., 2021; Henfridsson and Yoo, 2013; Wessel et al., 2021). The material factors converge the emergence and diffusion of a variety of digital technologies (Sebastian et al., 2017); digital properties (Yoo, 2010); and data availability (e.g. Weichert, 2017). The organizational factors encompass organizational strategy and legacy such as the organization's resources, processes, values, and culture (Benner, 2007; Krotov and Junglas, 2008); as well as the DT awareness of top management like a positive attitude towards change and technology (Dery et al., 2017). The environmental factors contain legal and infrastructural conditions like regulatory frameworks (Cortet et al., 2016); technology-driven industry dynamics (Wamba and Chatfield, 2009); and digital consumer demand (Brynsjolfsson et al., 2013; Oestreicher-Singer and Zalmanson, 2013). This study uses the contextual conditions that trigger and shape digital transformation as our starting point to uncover the factors of the green digital transformation in our case study.

2.2 Green Digital Transformation & the Concept of Piggybacking

This research is concerned with the interorganizational processes of DT, environmental sustainability, and, thus, green transformation. By combining the perspectives of digital technology, transformation,

and sustainability (see *Figure 1*), it serves the understanding of how the Green Transformation can piggyback on DT. The outcome of the piggybacking, which this paper refers to as 'green DT' (GDT), can be summarized in leveraging digital technologies and, hence, the capabilities of DT for a green transformation.

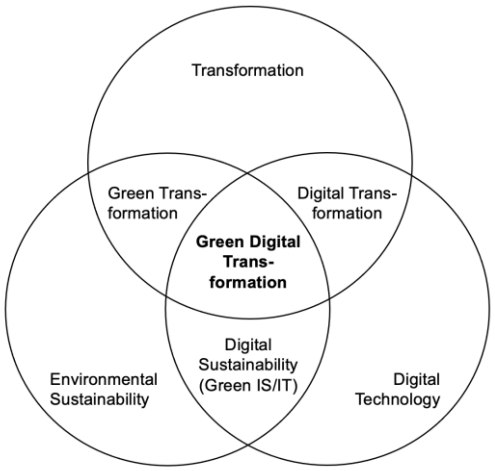

Figure 1. Intersection of perspectives covered in this research.

Piggybacking employes strategies that leverage existing yet seemingly unrelated systems and networking. Piggybacking can help to facilitate the creation of novel business ventures, the diversification of revenue sources, the enhancement of product appeal, and the amplification of organizational visibility (Havard Business Review, 2023). The concept of piggybacking also appears in digital platform research where piggybacking is a strategy used to launch new platforms by connecting with an existing user base from another platform. This approach helps the new platform attract users from the established one by offering value that encourages them to join (Parker et al., 2016). For instance, PayPal effectively utilized the piggyback strategy by integrating with eBay's auction platform.

The concept can also be used within the field of Green IS literature, for example: Information systems can support sustainability initiatives by leveraging existing communication networks and data analytics platforms. For instance, environmental monitoring systems can utilize existing mobile networks to collect and transmit data from remote sensors. This reduces the need for new infrastructure and enables quick deployment of monitoring technologies that can track environmental changes in real time (Melville, 2010). Information systems can also enhance environmental sustainability by piggybacking on existing IT infrastructure. For example, data centers can implement energy-efficient practices such as virtualization and cloud computing to reduce their carbon footprint. These practices make use of existing servers and network infrastructure while optimizing their energy usage (Watson et al., 2010).

3 Method

3.1 Case Description

This study examines the agri-food industry due to its significant contribution to carbon emissions. Unlike the ease of transitioning from a car to a bike, the nature of food makes it challenging to find straightforward sustainable options. One of the interviewees sums up this challenge in the following way: *"This is an industry which needs to change. And it's the most important industry because it touches humans multiple times a day. So that's why I think today there is a big pressure for a shift*

driven by ESG [Environmental Social and Governance criteria], by customers demand and it's something that the industry cannot be replaced." Similar to other industries, the agri-food sector faces environmental challenges, including GHG emissions, water usage, and energy consumption. Particularly concerning are the elevated GHG emissions associated with farming practices, such as the methane output from livestock, and the release of carbon from annual crops. Water usage further poses a significant concern, necessitating solutions for upcycling wastewater. High energy consumption is of concern in most manufacturing processes, like the malting process in brewing beer or whisky. However, the food industry also grapples with unique challenges, including issues of food waste and soil health. Post-harvest waste is a notable concern due to the perishable nature of food products. Additionally, there is growing awareness about the waste of by-products and consumer food waste.

Perhaps one of the most pressing challenges is the impact on soil health. Extensive land use in agricultural practices has resulted in a large amount of unfertile soil, causing topsoil depletion—a critical element for 95% of our food products. The Food and Agriculture Organization (FAO) warns that 90% of topsoil is at risk by 2050 (FAO, 2022). The depletion of topsoil threatens future harvest yields, posing a significant risk to both human and animal food sources.

