

Perspectives on the twin transition: Instrumental and institutional linkages between the digital and sustainability transitions

Albert Meijer

Utrecht University School of Governance, Bijlhouwerstraat, Utrecht, The Netherlands

E-mail: a.j.meijer@uu.nl

Abstract. A rich academic understanding of the relation between e-governance and sustainable development is crucial for studying the current ‘twin transition’, i.e. the connection between the digital and sustainability transition. An analysis of current literature highlights that there is a strong emphasis on the question how e-governance can be an instrument for realizing sustainable development. This research is important but does not cover all relevant problem areas. Our conceptual analysis extends the dominant focus on the digital and sustainable transitions to include destructive connections – the environmental costs of e-government – and an institutional perspective on e-governance. Developing multiple perspectives on the twin transition is crucial since the current, seemingly unconditional, faith in the power of technology, may hamper a fundamental debate on the contribution of e-governance to sustainable development. This paper concludes with a research agenda that stresses the need to study three key issues: (1) green e-governance as mitigating the environmental costs of e-governance, (2) e-governance as a barrier for the sustainability transition, and (3) the ecology logic as a basis for shaping the twin transition.

Keywords: Sustainable development, SDGs, digital transformation, twin transition, institutional logic

Key points for practitioners:

- Governments should not only focus on positive connections between the digital transformation and the sustainability transformation but also pay attention to the environmental costs of the digital transformation;
- Too much faith in the power of the digital transformation to realize the sustainability transformation is potentially dangerous since it may prevent governments from realizing the much needed structural changes;
- Taking an ecological perspective on the digital transformation which emphasizes long-termism and holism is important for realizing the twin transition at the deeper level of changing power, values, norms and perceptions.

1. Introduction

Environmental sustainability problems are often framed as technological challenges (Hansson, 2010) and the attention for the contribution of electronic governance to finding solutions for these challenges is increasing (as witnessed by earlier publications such as Estevez & Janowski, 2013; Janowski, 2016; Medaglia et al., 2021). Current threats such as global warming, decreasing biodiversity and environmental pollution are seen as challenges that can be tackled through innovative solutions. Technological systems such as electronic governance, are to bring us, among other things, clean energy systems, sustainable modes of transport, protection against flood and forest fires, clean air and green agriculture (Evans et

al., 2019; Tomor et al., 2019). The value of technology is highlighted time and again, and the need to tackle environmental sustainability problems is one of the key arguments for investing in research and development of new technologies.

The hopeful perspective on the relation between, on the one hand, technology in general and electronic governance specifically and, on the other hand, environmental sustainability in general and sustainable development specifically, is dominant but not the only perspective on the relation presented in the literature. Critical voices highlight the environmental costs of technologies and stress that new technologies also have a negative effect on the sustainability of our planet (Chou & Chou, 2012). The energy and environmental costs of data warehouses, data processing and maintenance of infrastructures is increasingly acknowledged and there is a growing emphasis on sustainable information systems or ‘green IT’ (Murugesan, 2008). While the criterion ‘sustainability’ is still not used much to decide upon the selection of electronic governance solutions, consciousness about this issue has grown in the private sector (Molla & Cooper, 2010) and may be expected to also grow in the public sector in the coming years.

While the problem-solving value of technology is often emphasized and the problem-generating elements are increasingly addressed, the transformational connection between technology and environmental sustainability – the ‘twin transition’ (Almansour, 2022) – has only recently been receiving some attention. A recent report from the European Union has highlighted the key role that this twin transition – the green and digital transitions – is crucial for its sustainability policies (Muench et al., 2022). In this report with the title ‘Toward a green and digital future’, key requirements for successful twin transitions in the European Union are identified in the social, technological, environmental, economic, and political domains. The key message of the report is formulated as follows: ‘To unlock their potential and to prevent negative effects, the green and digital transitions require a proactive and integrated management.’ (Muench et al., 2022, p. iv).

The focus on transitions rather than on instrumental usage highlights how current institutional forms are challenged by the need to respond to sustainability problems and pushed by technologies that facilitate new organizational and societal interactional patterns. The agenda proposed by the EU in the report ‘Toward a green and digital future’ aims to stimulate new forms of governance based on innovative usage of information and communication technologies to realize sustainable development. This transition perspective on the connection between technology and sustainability stresses the institutional connections between technology and development and builds upon the research tradition that views technology as an institution rather than an instrument (Kling & Iacono, 1989; Fountain, 2001; Luna-Reyes & Gil-Garcia, 2011; Hinings et al., 2018).

In this theoretical and conceptual article, we will argue that there is a growing realization of the need to focus electronic governance on the realization of sustainable development but the current literature fails to explore institutional nature of the twin transition. To fill this gap in our conceptual understanding of the relation between e-governance and sustainable development, this paper presents a systematic overview of the relations between e-governance and environmental sustainability and a research agenda for investigating the twin transition at both an instrumental and an institutional level. This paper uses the distinction between an instrumental and an institutional perspective on technology (Kling & Iacono, 1989; Luna-Reyes & Gil-Garcia, 2011; Hinings et al., 2018) as a basis for our map of the relations between e-governance and sustainable development. We analyze the relations between e-governance and sustainable development both at the level of the instrumental decisions and the level of fundamental ontological and normative axioms. In this paper, we will show that e-governance can be framed both as a solution and problem for sustainable development for the instrumental and institutional levels. At the same time, the research attention for the different relations varies considerably and thus we will identify new directions for research.

The paper is based on the analysis of publications on this topic from different fields such as e-governance studies, public administration, public management and science and technology studies. We use both classical sources and current literature to develop new theoretical understandings and provide empirical illustrations. This ambition of this paper is to enrich our conceptual understanding of the twin transition (Almansour, 2022; Muench et al., 2022) and to identify key topics for the academic and societal agenda.