On a positive note, the agri-food industry, and in particular, the grain industry, has the capacity to sequester carbon dioxide (CO2) in the soil through the cultivation of plants. Moreover, the growing plant-based industry, which utilizes legumes, grains, etc. to replicate animal products, represents a promising trend. The plant-based dairy and meat industry is a more environmentally friendly industry compared to the traditional dairy and meat industry. For instance, livestock emits 82 % of the carbon footprint in the European Union, which accounts for animal-based products such as meat or dairy (European Court of Auditors, 2021). According to the Lancet Food Commission, switching to a plant-based diet might be the single most efficient action to mitigate climate change (Willett et al., 2019). Therefore, the agri-food industry marked by a diverse set of stakeholders with different interests and complex interdependencies emerges as a 'strategic research site' (Merton, 1987) for the purpose of this study.

3.2 Data Collection

This study pursued an in-depth interpretative case study of the agri-food industry, focusing on the grain industry (Walsham, 1995). Archival data sources were used to obtain information about the industry architecture. This information included industry reports, white papers, internal strategic documents, YouTube videos, podcasts, websites, and newspaper articles. Participant observations and interviews were also conducted.

The 41 in-depth stakeholder interviews for each step along the value chain followed a semi-structured interview guide. Most of the interviewees were either Procurement or Sustainability Lead, but some were also Technology Lead or founders of digital platforms. The interview guide contained questions within five distinct categories: challenges, value chain relationships, sustainability, digital technology and data use, and collaboration.

The data was collected in three phases (*see Table 1*). The first round of data collection was of an exploratory nature to understand the key factors of how the industry is changing. The data sources for the first collection phase (November 2020 – May 2021) were observations and informal interviews (around 55 hours with extensive notes), 26 semi-structured interviews (45-80 minutes interviews with 26 hours recorded), and over 100 archival data sources. The previously found key factors informed the development of the second round of data collection (March-October 2022) adding 9 further interviews and 30 hours of observations. In the second round, the factors were investigated in more detail to understand how digital technology and data use can influence the plant-based industry. The third round solely focused on the stakeholders' sustainability goals and initiatives, and their technology usage to foster environmental sustainability, adding 6 interviews and 20 hours of observation.

Source	Description	Nov. 2020 – May 2021	Feb. – May 2022	Sept. – Nov. 2022
Interviews	Interviews (45-80 min) conducted with procurement, technology and sustainability executives	26	9	6
Participant Observation	Conferences; workshops, project meetings within analytical company	150 h	30 h	20 h
Archival Data	YouTube videos, podcasts, industry reports, internal strategic documents, websites, white papers	53	75	80

Table 1. Data sources

3.3 Data Analysis

All interviews were recorded and transcribed, and the analysis was done with Atlas.ti 22, a software program designed to aid in analyzing qualitative data. An inductive approach was adopted while constantly comparing different data sources and framing the understanding of green DT based on prior literature. The analysis was guided by data-driven thematic analysis (Braun and Clarke, 2006) and the data was coded accordingly. In the initial round of coding, the raw interview data were analyzed by staying close to the words and phrases of the interviewees. The analysis of the first 26 interviews resulted in 474 descriptive codes. This second interview round contained 9 interviews, resulting in 292 descriptive codes. Based on the descriptive codes, 25 theme codes were developed. The themes ranged from very general themes such as "challenges", "data", and "collaboration" to more concrete themes such as "regulation", "network", and "social license". After carefully analyzing the codes and understanding their relations, aggregated dimensions were formed, such as "interorganizational factors", "digital technology use in practice" and "piggyback indicators".

4 Findings

Factors influencing the green transformation appear to act on three levels: on a macro level containing the contextual environment like political, economic, and social context – "market factors"; on a meso-level concerning supply chain stakeholders – "interorganizational factors"; and on a micro level concerning the organization itself – intraorganizational factors"; As the value chain is interconnected, each factor trickles up and down to the other levels. Thus, it is important to consider every factor on all levels. Market factors encompass regulations, market incentives and consumer awareness. Interorganizational factors encompass organizations' social license to operate and co-investment in green solutions.Intra-firm factors concern an individual organization that is part of the industry ecosystem. Intra-firm factors encompass an organization's transformative mindset, organizational capabilities and its stakeholders' network.

A successful transformation can only happen when considering a multi-level perspective. To do so, there is a need to consider the contextual environment (market factors), have your house in order as an organization (intraorganizational factors) and to actively collaborate with stakeholders (interorganizational factors) as the green transformation only has an effect on an industry level.

Market factors concern the contextual environment like political, economic, and social contexts. For the green transformation, three macro factors in particular prevailed, namely, regulation, consumer awareness, and market incentives.

Regulation creates a level playing field for an industry: regulations can "*bring people together under one umbrella. This is why, I think legislation is important. Legislation can give you the umbrella without micromanaging."* (Former CSO of C-TRADER). A level playing field for all companies is needed

to equal out unfair price advantages when neglecting sustainability. However, regulation can be a double-edged sword. For example, new breeding techniques could accelerate innovation towards more climate resistant, higher-yielding or sustainable crop seeds. However, these new techniques are heavily regulated: As a former product manager D- Seed manufacturer elaborated, "*We were hoping that they would approve that these new breeding techniques like CRISPR, CAES, that kind of thing, would be regulated not as a GMO, but as a new breeding technique*. B*ut they decided that it should be regulated as a GMO. So that will for the euro zone be a real heavy burden. You could say that we have to walk on these very old breeding techniques when Asia and US can get in their helicopters and* get so far with these". As agri-food supply chains are partly global, different regulations may accelerate or slow down the green transformation in some areas as the breeding example showed.

Consumer Awareness and their decisions pressure the food industry to transform: "*The other significant pressure that is going to accelerate change in this industry is customer awareness. Customers are aware of the fact that good food is impacting their health. Customers are aware and asking about the impact that their purchasing power has on the planet."* (former executive in Tech & Operation of A-TRADER). Another noteworthy shift can be seen within consumer preferences like the shift from animal protein to more plant-based proteins. Previously, large corporations downplayed the consumer demand, but it constantly grew: *"So ten years ago, I was in a meeting with [an industry consortium] and we had a joint meeting with all the big dairy companies, all of them said: 'plant-based, they are our enemies. We need to fight them like hell. We're going to go into war, we're going to lobby against them'.* By now the attitude has changed and these corporations need to incorporate plant-based alternatives and they are heavily investing: "*Ten years later, everybody has plant-based products in their portfolio today. They are moving in different speeds, of course, but they all have a dairy product or non-dairy product in their portfolio."* (Segment manager of a global analytical company) Consumers are a powerful element to shift the industry towards more sustainable practices.

Market Incentives are created by governments or by institutions. Incentives for spending additional capital on sustainable products or technology enhancements have a positive impact on the green transformation. For example, the finance sector nudges through better credit rates for sustainable acting companies: *"Louis-Dreyfus got a one-billion-dollar credit line from Rabo bank, at one percent lower than the market rate. I mean, those are the kind of economic incentives you need across the supply chain. So that's the most important: you need economic incentives to change things. Because then it will also be [that] everybody is going into the same direction, and it will be fast because everybody is migrating towards the economic equilibrium and efficiency."* (Former CSO of C-TRADER) Thus, economic incentives like lower credit rates from financial banks have a powerful impact on the green transformation.

Interorganizational factors concern stakeholders in the industry ecosystem. Interorganizational factors encompass organizations' social license to operate and co-investment in green (digital) solutions

Organizations' **social license** to operate is the ability of an organization to carry out its business because of the confidence society has that it will behave legitimately, with accountability, and in a socially and environmentally responsible way. The social license is challenged with the heightened focus on the environment. As each stakeholder is only as good as their worst supplier in their supply chain, a mutual commitment is indispensable: *"Businesses want to collaborate and share, they need to. They're not going to fix this individually because it's a sector wide problem and a jurisdictional wide issue. It's a problem that you don't fix individually just for your supply chain, because the supply chain is tainted by the worst players in that supply chain." (*Former CSO Confectionary Manufacturer) Thus, the industry stakeholders collaborate to implement industry standards and commitments to operate in a more environmentally friendly way. A digital platform for social license was established by food and beverage manufactures and commodity giants as part of the sustainable agriculture initiative. This platform standardizes sustainability reporting throughout the whole supply chain: *"So they created [digital platform] to try and provide a common reference. You have seen Lord of the Rings - this is the one ring to bind them all. This makes sure what compares with what, and it's done on the wording of*

the standard." (former General Manager of sustainable agriculture initiative platform) Many stakeholders have adopted the system and are requiring that suppliers are evaluated based on the referenced standards: *"The major system that we nowadays operate is to make use of the [digital platform[…] a system where farmers can verify their own production according to the system. And then you have an idea about a certain level of sustainability. So that's why we ask nowadays our suppliers to stick to this level and focus here. It's not really setting limits with respect to the use of a certain sustainability results yet, but in the future that can be the case."* (Head of Quality and Procurement of a malting company) Due to this platform, the evaluations have become more transparent in aiding companies and in particular farmers to acquire a better overview and make better decisions. This ultimately enhances the suppliers' sustainability practices and results in fairer prices in the market. Nevertheless, for a green transformation success, an understanding of the reasoning of the transition and receiving monetary compensation (of stakeholder in the upstream supply chain like farmers) is central "*for a collaborative approach, you cannot simply force everything down the throat of your suppliers and your producers. Producers need to understand the why. And they need also to be compensated*." (Former CSO of C-TRADER) Setting these industry standards and facilitating stakeholder dialogue creates pressure on the industry to change by creating a social license to operate in a more environmentally friendly way.