2. Building blocks and roadmap for our line of argument

We will start this paper with conceptual clarification. In the literature, many different perspectives on both sustainable development and electronic governance have been presented. In addition, the institutional perspective is a very rich perspective on technology which has been presented in various ways. A short note on our understanding of the key concepts and our use of the institutional perspective is needed to ensure a correct reading of our argument. We do not pretend to provide a substantive discussion but we aim to provide clarity about our understanding of these concepts and institutional theory within the framework of this paper.

While the concept of *sustainability* is applied increasingly broadly, our analysis focuses primarily on environmental sustainability (SDGs 13 (climate action), 14 (life below water) and 15 (life on land)) and its relations to economic development. The starting point for the concept ‘sustainable development’ was the well-known Brundtland Report on ‘our common future’ (World Commission on Environment and Development, 1987). Kemp et al. (2005) have analyzed how the problems of ecological degradation and uneven development gave rise to the new concept of ‘sustainable development’. This concept created a new pathway for development that was not based on the resource intensive, exploitative and polluting forms of development that were previously dominant. The concept of sustainable development highlighted the need to not balance development and ecology but integrate these two desirable outcomes. This concept spurred not only a wide range of academic publications but also made a huge impact on societal and governmental debates about course for development. More recently, the United Nations (2017) has shaped the global agenda for sustainable development and operationalized objectives through its Agenda for the Sustainable Development 2030. This agenda follows up on the previous millennium goals and presents operational objectives for 17 areas ranging from no poverty to affordable and clean energy. All these objectives are in line with the double ambition inherent to the concept of sustainable development. In this paper, we follow the classical definition from the Brundtland Report: ‘Sustainable Development is the development that satisfies the needs of the present without compromising the ability of future generations to meet their own needs.’ (World Commission on Environment and Development, 1987, par. 27).

In discussions of sustainable development, technology plays a key role (Saetra, 2023). Interestingly, technology is both framed as a key element in solving a broad variety of sustainability problems through solar energy, electrical mobility, clean industries, etc. and also as a key cause of a variety of environmental problems by contributing to global warming through fossil fuel combustion, by polluting the air through industrial production and by ruining our ecological environment through massive exploitation of resources. The solution and problem frames are often connected and then technology is presented as a solution for problems that were created by the use of technology (Saetra, 2023). In addition, these frames are hardly straight forward in the sense that positive and negative effects may be unevenly divided over different stakeholder groups. These two frames, however, can analytically be used to distinguish arguments on how technology should be stimulated and developed to transform current practices (‘technology as a solution’) from arguments that emphasize how technology use needs to be minimized or how effects need to be mitigated to ensure a minimum negative effect on the environment (‘technology as a problem’).

Electronic governance is a concept that was introduced in the literature to capture the broader application of new technologies, not only in government services but also in networks of public and private actors. Based on Grönlund and Horan (2005), Estevez and Janowski (2013) present a nuanced discussion of the difference between electronic government and electronic governance. They emphasize that electronic government is about what is happening within government and electronic governance, in line with the broad literature on governance (Bevir, 2012), refers to the whole system involved in managing the society. In a similar vein, Dawes (2008, p. 586) presents the following definition that we will follow in this paper: “e-Governance comprises the use of Information and Communication Technologies (ICTs) to support public services, government administration, democratic processes, and relationships among citizens, civil society, the private sector, and the state”.

In addition to the conceptualizations of sustainability and e-governance, we need to be precise about how we will use the *institutional perspective on technology*, which is a key perspective in socio-technical studies of technology in society. We can certainly not discuss all the nuanced and different positions but we do think it is important to highlight how we will apply this perspective. In the literature on technology in organizations, the institutional perspective was introduced by Kling and Iacono (1989) who build on classical work from organizational science on an institutional perspective (Selznick, 1957; Perrow, 1979; Meyer & Rowan, 1977; Scott, 1987). Kling and Iacono (1989) highlight that the use of technology is closely entangled with social and political choices and that these choices become embedded in technological systems which thus become carriers of values and interests rather than neutral instruments. More recent analyses build upon these key insights but add insights from science and technology studies (STS) and extend the analyses to large infrastructural systems, such as the internet (Winter et al., 2014). Also, conceptual work in the field of e-government studies has translated this perspective to the study of e-governance (Fountain, 2001; Luna-Reyes & Gil-Garcia, 2011; Hinings et al., 2018). Influential in the field of IS research has been Orlikowski’s (1992) translation of Giddens’ (1984) rich and nuanced perspective on institutions. In this paper, we will follow Giddens’ (1989) and Orlikowski’s (1992) work on structuration and apply their three-dimensional perspective by focusing on values, power relations and epistemologies (see also Jones & Karsten, 2008). We will integrate these dimension in the overarching term ‘logic’ as an overarching label for characterizing the institution features (Thornton & Ocasio, 2008). This perspective is not used for a rigorous analyses of specific practices but rather to map overarching perspectives on the relation between e-governance and sustainable development.

Building upon these conceptualizations, we will analyze the relations between electronic governance and sustainable development on the basis of an analytical model that consists of two dimensions: (1) instrumental and institutional perspectives on technology and (2) a focus on the destructive and constructive contributions of technology to sustainable development. We fully acknowledge that there are various approaches that could be used to discussing the relations between e-government and sustainable development. One can focus on developmental stages of e-government, types of e-government (Layne & Lee, 2001), level of transformation of e-government (Janowski, 2015) and one can focus on differences between mitigation and adaptation strategies (VijayaVenkataRaman et al., 2012) and between a focus on different aspects of ecological sustainability (e.g. biodiversity, global warming, resource depletion) (Mooney et al., 2009). We chose our focus since we believe it provides a basis for highlighting key ontological differences (technology as instrument or institution) and key normative debates (destructive or constructive power of technology).

Building upon these conceptualizations of e-governance and sustainable development and the two dimensions, this paper discusses four different relations between e-governance and sustainable development. Table 1 presents an overview of the four sets of relations that we will discuss in this paper.