Co-investments in green digital solutions are challenging for the agri-food industry, particularly for one stakeholder alone, such as farmers, as they run on low margins. To acquire sustainable investments, organizations' creativity and risk-taking is applied for collaborative investments: one interviewees company created a sustainable innovation hub were they eco-innovated their processes as well as their raw and waste materials while also scouting and closely working with start-ups "*When this [sustainable innovation] was first brought to our attention, I was one of the first people to visit the location. It was very, very small. It was a pilot scale. It was dealing with a couple of liters of water. But in the concept, we were prepared to work with that company to invest time to develop a proof of concept."* (Head of sustainable sourcing of a malt company) Even though sustainable innovation was at that stage just a concept, they decided to invest and collaborate to find a solution on an industry scale: *"So [sustainable innovation] is something that we believe was co-created. In fact, we have the patent for the application of this particular technology in malting. That patent is co-written by some people in our organization. We're very proud of that. We have the intellectual property on how it's been adapted. We believe improved and optimized for the industry that we belong."* (Head of sustainable sourcing of a malt company) By investing in a concept for a small-scale operation, the company co-created a technology that will optimize the water usage of the industry on a large scale. As water is the key aspect in the production of the brewery supply chain, this investment in digital innovation has a significant and wide-ranging impact on sustainability.

Another company invested in new technology like artificial intelligence (AI) which could be "*the future of food*" (Plant-based protein Advisor). In this case, one of largest food and beverage companies in the world invested in an AI software company that can replace high emissions products like animal-based products with plant-based products: "*We just announced we're doing a joint venture with [food conglomerate]. [Food conglomerate] has a whole portfolio of animal-based products, and we have this engine that can help create a plant-based portfolio and get it out into the market."* (Head of Machine Learning, AI Software company) The algorithm predicts the best compositions of plant-based ingredients to match recipes from animal-based products. AI analyzes the structure of animal-based products on a molecular level and can identify and replicate that structure by only using plant-based ingredients. The algorithm was fed by vast dataset from public data like the US Department of Agriculture, National Agricultural Library, and vast amount of private data on food formulation. The AI technology is far more efficient than the previous long trial and error product formulation processes and has far reaching impacts on environmental sustainability in the agri-food industry when applied for big industry players: "*Our mission is to change the way that people eat food, the kinds of foods that they eat, that is produced in a more sustainable manner. So, if you have a huge company like [food*

conglomerate] with global distribution – we [are] kind of getting behind that mission. It's a really positive signal and saying, 'Hey, there is something systemic here that needed addressing, and big companies are aligning with that mission." (Head of Machine Learning, AI Software company) Together, they are hoping to systemically change the industry step by step to a more sustainable future.

Intraorganizational factors concern an individual organization that is part of the supply chain. In the following, an example of a malting company is used to illustrate how they are thriving towards green transformation. A transformative mindset, organizational capabilities and nurturing a network appear to be important drivers that go hand in hand with DT and green transformation.

A key element of organization's green transformation is a **transformative mindset,** as there needs to be a strong motivation to change. The head of sustainable sourcing of a malting company passionately explained the company's mindset as the following: *"We are very passionate about what we do. We want to do the right thing and I don't say that lightly because in [company name], we do make decisions which are based on doing the right thing which is not always the easy thing to do. But that's again fully supported by our CEO."* Transformative mindset towards sustainability is enacted on a corporate management level as part of the strategy.

Another factor for a successful transformation is the organization's ability to leverage digital technologies through mature **organizational capabilities**: *"Now we have enough confidence to do it on an industrial scale. So, the journey, to be fair, it wasn't something you could just go down to your local shopping center and pick something off the shelf. This took time. It took resource and I think we're very lucky that in the leadership of our company, we have a CEO who is extremely supportive." (*Head of sustainable sourcing of a malting company). A lack of mature capabilities impacts the success of the transformative outcome.

Finally, they stated that the company "*greatly encourages networking outside of the industry as well, just to see what other people are doing."* Nurturing a **network** of stakeholders who can jointly focus their attention on specific environmental challenges is essential to creating impact. The interconnected nature of the supply chain renders isolated efforts ineffective in tackling the issues raised by green transformation.

5 Discussion

The identified factors influencing the green DT are multifaceted and often interconnected. This section showed evidence on why these factors matter for DT and drive industries towards green transformation. The heightened sustainability focus imposes different organizational challenges on companies as these might fall outside their core competencies. With the help of digital technology, these challenges can be reconciled through e.g., smart data use like machine learning. Most companies have experience with DT and can now use these capabilities (intraorganizational factors) to foster the green transformation, thus piggybacking on their DT efforts. For example, the food industry tries to find meat and dairy alternatives to lower the overall GHG footprint and respond to consumer awareness (market factors). They encounter the challenge of properly mimicking animal-based products, where digital technology like AI algorithms are able to reconcile that challenge by matching animal-based protein with plant-based protein which requires collaboration such as co-investments (interorganizational factors).

The same factors that supported the industry's DT are now key building blocks for what we call the "green DT". This study showed that DT can be leveraged for green transformation. We conceptualized green DT and showed how the green transformation piggybacks on the digital transformation in practice. 'Piggybacking' generally refers to the practice of leveraging an existing infrastructure, process, or initiative to achieve additional goals or benefits (MITSloan Management Review, 2023). It involves capitalizing on something already in place, often to gain efficiency, support, or additional value. Piggybacking in the context of the discussed research refers to leveraging existing digital transformation

efforts to facilitate or catalyze green transformation within the agri-food industry. The key idea behind piggybacking is to make use of pre-existing resources or momentum to achieve objectives more effectively or efficiently than starting from scratch. It often involves a strategic approach to leverage what's already in place for mutual benefit. It involves utilizing the momentum, technologies, and strategies developed for digital transformation to address and propel environmental sustainability goals. Essentially, piggybacking suggests that the progress made in digital transformation can be repurposed or extended to drive sustainability initiatives, creating a symbiotic relationship between digital and green transformation.

Table 2, presents an overview of how the factors of green digital transformation are piggybacking on the digital transformation.

<table>
<tr><th>DT high-level factors</th><th>Specific DT Factors</th><th>Specific GDT Factors</th><th>GDT high-level factors</th></tr>
<tr><td>Material factors</td><td colspan="2">Diffusion of Digital Technology
Digital Properties
Data Availability</td><td>DT Factors</td></tr>
<tr><td rowspan="5">Environmental Factors</td><td>Legal and Infrastructural Conditions</td><td>Regulation</td><td rowspan="3">Market Factors</td></tr>
<tr><td></td><td>Market Incentives</td></tr>
<tr><td>Consumer Demand</td><td>Consumer Awareness</td></tr>
<tr><td>Technology-driven Industry Dynamics</td><td>Co-Investments in Technology</td><td rowspan="2">Interorganizational Factors</td></tr>
<tr><td></td><td>Social License</td></tr>
<tr><td rowspan="4">Organizational Factors</td><td>Digital transformation awareness</td><td>Transformative Mindset</td><td rowspan="4">Intraorganizational Factors</td></tr>
<tr><td rowspan="2">Organizational Strategy and Legacy</td><td>Organizational Capabilities</td></tr>
<tr><td rowspan="2">Network</td></tr>
<tr><td></td></tr>
</table>

Table 2. DT and GDT comparison

As green DT (GDT) builds upon DT, the material factors of green digital transformation are essentially the same: diffusion of technology, technology characteristics (such as digital properties (Yoo, 2010), data availability (e.g. Weichert, 2017). In this case study, AI and digital platforms played a crucial role in facilitating technology diffusion for GDT.

The environmental factors of DT can be divided in market and interorganizational factors. These factors such as legal and infrastructural conditions (Cortet et al., 2016) and consumer demand (Oestreicher-Singer and Zalmanson, 2013) can be found within the market factors of the GDT. Additionally, the GDT is driven by *market incentives*, where governments or financial institutions provide additional capital for sustainability-focused technological enhancements.

Technology-driven industry dynamics like the constant diffusion of new technology (Andal-Ancion et al., 2013) are classified in the interorganizational factors of GDT. Yet, *social license* arose from environmental challenges that the industry faces on a sector level. Social license such as industry standards create pressure on other stakeholders and foster dialogue.

DTs organizational factors such as the awareness of top management like a positive attitude towards change and technology (Dery et al., 2017); organizational strategy and legacy like organization's existing processes (Benner, 2007) and resources (Krotov and Junglas, 2008) are classified in the intraorganizational GDT factors. Although the factor *network* could be part of the DT factor existing re-

sources (Krotov and Junglas 2008), GDT is important to nurture a network where organizations collectively focus their attention on addressing specific environmental challenges.

The presented table summarizes the findings and illustrate how piggybacking unfolds across different levels and factors. In the study, piggybacking is exemplified by the integration of digital technologies to foster sustainability in the agri-food industry. For instance, the implementation of AI algorithms to substitute plant-based proteins for animal-based proteins showcases how advancements in digital technology can address environmental concerns by promoting more sustainable practices. This approach acknowledges the interconnectedness of digital and green transformations, emphasizing that advancements in one domain can be strategically applied to accelerate progress in the other.

Moreover, transformation diverges across levels, in a context where organizations and society are simultaneously affected by change. Thus, a multi-level perspective can be beneficial to unpack and relate these simultaneous changes (Burton-Jones and Gallivan, 2007). The present research offers a contemporary perspective on interorganizational green IS as it pursues a multi-level perspective. The purpose of interorganizational green IS is to share information about environmental sustainability (Leidner et al., 2022). While previous studies on information sharing for sustainable purposes were without notable benefits of participating organizations (Leidner et al., 2022), this study could identify multiple areas of gains for participating organizations. Notably, organizations participating in green interorganizational IS can experience efficiency gains, such as implementing a standard reporting system for sustainability, resulting in time and cost savings when evaluating suppliers. Additionally, the integration of digital technology, like investing in AI, to substitute animal-based proteins with plant-based protein, creates new business opportunities towards environmentally friendlier solutions. The identification of coopetition possibilities, such as competitors collaborating on monetizing carbon certificates from regenerative farming practices, exemplifies how organizations can achieve significant cost-efficiency benefits while contributing to broader societal gains through green transformations.