Table 1
Relations between e-governance and sustainable development

		Technology as an instrument			
		Green IT		EGOV4SD	
Technology as a problem	Mitigating the negative effects of e-governance on sustainable development (<i>section 4</i>)		E-governance as instrument for realizing sustainable development (<i>section 3</i>)		Technology as a solution
	Machine logic of e-governance E-governance as a logic that is environmentally destructive (<i>section 5</i>)		Ecology logic of e-governance E-governance as a logic that is environmentally constructive (<i>section 6</i>)		
		Technology as an institution			

Our discussion of this table will focus on providing an overview of the four perspectives. Our exploration serves to identify relevant research questions as a basis for a research agenda for each cell. The exploration is based on an explorative analysis of the literature which was rather different for each cell since from some cells there was a large amount of studies whereas other relations are hardly discussed in the literature:

- The literature for the cell ‘EGOV4SD’ is rather expansive and therefore we focused on analyzing some overview papers, often systematic literature reviews (most importantly: Heeks, 2006; Estevez & Janowski, 2013; Tomor et al., 2019; Medaglia et al., 2021).
- In contrast, there was hardly any literature for the cell ‘Green IT’ and therefore we build upon key studies from research into green IT in the private sector (Eastwood, 2009; Chou & Chou, 2012; Malhotra et al., 2013; Darshana et al., 2017) and discussed the implications for Green IT in the public sector.
- No specific literature was available for the cell ‘Machine logic of e-governance’ and therefore we build our argument for this cell on classic studies on sustainable development (Carson, 1962; Daly, 1974; Parfit, 1984) and connected this to critical reviews of e-government studies (Morozov, 2014; Meijer & Bekkers, 2016; Van Dijck et al., 2018).
- Finally, for the cell ‘Ecology logic of e-governance’, we analyzed key text on the use of the ecology metaphor for understanding information systems in government (Nardi & O’Day, 2000; Meijer et al., 2019).

This paper does not provide an exhaustive overview of relevant literature but aims to provide a conceptual understanding of the different relations between e-governance and sustainable development as a basis for a research agenda for investigating the twin transition.

3. EGOV4SD: Instrument for realizing sustainable development

The instrumental potential of e-governance to provide a broad range of solutions to environmental problems is highlighted in various articles (which according to Medaglia et al. (2021) still only form a small fraction of the total body of literature on digital government). E-governance is argued, for example, to be crucial for the development of sustainable smart cities (Corbett & Mellouli, 2017; Bibri & Krogstie, 2017; Tomor et al., 2019). A comprehensive overview of possible applications e-governance contributions to all the 17 SDGs is presented by Agbozo (2018). Policy plans highlighting the connection between e-governance and the realization of the SDGs fit perfectly within this perspective and fit within what Taffel (2018, p. 163) refers to as a ‘metanarrative of technological progress has been fueled by decades of advances in computational, networked, mobile and pervasive technologies’.

Table 2
 USAGE: E-governance as instrument for sustainable development

The European Horizon 2020 Project USAGE (Urban Data Space for Green Deal, www.usage-project.eu) presents an example of the optimistic line of argument regarding the connection between e-governance and sustainable development. The ambition of this project is to support European cities in using data-driven approaches for tackling climate change. The project focuses on four European cities with different uses of technologies and different aims for sustainable development: (1) Ferrara (Italy) aims to expand green spaces, mitigating heat islands and flash flooding events, with Internet of Things and sensor data, (2) Leuven (Belgium) aims to become climate neutral by 2050 with machine-learning to identify buildings suitable for green roofs, (3) Graz (Austria) aims to model, simulate and predict urban climate conditions with artificial intelligence and real-time environmental data and (4) Zaragoza (Spain) aims to connect citizen participation, open data and geospatial data to local Green Deal priorities.

In their rich and foundational paper on electronic governance for sustainable development, Estevez and Janowski (2013, p. S96) develop the concept of EGOV4SD (Electronic Governance for Sustainable Development) which neatly captures the argument related to e-governance as a solution for sustainable development (see also: Durkiewicz & Janowski, 2021):

‘EGOV4SD is the use of ICT to support public services, public administration, and the interaction between government and the public, while making possible public participation in government decision-making, promoting social equity and socio-economic development, and protecting natural resources for future generations.’

EGOV4SD can be regarded as the follow-up to earlier research in ICT4D (Heeks, 2006; Dzhusupova et al., 2011). The range of topics addressed in this literature is broad and ranges from delivering basic services like water, electricity, housing and waste management to prioritizing and raising awareness about environmental issues and monitoring and enforcing regulations (Estevez & Janowski, 2013).

In the literature on smart cities, there is much attention for the use of technologies in governance as a solution for the realization of the sustainable development goals. Various domains are discussed such as the quality of drinking water (Corbett & Mellouli, 2017), smart mobility (Docherty et al., 2018), green energy (Mosannenzadeh et al., 2017), public green spaces (Corbett & Mellouli, 2017), circular economy (Rukanova et al., 2021) and smart housing (Tomor et al., 2019). The overall argument is that smart forms of governance based on innovative IT solutions will help urban governments to transform their cities into more sustainable environments (Tomor et al., 2019). An example of this line of argument is presented in Table 2.

The literature generally focuses on perceived benefits and on ways of realizing these through better forms of implementation. Adverse and perverse effects are largely ignored. Tomor et al. (2019, p. 13) emphasize that use of technologies focusing on sustainable development may also produce adverse effects such as increased emissions in other domains than targeted through the technologies, a growth in energy intensive modes of transport and disempowerment of citizens. These adverse effects of policy interventions are not yet well understood and also largely ignored in academic research which focuses on measuring success rather than understanding adverse or perverse effects. Additionally, Medaglia et al. (2021) highlight that investment in ICTs may also result in opportunity costs when this drains away resources from other sustainable development goals

In sum, the literature on e-governance as a solution for sustainable development is quite extensive (for overviews: Estevez & Janowski, 2013), especially when we also take the literature on smart governance for sustainable cities into account (for an overview: Tomor et al., 2019). This literature is quite optimistic and addresses all kinds of opportunities for strengthening sustainable development through the use of new technologies. The literature emphasizes that certainly not all opportunities are being use and especially Tomor et al. (2019) stress that the optimism has not yet materialized: there is little evidence

that e-governance actually delivers upon its promise and this could actually also mean that e-governance results in opportunity costs (Medaglia et al., 2021). Finally, Tomor et al. (2019) emphasize that in the academic literature on smart governance, there is little attention for the negative effects of e-governance for sustainable development. The negative relation, e-governance as a problem for sustainable development, is addressed in other, more narrowly focused, literature on 'green IT'.