6 Conclusion

This study provided a comprehensive exploration of how DT and green transformations within the agri-food industry are related. It uncovered driving factors that show how green transformation can piggyback on DT and lead to green digital transformation. The distressing effects of climate change highlight the urgency for the agri-food industry as a major contributor to greenhouse gas emissions to re-evaluate and transform its business practices. As the agri-food industry lags in technology adoption (Harvard Business Review, 2016), DT emerges as a potent catalyst for green transformation (Melville, 2010; vom Brocke et al., 2013). By adopting a multi-level approach, this study identified factors influencing green DT, showcasing the interconnectedness and multifaceted nature of these driving factors.

Notably, this study focused mainly on the agri-food industry, offering a targeted glimpse into the potential of digital technologies to drive environmental sustainability. Importantly, piggybacking on existing DT efforts proves integral to navigating uncertainties and leveraging established momentum, technologies, and strategies for mutual benefit. This strategic approach allows the green DT to capitalize on pre-existing resources, enhancing efficiency and effectiveness in achieving sustainability goals.

While this study unveils the present landscape, the long-term impact of green DT remains uncertain. Piggybacking on existing DT initiatives provides a pragmatic and strategic framework for extending the reach and impact of sustainability efforts. Further research is essential to comprehend how these digital technologies will impact sustainability within value chains over time. To uncover the long-term implications of the green DT, further longitudinal studies should be conducted.

This study should be viewed as a snapshot of how digital technologies and DT efforts can impact the green transformation. This study focused specifically on some cases of the agri-food industry. Thus, further studies could deep dive into different aspects of the agri-food industry. As every industry is unique and has different value chain set-ups and power dynamics, future studies could explore the fac-

tors in other industries such as the well-advanced energy sector. This can enrich the understanding of the broader implications of the green DT. This research unravels the complexities of the evolving landscape of green DT, yet much work remains to comprehensively grasp.

References

Andal-Ancion, A., Cartwright, P. and Yip, G. (2003). "The digital transformation of traditional business." *MIT Sloan Management Review*, 34–41.

Aubert, B. A., Schroeder, A., and Grimaudo, J. (2012). "IT as enabler of sustainable farming: An empirical analysis of farmers' adoption decision of precision agriculture technology". *Decision Support Systems, 54*(1), 510-520.

Bai, C., and Sarkis, J. (2013). "Green information technology strategic justification and evaluation". *Information Systems Frontiers, 15*(5), 831-847.

Baiyere, A., Hannu, S. and Tapanainen,T. (2020): "Digital transformation and the new logics of business process management." *European journal of information systems* 29.3 238-259.

Bendig, D., Schulz, C., Theis, L., and Raff, S. (2023). "Digital orientation and environmental performance in times of technological change". *Technological Forecasting and Social Change, 188*, 122272.

Bengtsson, F., and Ågerfalk, P. J. (2011). "Information technology as a change actant in sustainability innovation: Insights from Uppsala." *Journal of Strategic Information Systems, 20*(1), 96-112.

Benner, M. J. (2007). "The incumbent discount: Stock market categories and response to radical technological change." *Academy of Management Review*, 32, 703–20.

Brynjolfsson, E., Hu, Y. and Rahman, M. (2013). "Competing in the age of omnichannel retailing". *MIT Sloan Management Review*, 54, 23–9.

Coffey, P., Tate, M., and Toland, J. (2013). "Small business in a small country: Attitudes to "Green" IT." *Information Systems Frontiers, 15*(5), 761-778.

Coile, R. (2000). "The digital transformation of health care". *The Physician Executive*, 26, 8–15.

Cooper, V., and Molla, (2017). "Information Systems Absorptive Capacity for Environmentally Driven IS-Enabled Transformation," *Information Systems Journal* 27 (4), 379-425.

Corbett, J. (2013). "Designing and Using Carbon Management Systems to Promote Ecologically Responsible Behaviors," *Journal of the Association for Information Systems* 14(7), 339-78.

Dedrick, J. (2010). "Green IS: concepts and issues for information systems research." *Communications of the Association for Information Systems, 27*(1), 11.

Dery, K., Sebastian, I. M. and van der Meulen, N. (2017). "The digital workplace is key to digital innovation'. *MIS Quarterly Executive*, 16, 135–52.

Dong, M. C., Fang, Y., and Straub, D. W. (2017). "The Impact of Institutional Distance on the Joint Performance of Collaborating Firms: The Role of Adaptive Interorganizational Systems," *Information Systems Research* 28 (2), 309-331.

FAO (2019). "Food in the Anthropocene: the EAT–Lancet Commission on healthy diets from sustainable food systems." *The Lancet, 393*(10170), 447-492.

Food and Agriculture Organization of the United Nations (2021). The share of food systems in total greenhouse gas emissions. Global, regional and country trends, 1990–2019. *FAOSTAT Analytical Brief* Series No. 31. Rome.

Food and Agriculture Organization of the United Nations. (2022). "Saving our soils by all earthly ways possible". URL: https://www.fao.org/fao-stories/article/en/c/1599222/

Gallaugher, J. and Ransbotham, S. (2010). "Social media and customer dialog management at Starbucks". *MIS Quarterly Executive*, 9, 197–212.

Gandhi, P., Khanna, S., Ramaswamy, S. (2016). "Which industries are the most digital (and why)?" *Harvard Business Review*. URL: https://hbr.org/2016/04/a-chart-that-shows-which-industries-are-the-most-digital-and-why

George, G., and S.J.D, Schillebeeckx (2021). "Digital sustainability and its implications for finance and climate change". *Macroeconomic Review* 10(1), 103-108.

George, G., R.K. Merrill, and S.J.D, Schillebeeckx (2021). Digital sustainability and entrepreneurship: How digital innovations are helping tackle climate change and sustainable development. *Entrepreneurship Theory and Practice* 45(5), 999-1027.

Graf-Drasch, V.; Kauffeld, L. Kempf, L.; Oberländer, A. M.; and Teuchert, A. (2023) "Driving Twin Transformation – The interplay of digital transformation and sustainability transformation". *ECIS 2023 Proceedings.*

Hanelt, A., Bohnsack, R., Marz, D., and Antunes Marante, C. (2021). "A systematic review of the literature on digital transformation: Insights and implications for strategy and organizational change." *Journal of Management Studies, 58* (5), 1159-1197.

Hanelt, A., Sebastian, B., and Lutz, M. K. (2017). "Driving Business Transformation toward Sustainability: Exploring the Impact of Supporting IS on the Performance Contribution of Eco- Innovations," *Information Systems Journal* 27 (4), 463-502.

Henfridsson, O. and Yoo, Y. (2013). 'The liminality of trajectory shifts in institutional entrepreneurship'. *Organization Science*, 25, 932–50.

Hu, P. J.-H., Hu, H.-F., Wei, C.-P., and Hsu, P.-F. (2016). "Examining firms' Green information technology practices: A hierarchical view of key drivers and their effects." *Journal of Management Information Systems, 33*(4), 1149-1179.

Kaganer, E., Gregory, R. W., & Sarker, S. (2023). "A process for managing digital transformation: An organizational inertia perspective." *Journal of the Association for Information Systems*. 24(4), 1005-1030.

Kiron, D. and Unruh, G. (2018). "The Convergence of Digitalization and Sustainability" *MIT Sloan Management Review*. URL: https://sloanreview.mit.edu/article/the-convergence-of-digitalization-and-sustainability/

Kotlarsky, J.; Oshri, I.; and Sekulic, N. (2023). "Digital Sustainability in Information Systems Research: Conceptual Foundations and Future Directions," *Journal of the Association for Information Systems*, 24(4), 936-952.

Krotov, V. and Junglas, I. (2008). "RFID as a disruptive innovation". *Journal of Theoretical and Applied Electronic Commerce Research*, 3, 44–59.

Kurkalova, L. A., and Carter, L. (2017). "Sustainable production: Using simulation modeling to identify the benefits of Green information systems". *Decision Support Systems, 96*, 83-91.

Leidner, D. E., Sutanto, J., and Goutas, L. (2022). "Multifarious Roles and Conflicts on an interorganizational green IS". *MIS Quarterly*, 46 (1), 591-608

Loeser, F., Recker, J., vom Brocke, J., Molla, A., and Zarnekow, R. (2017). "How IT Executives Create Organizational Benefits by Translating Environmental Strategies into Green IS Initiatives," *Information Systems Journal*. 27(4), 503-553.

Loock, C-M., Thorsten, S., and Frédéric, T. (2013). "Motivating Energy-Efficient Behavior with Green IS: An Investigation of Goal Setting and the Role of Defaults," *MIS Quarterly* 37 (4), 1313-1332.

Lucas, H. C. and Goh, J. M. (2009). "Disruptive technology: How Kodak missed the digital photography"

Mair, J., and T. Gegenhuber (2021). "Open social innovation". *Stanford Social Innovation Review*, 19(4), 26-33

Markus, M. L. and Robey, D. (1988). 'Information technology and organizational change: Causal structure in theory and research'. *Management Science*, 34, 583–98.

Melville, N. P. 2010. "Information Systems Innovation for Environmental Sustainability," *MIS Quarterly.* 34(1), 1-21.

Merton, R. K. (1987). "Three fragments from a sociologist's notebooks: Establishing the phenomenon, specified ignorance, and strategic research materials". *Annual review of Sociology.* 13(1), 1-29.

Nishant, R., Teo, T. S. and Goh, M. (2017). "Do Shareholders Value Green Information Technology Announcements?," *Journal of the Association for Information Systems* 18 (8), 542-576.