4. Green e-governance: Mitigating negative sustainability effects

While digital technologies may play a key role in managing processes that are crucial for sustainable development such as traffic management and monitoring air quality, the use of ICTs in itself requires extensive energy resources. To understand the problem frame in the instrumental relation between e-governance and environmental sustainability, in our terms: 'e-governance as a problem', we need to delve into the literature on 'Green IT'. Building upon Malhotra et al. (2013), the concept of 'Green IS' refers to the study of the design, implementation and impact of information systems on sustainable development and thus this concept neatly captures the essence of the previous section. The concept of 'Green IT', however, refers to the study of energy efficiency and equipment utilization. The basic idea of Green IT is that whereas our analysis in Section 3 focused on greening via IT – using IT to make society more sustainable – Green IT is about greening of IT – reducing the environmental sustainability costs of the use of IT (Darshana et al., 2017).

Building upon the broader literature on green IT (Chou & Chou, 2012), the potential negative impact of e-governance on the environment through its extensive use of energy resources is highlighted. A negative relation between e-governance and the SDGs is highlighted in this perspective and mitigation is required to limit these negative impacts. The need for developing 'green e-government', for example, is identified to limit the negative impacts of e-governance and CO₂-emissions. This concept, thus, highlights the need to minimize the negative impacts of the use of ICTs for governance such as the energy usage of large data warehouses used to store, retrieve and process government data. This perspective is summarized in the following definition of green IT as 'a collection of strategic and tactical initiatives that directly reduces the carbon footprint of an organization's computing operation' (Eastwood (2009) in: Asadi et al. (2018, p. 106)).

A variety of strategies is proposed to mitigate these negative effects and minimize the carbon footprint of e-governance. The life cycle approach is used by Murugesan (2008) to map four domains of green IT: green use, green design, green manufacturing and green disposal of IT systems. These domain help to enhance our understanding of the various actions that organizations can take to reduce sustainability costs. While green use focuses on reducing the energy consumption associated by environmentally friendly forms of using information systems (e.g. by using green energy), green design considers designing energy-efficient equipment. Green disposal emphasizes the need to repair and the recycle electronic equipment and green manufacturing refers to modes of production of computers that have minimal or no impact on the environment.

The literature review by Darshana et al. (2017) provides an overview of studies into green IT, from three disciplines: computer science, information systems and management. They highlight that new approaches have been developed to reduce the environmental sustainability costs of IT and a variety of strategies has been identified to implement these strategies in organizations. More specifically, they identify the following green technological practices: algorithmic efficiency, resource allocation, power management, virtualization, data center design and management, materials recycling and product longevity. Thus: approaches for greening IT seem widely available. At the same time, they note that organizations are

Table 3
UK government's strategy for green e-governance

The policy paper on greening government by UK's Department for Environment Food & Rural Affairs (2020) presents an example of a government's commitment to Green IT. The following commitment is expressed in this policy paper: 'Sustainability is central to the procurement, design and management of digital services and ICT to reduce costs and carbon. Wherever possible, waste is removed from the system, for example redundant services, duplicate files, legacy ICT systems and hardware, promoting shared systems and services across HMG.' The ambition is to realize net zero emission by 2050 or sooner. This highlights that the ideas about Green IT from the private sector are also integrated in government visions. At the same time, this commitment is still rather new and certainly not yet widely embraced by governments around the world.

reluctant to adhere to green IT practices when this has no direct value to them. This is also one of the reasons why certain studies highlight not only the sustainability gains but also the financial benefits of green it (Brooks et al., 2010).

Even though there is some literature on green IT for private sector organizations, to our surprise this topic has not yet received any attention in the community of e-governance scholars. Searches in the Web of Science on the terms "green e-government", "green e-governance", "green digital government" and "green digital governance" gave no hits at all. One conference paper, Zamou and Pramatarari (2011), assesses the environmental impact of e-government services by using a process based method and the Life-Cycle Assessment methodology and find that e-government services have different environmental profile. They argue that the parameter of environmental sustainability should be considered when implementing e-governance to reduce environmental impacts by focusing most importantly on reduction of energy usage. The idea of green e-governance is also observed in a very limited number of policy visions (see Table 3).

Overall, the discussion in the literature on e-government as a problem for sustainable development is quite hopeful in the sense that solutions for mitigating the negative side effects have been proposed and are expected to be effective. This confidence is currently hardly based on research that systematically maps the sustainability costs of e-governance and the effects of energy-saving measures. Also, even though front runners in governance have acknowledged the need to work on green IT, the attention for these side effects and the need to pay attention to the environmental sustainability costs of e-governance have not yet been widely acknowledged in government programs. We found it quite telling that terms such as 'green e-governance' or 'green e-government' are, not yet used in the academic literature or in policy reports.

5. Machine logic of e-governance: Environmental destruction through technology

While the previous sections discussed direct, instrumental relations between e-governance and sustainable development, we will now explore the institutional relations. There is no specific literature on this perspective but the perspective taps into a but long running stream of critical analyses of technology. We'll start with (classical and modern) perspectives that express a highly critical view on technology and at the basis argue that technology is one of the root causes of our current environmental sustainability crisis. These analyses fits within what Taffel (2018, p. 163) refers to as an 'apocalyptic discourse of the Anthropocene, whereby human activity is understood to be responsible for precipitating the sixth mass extinction of life in Earth's geological record'. From a critical perspective, classic and influential authors from different disciplines technology and sustainability (Carson, 1962; Daly, 1974 and many others), have argued that the current environmental destruction is at least partly based on a technocratic frame – the machine – with little or no attention for human and ecological aspects. These analyses are fundamental in nature but need to be considered for a critical analysis of the current institutional logic of e-governance.