Oestreicher-Singer, G. and Zalmanson, L. (2013). "Content or community? A digital business strategy for content providers in the social age". *MIS Quarterly*, 37, 591–616.

Pan, S. L., Li, M., Pee, L. G., and Sandeep, M. S. (2020). "Sustainability design principles for a wildlife management analytics system: An action design research". *European Journal of Information Systems, 30*(4), 452-473.

Pan, S.L., and Zhang, S. (2020). "From fighting COVID-19 pandemic to tackling sustainable development goals: An opportunity for responsible information systems research". *International Journal of Information Management* 55, 102196

Parker, G. G., Van, A. M. W., and Choudary, S. P. (2016). *Platform revolution : How networked markets are transforming the economy and how to make them work for you.* W. W. Norton & Company, Inc.

Petrini, M., and Pozzebon, M. (2009). "Managing sustainability with the support of business intelligence: Integrating socio-environmental indicators and organisational context". *Journal of Strategic Information Systems, 18*(4), 178-191.

Savaget, P. (2023). "The "Piggyback" approach to innovation." *Harvard Business Review.* URL: https://hbr.org/2023/11/the-piggyback-approach-to-innovation

Sebastian, I., Mocker, M., Ross, J., Moloney, K., Beath, C. and Fonstad, N. (2017). 'How big old companies navigate digital transformation'. *MIS Quarterly Executive*, 16, 197–213.

Seidel, S., Chandra Kruse, L., Székely, N., Gau, M., and Stieger, D. (2018). "Design principles for sensemaking support systems in environmental sustainability transformations." *European Journal of Information Systems, 27*(2), 221-247. "

Seidel, S., Kruse, L. C., Székely, N., and Gau, M. 2017. "Design Principles for Sensemaking Support Systems in Environmental Sustainability Transformations," *European Journal of Information Systems* 27 (2), 221-247.

Seidel, S., Recker, J., and vom Brocke, J. (2013). "Sensemaking and Sustainable Practicing: Functional Affordances of Information Systems in Green Transformations," *MIS Quarterly* 37(4), 1275-1299.

Tim, Y., Cui, L., & Sheng, Z. (2021). "Digital resilience: How rural communities leapfrogged into sustainable development." *Information Systems Journal*. 31(2), 323-345.

Tim, Y., Pan, S. L., Bahri, S., and Fauzi, A. (2018). Digitally enabled affordances for community-driven environmental movement in rural Malaysia. *Information Systems Journal, 28*(1), 48-75.

United Nations. (1987). "Our Common Future." Oxford University Press.

Verhoef, P. C., Broekhuizen, T., Bart, Y., Bhattacharya, A., Dong, J. Q., Fabian, N., and Haenlein, M. (2021). "Digital transformation: A multidisciplinary reflection and research agenda". *Journal of business research, 122*, 889-901.

Vial, G. (2019). 'Understanding digital transformation: A review and a research agenda'. *Journal of Strategic Information Systems*, 28, 118–44.

Volkoff, O., Strong, D. M. and Elmes, M. B. (2007). "Technological embeddedness and organizational Change". *Organization Science*, 18, 832–48.

vom Brocke, J., Watson, R. T., Dwyer, C., Elliot, S., and Melville, N. (2013). "Green information systems: Directives for the IS discipline." *Communications of the association for information systems*, 33(1), 30.

Wade, M. (2020.). "Corporate Responsibility in the Digital Era." *MIT Sloan Management Review*: https://sloanreview.mit.edu/article/corporate-responsibility-in-the-digital-era/

Walsham, G. (1995). "Interpretive case studies in IS research: nature and method." *European Journal of information systems*, 4(2), 74-81.

Wamba, S. F. and Chatfield, A. (2009). "A contingency model for creating value from RFDI supply chain network projects in logistics and manufacturing environments". *European Journal of Information Systems*, 18, 615–36.

Watson, R. T., Boudreau, M. C., and Chen, A. J. (2010). "Information Systems and Environmentally Sustainable Development: Energy Informatics and New Directions for the IS Community," *MIS Quarterly* 34 (1), 23-38.

Weichert, M. (2017). "The future of payments: How FinTech players are accelerating customer-driven inno- vation in financial services". *Journal of Payments Strategy & Systems*, 11, 23–33.

Wessel, L., Baiyere, A., Ologeanu-Taddei, R., Cha, J. and Blegind-Jensen, T. (2021). "Unpacking the difference between digital transformation and IT-enabled organizational transformation". *Journal of the Association for Information Systems*, 22 (1), 102-129.

World Economic Forum (2019). "Digital technology can cut global emissions by 15%. Here's how". URL: https://www.weforum.org/agenda/2019/01/why-digitalization-is-the-key-to-exponential-climate-action/

Yoo, Y. (2010). "Computing in everyday life: A call for research on experiential computing". *MIS Quarterly*, 34, 213–31.