A first argument against the logic of technology concerns its blind faith in technology as the main pathway towards progress. In her classic book ‘*Silent Spring*’, Carson (1962) analyzes the destructive logic of resource intensive agriculture through the use of pesticides and how this had resulted in massive death of birds. This book played a key role in putting the environmental costs of economic activity on the agenda but also linked directly to the question how science contributed to societies. The pesticides had been developed through scientific activities and were seen as a major contribution to generating food security and economic prosperity. The neglect, however, of the impact on the ecology was identified as a core feature of technological development. Technological development was targeted at specific objectives and failed to include a rich understanding of ecological systems. This analysis was certainly not specifically targeted at information technology, let alone e-governance, but it highlights the limitations of an instrumental logic with a narrow focus. In that sense, it connects to a broader analysis of the destructive nature of the use of digital technologies for our democracies (Noam, 2005) and for human learning (Baron, 2021). Carson’s (1962) analysis also highlights the risks of blind faith in technology and stresses the need to consider the option not to use technological solutions. This risk is certainly relevant for debates about use of technology in society in general since the non-technological option is often not considered at all (Morozov, 2014). The rejection of technological options is a blind spot in the literature on e-governance since adoption is generally regarded as the only rational course of actions (Sana’a, 2016).

A second argument against technology concerns its emphasis on continuous growth. The American economist, Herman E. Daly started from a very different angle but also came to a critical analysis of the institutional logic of our economic system. Daly (1974) emphasizes that, in the long run, growth is not sustainable since the costs will exceed the benefits. He emphasized that we need to strive for a steady state economy with respect for the limits of our planet. Economists in the 1970s reacted with derision and largely ignored his argument but the current de-growth movement strongly connects to it. The institutional logic of e-governance, however, is strongly focused on growth and expansion. The idea that we may have enough technology and that no further expansion is needed does not fit within an institutional community that always rapidly embraces the latest hype and argues that governments can not lag behind when social media, the blockchain or platform technologies become fashionable (Meijer et al., 2009).

A third argument against technology is its focus on the short term. The philosopher Derek Parfit (1984) highlighted the need to only include current populations in our ethical considerations but also assume our responsibility towards future generations. This consideration was also present in the Brundlandt Report and further developed in recent reflections in what is now referred to as ‘longtermism’. In a recent book William MacAskill (2022) defines longtermism as the view that positively influencing the longterm future is a key moral priority of our time. This consideration is clearly extremely important for sustainable development but hardly a key feature of information systems. The issue of digital longevity – i.e. focusing on the long-term value of information – and its specific implications for e-governance was also addressed in the literature when there was concern about the millennium bug (Rothenberg, 1995). Since then, especially in the field of recordkeeping and archival systems (Wut et al., 2021), there is attention for this issue but the dominant logic of information systems is still a short-term orientation.

The critical analyses of technology from the 1960s and 1970s have remained as an important starting point for critical analyses of current developments. Surprisingly, there are few fundamental critical analyses of e-governance. Meijer and Bekkers (2016) highlight that most research in the field of e-governance studies has a reductionist perspective. While critical media studies is a field of study in its own right, we could not find any paper that positioned itself as critical e-government studies. At the same time, the number of critical analyses of technology in the public sector in general (for good overview: Van Dijck et al., 2018) and smart city technologies specifically is rapidly growing. Various authors have

Table 4
Machine logic: Netherlands policy for clean air travel

Government support for so-called ‘clean air travel’ forms an example for the machine logic of e-governance. Recently, the Dutch Minister of Transport indicated that air travel may not grow for five years but after that period, in 2027, clear and silent airplanes will have been developed and there will be no need to limit air travel (Volkskrant, 2022). Use of new technologies for sustainable air travel are highly attractive both for dominant business interests, such as airlines and travel agencies, and for consumers since new technologies hold the promise that we do not need to drastically reduce air travel. At the same time, there is a high risk that technology may not be able to develop upon its promise but then the sustainability transition will have been hindered by the idea that substantive changes were not required.

pointed out that smart cities area false promise that only benefits the ‘haves’ in our capitalist societies and do not bring benefits to people or the ecological environment (Hollands, 2008; Krivy, 2018). A general point is that e-governance may result in a suboptimal outcome of efforts targeted at realizing more environmental sustainability by re-arranging current practices instead of challenging these practices at a fundamental level. One can question, for example, whether individualized electronic car traffic is indeed the correct pathways towards sustainable transport or whether we need to rethink the individual nature of traffic and the need to travel so much (Kuo et al., 2023; Chatterjee et al., 2020) and realize a more radical transformation of personal mobility.

In addition to the absence of criticism of the dominant logic of e-governance, an even more malign relation can be identified: e-governance can be understood as a ‘pacifier’. Technology temporarily soothes our pain but undermines the incentives for finding solutions. E-governance creates the illusion that no radical changes are needed to our societies and economies since technological progress will help us to deal with the broad range of sustainability problems. This perspective is closely connected to what Morozov (2014) refers to as ‘technological solutionism’: technology is the only answer to a wide variety of problems in modern societies (see also: Taffel, 2016). Faith in technological solutions is a very attractive option since it does not confront us with the need to bring about radical changes. Technological developments promises that we can continue to drive and fly, to use energy, water and other resources, to buy and consume and to live a prosperous life since technology will solve all current problems. In that sense, the perspective of e-governance as instrument for realizing sustainable development (Section 3) is not only naïve but also potentially pernicious and destructive to society since it stops societies from making institutional changes required for sustainable development by making a false promise (see the example in Table 4).

While our analysis in this article started with a hopeful perspective on the relation between e-governance and sustainable development, the key lesson from this section is that we have to be extremely careful in putting all our hopes on technology as a solution for environmental problems. Key limitations of the current institutional logic of e-governance are its blind faith in technology, the focus on growth and its short-term orientation. These limitations arguably take the twin transition – the coupled digital and sustainability transition – in the wrong direction of actually strengthening unsustainable practices. In addition, the promise of technology may result in the opportunity costs of spending resources on IT instead of other sustainability measures and possibly prevent governments from searching ‘deep’ solutions as technology can be a ‘pacifier’ that stops us from making the difficult but needed transition to a sustainable society.

6. Ecological logic of e-governance: Sustainability metaphor for technology

The critical analyses of the dominant institutional logic of e-government highlights its emphasis on machine metaphors and on reductionist and short-term objectives. This institutional logic of technological

development, however, is not the only institutional logic discussed in the literature. In reflections on and practices of the use of technology in the public sector, new forms of organization are proposed to replace the machine logic. Innovative solutions emphasize community engagement, stakeholders engagement, cocreation, collective management of resources, etc. This constructive logic can form a basis for an institutional transformation that is more focused on human-centered and sustainable practices. We will analyze this other institutional logic through its use of a metaphor that connect to sustainability discourses: ecology.

The metaphor that is both prevalent in discourses about sustainable development and on electronic governance is ecology. Another application of a relevant metaphor – the idea of an ecology – is present in the work of Nardi and O’Day (2000). Their book highlights that in the same way that a biological ecology relies on diversity, information resources are also enriched by not viewing them in isolation but rather as components of an ecology. Bekkers and Homburg (2005) used Nardi and O’Day’s (2005) work to develop an innovative analysis of information resources in government. More current example are work on open data ecosystems (Dawes et al., 2016; Zuiderwijk et al., 2014) and Susa et al.’s (2023) work on data collaboratives from an ecosystem perspective. A key feature of the ecosystem approach is that information systems are not seen as isolated interventions but components of complex socio-technical systems. Nardi and O’Day (2000) explicitly highlight the importance of connections to non-technical systems such as experience and tacit knowledge of human actors. In a clear parallel to the reduction of diversity through dominant species in biological ecosystems, they highlight that technological interventions may harm the ecology and reduce its resilience if they drive out other ways of knowing.

The metaphor of ecology has also been used to develop new perspectives on the governance of information resources. The idea of governing the commons is increasingly translated to perspectives on governing public information. The key analysis of ‘governing the commons’ is present the work of Nobel Prize Winner Elinor Ostrom. Ostrom (1990) stresses that common pool resources – such as water and air – require governance principles to manage these resources sustainably and avoid the ‘tragedy of the commons’ (Hardin, 1968). A key application of the metaphor of the commons – crucial in current thinking about sustainable development – to the world of technology comes from Schweik and English (2012). Their analysis of open source software for nature resource conservation uses the idea of the commons actually in two ways: nature resources as a common but also the open source software as a common.

The idea of an alternative logic of e-governance that does not build on a machine metaphor but rather on a ecology metaphor has been developed conceptually by Meijer et al. (2019) in their paper on open governance. This new form of governance is closely connected to the use of new technologies and embodies a more networked and horizontal form of governance based on networked interactions between individuals. In this paper, the authors identify five elements that render open governance radically different more traditional forms of governance: radical openness, citizen-centricity, connected intelligence, digital altruism and crowdsourced deliberation. They analyze various examples and argue that this new logic may challenge current forms of governance. At the same, they note that this form of governance is still at its infancy and it is far from clear whether this new form will actually challenge older forms of governance (see also Table 5).

In sum, we see that the ‘machine metaphor is not the only possible perspective on e-governance. The ecology metaphor puts much more emphasis on a holistic and long-term perspective on the management of public information resources. In that sense, this institutional logic holds a promise for a new connection between the digital and the sustainability transition. At the same time, this type of optimism has been dominant in debates about the societal implications of the internet from the 1990s onwards and, for

Table 5
Ecology logic: Forest watchers and sniffer bicycles

Initiatives to strengthen the monitorial capacity of damage to the environment form interesting examples of this emerging institutional logic. One of the initiatives of citizen-generated open data projects analyzed by Meijer and Potjer (2018) is Forest Watchers. This is an international platform for citizens monitoring the quality of forests. Citizens work together and contribute to the governance of this commons. Similarly, the project Sniff Bicycle in the Dutch Province of Utrecht also entails the participation of citizens in the measurement of air quality by positioning sensors on their bicycles (Wesseling et al., 2021). One should note, however, that these examples of this institutional logic are still at a very initial stage and relate to monitorial capacity rather than actually governing the commons. We are not aware of examples that already apply this logic on a full scale in line with Ostrom's (1990) ideas to govern the commons which result in important contributions to sustainable development.

the moment, this promise has not yet materialized as current practices are mostly limited to collective monitoring of biological resources. It is also important not to be critical about this alternative metaphor for understanding electronic governance since it may undermine key features of government such as accountability and the role of law (Meijer et al., 2019).

7. Re-orienting the research agenda

We set out to enrich our perspectives on the twin transition. We started with the dominant perspective – e-governance as an instrument for the sustainability transition – and showed that current academic and societal debates increasingly acknowledge the societal need to focus e-governance not only on better services but also on key areas of sustainable development such as mobility, energy, water management, environmental protection, CO2 reduction, etc. Secondly, we concluded that there is still limited academic attention for green e-governance but the relevance of focusing on not only the quality of technological systems but also their environment impact is acknowledged. In view of what is happening in the private sector we can be moderately hopeful that attention for green e-governance will be growing in the next decade. Thirdly, our analysis of an institutional perspective on technology as a problem identified the relevance of fundamental problems, which have been identified over the previous decades, related to the destructive nature of current reductionist and short-term orientations inherent to electronic governance. Finally, we discussed a (hopeful but underdeveloped) positive discourse that emphasize the use of ecological metaphors in our ideas about e-governance.

Table 6 presents an overview of the key findings from our exploration of the literature.

In our application of this model, we detected three still unexplored territories for academic research: the mitigation of destructive environmental sustainability effects of the application e-governance, the destructive effects of the machine logic of e-governance through its radical application and the potential of reconceptualizing e-governance on the basis of an ecological metaphor. To contribute to an academic and societal understanding of the twin transition, new knowledge about these unexplored territories is urgently needed. More specifically, we would like to formulate the following three topic to broaden the research agenda on the twin transition to generate knowledge that is urgently needed both in academic and societal debates:

1. *How can we realize green e-governance?* We found that there is research on Green IT (Chou & Chou, 2012; Darshana et al., 2017) – IT with limited environmental sustainability costs – but this research has not yet been connected to academic and societal debates about and practices of e-governance. New research needs to develop a conceptual understanding of 'Green E-Governance' and investigate the sustainability costs of current e-governance practices, assess interventions that have been proposed for greening e-governance and enhance our understanding of motivational drivers for green e-governance.

Table 6
Relations between e-governance and sustainable development: Insights from the literature

		Technology as an instrument	
	Green IT	EGOV4SD	
	<ul style="list-style-type: none"> – No specific literature on ‘green e-governance’ – Body of literature on Green IT in private sector can form basis for development ‘Green E-Governance’ – Variety of strategies for Green IT in the literature 	<ul style="list-style-type: none"> – Specific conceptualization of EGOV4SD in literature – Contributions of EGOV4SD to all SDGs have been proposed – EGOV4SD applied to many topics such as water, electricity, housing and waste management – Perverse effects and opportunity costs of EGOV4SD are largely ignored 	
Technology as a problem	Machine logic of e-governance	Ecology logic of e-governance	Technology as a solution
	<ul style="list-style-type: none"> – No specific literature but long running stream of critical analyses of technology – Various institutional causes of sustainability problems (blind faith in technology, continuous expansion and short term focus) – Related institutional patterns in e-governance literature: reductionism, technological solutionism – High faith in technology can form barrier for sustainable transformation 	<ul style="list-style-type: none"> – Key publication on information ecologies and applications to government – Holistic and long-term perspectives both on information and governance of common pool resources – Few applications of information ecologies to sustainable development 	
		Technology as an institution	

2. *When, where and how does the e-governance form a barrier to the sustainability transition?* We highlighted that e-governance can form a barrier to the sustainability transition through its blind faith in technology, its emphasis on growth and the focus on short-term gains. More specifically, the current literature overemphasizes technological solutions for environmental sustainability problems. Our current knowledge of non-usage of e-governance is incomplete since most literature tends to conceptualize non-use in line with innovation theory as the non-rational choice. From a perspective of sustainability, however, non-use can make perfect sense, especially when long-term considerations are included. Empirical research – or maybe new analyses of earlier research – is needed to enhance our understanding of the rationality of non-adoption.
3. *How can a logic of ecology form the basis for the twin transition?* Even though some hopeful connections for the twin transition have been identified, this research field is still very new and unexplored. Building upon both an empirical understanding of specific practices but also on analyses of the dominance of current interests, values and perceptions in and around government, and various forms of social imaginations, research can provide new understandings of alternative futures for the twin transition.

What does this mean for the twin transition? Change in institutional logics is notoriously difficult to realize. We identified the various cognitive, normative and ontological assumptions that underly both a technocratic perspective on governance and a destructive perspective on the planet. The institutional transformation to a more holistic and long-term approach both to e-governance and to societal development is both unlikely and necessary. At the same time, our argument also identified a variety of positive connections between innovative forms of e-governance and pathways to sustainable development. These positive relations may form a starting point for developing new perspectives on the twin transition and imaging new futures of e-governance for sustainable development that transcend current perspectives. This means that there is an urgent need to provide a better understanding of both the institutional nature

of the relation between e-governance and sustainable development and also pathways for transforming current understanding of electronic governance and sustainable development.

A first critical reflection on our line of argument is that we have not analyzed the twin transition in its implications for different societal stakeholders. In response to the concern that the two transitions might have negative implications for the most vulnerable groups in societies, the call for a 'just transition' has become increasingly important in societal and academic debates. A just transition refers to the idea that the benefits and costs of the transition should be divided in line with principles of social justice (Wang & Lo, 2021). Future research will need to address the just transition further from the perspective of the four cells. One could assume that the ecology logic provides a strong basis for a just transition but this needs to be analyzed both theoretically and empirically.

A second critical reflection on our own line of argument is that the analytical distinction we have made between the instrumental and the institutional perspectives is valuable from an analytical perspective but overemphasizes the distinction between the two perspectives. In the social scientific literature on technology in organizations, new approaches have been developed which highlight the connection rather than the distinction between the instrumental and the institutional perspectives. Most prominently, both the social materiality perspective (Orlikowski & Scott, 2008) and Actor Network Theory (ANT) (Latour, 2007) are attempts to bridge the distinction between the instrumental and the institutional perspective. For this reason, the second and third research question that we identified can also be tackled from these perspectives that highlight the interactions between instrumental and institutional characteristics to provide nuanced answers.

The paper concludes that, for a strong contribution of e-governance to sustainable development, we need to look further than questions of instrumental use of technology. We need to study not only direct relations between e-governance and sustainable development but expand to the fundamental ontological and normative and foundations of dominant perspectives. In the end, the twin transition of digitalization and sustainability is not about using e-governance a little bit better to realize some efficiency gains but about a radical reorientation of government and societal practices. We would therefore like to reiterate Meijer and Bekkers' (2015) call for research that tackles the broad question of understanding transformational change in society. As scholars of e-governance, we need to make sure that we re-orient our research agenda to address the major challenges that we are facing not at an instrumental but at an institutional level.

Acknowledgments

This project has been funded by the European Union (grant agreement ID: 101079227) and supported by UKRI Innovate UK Council (project reference: 10052110).

References

- Agbozo, E. (2018). The role of data-driven e-government in realizing the sustainable development goals in developing economies. *Journal of Information Systems & Operations Management*, 12(1), 70-77.
- Almansour, M. (2022). Electric vehicles (EV) and sustainability: Consumer response to twin transition, the role of e-businesses and digital marketing. *Technology in Society*, 71, 102135.
- Asadi, S., Hussin, A.R.C., & Dahlan, H.M. (2018). Toward Green IT adoption: From managerial perspective. *International Journal of Business Information Systems*, 29(1), 106-125.
- Baron, N.S. (2021). Know what? How digital technologies undermine learning and remembering. *Journal of Pragmatics*, 175, 27-37.

- Bekkers, V.J., & Homburg, V. (Eds.). (2005). *The information ecology of e-government: e-government as institutional and technological innovation in public administration*. Amsterdam: IOS Press.
- Bevir, M. (2012). *Governance: A very short introduction*. OUP Oxford.
- Bibri, S.E., & Krogstie, J. (2017). Smart sustainable cities of the future: An extensive interdisciplinary literature review. *Sustainable Cities and Society*, 31, 183-212.
- Brooks, S., Wang, X., & Sarker, S. (2010) Unpacking Green IT: A Review of the Existing Literature. In: Sixteenth Americas Conference on Information Systems, 12–15 August 2010, Lima, Peru pp. 749-759.
- Carson, R.L. (1962). *Silent Spring*. Boston, MA: Houghton Mifflin.
- Chatterjee, K., Chng, S., Clark, B., Davis, A., De Vos, J., Ettema, D., Hardy, S., Martin, A., & Reardon, L. (2020). Commuting and wellbeing: A critical overview of the literature with implications for policy and future research. *Transport Reviews*, 40(1), 5-34.
- Chou, D.C., & Chou, A.Y. (2012). Awareness of Green IT and its value model. *Computer Standards & Interfaces*, 34(5), 447-451.
- Corbett, J., & Mellouli, S. (2017). Winning the SDG battle in cities: How an integrated information ecosystem can contribute to the achievement of the 2030 sustainable development goals. *Information Systems Journal*, 27(4), 427-461.
- Daly, H.E. (1974). The economics of the steady state. *The American Economic Review*, 64(2), 15-21.
- Darshana, S., Lokuge, S., Tushi, B., & Tan, F. (2017). Multi-disciplinary green IT archival analysis: A pathway for future studies. *Communications of the Association for Information Systems*, 41(28), 675-733.
- Dawes, S.S., Vidiasova, L., & Parkhimovich, O. (2016). Planning and designing open government data programs: An ecosystem approach. *Government Information Quarterly*, 33(1), 15-27.
- Docherty, I., Marsden, G., & Anable, J. (2018). The governance of smart mobility. *Transportation Research Part A: Policy and Practice*, 115, 114-125.
- Durkiewicz, J., & Janowski, T. (2021). Is digital government advancing sustainable governance? A study of OECD/EU countries. *Sustainability*, 13(24), 13603.
- Dzhusupova, Z., Janowski, T., Ojo, A., & Estevez, E. (2011). Sustaining electronic governance programs in developing countries. In *Proceedings of the 11th European Conference on eGovernment (ECEG 2011)*, pp. 203-212.
- Eastwood, G. (2009). *Best practice in green IT: Implementing green IT in the enterprise and its cost benefits*. Wellington NZ: Business Insights.
- Estevez, E., & Janowski, T. (2013). Electronic Governance for Sustainable Development-Conceptual framework and state of research. *Government Information Quarterly*, 30(Supplement 1), S94-S109.
- Evans, J., Karvonen, A., Luque-Ayala, A., Martin, C., McCormick, K., Raven, R., & Palgan, Y.V. (2019). Smart and sustainable cities? Pipedreams, practicalities and possibilities. *Local Environment*, 24(7), 557-564.
- Fountain, J.E. (2001). *Building the virtual state. Information technology and institutional change*. Brookings Institution Press, Washington, D.C.
- Giddens, A. (1984). *The constitution of society*. Cambridge UK: Polity Press.
- Hardin, G. (1968). The tragedy of the commons: The population problem has no technical solution; it requires a fundamental extension in morality. *Science*, 162(3859), 1243-1248.
- Heeks, R. (2006). Theorizing ICT4D research. *Information Technologies & International Development*, 3(3), 1-4.
- Hinings, B., Gegenhuber, T., & Greenwood, R. (2018). Digital innovation and transformation: An institutional perspective. *Information and Organization*, 28(1), 52-61.
- Hollands, R.G. (2008). Will the real smart city please stand up? *City*, 12(3), 303-320.
- Janowski, T. (2015). Digital government evolution: From transformation to contextualization. *Government Information Quarterly*, 32(3), 221-236.
- Janowski, T. (2016). Implementing sustainable development goals with digital government-aspiration-capacity gap. *Government Information Quarterly*, 33(4), 603-613.
- Jones, M.R., & Karsten, H. (2008). Giddens's structuration theory and information systems research. *MIS Quarterly*, 32(1), 127-157.
- Kemp, R., Parto, S., & Gibson, R.B. (2005). Governance for sustainable development: Moving from theory to practice. *International Journal of Sustainable Development*, 8(1-2), 12-30.
- Kling, R., & Iacono, S. (1989). The institutional character of computerized information systems. *Office Technology and People*, 5(1), 7-28.
- Krivý, M. (2018). Towards a critique of cybernetic urbanism: The smart city and the society of control. *Planning Theory*, 17(1), 8-30.
- Kuo, Y.H., Leung, J.M., & Yan, Y. (2023). Public transport for smart cities: Recent innovations and future challenges. *European Journal of Operational Research*, 306(3), 1001-1026.
- Latour, B. (2007). *Reassembling the social: An introduction to actor-network-theory*. Oxford: OUP.
- Layne, K., & Lee, J. (2001). Developing fully functional E-government: A four stage model. *Government Information Quarterly*, 18(2), 122-136.

- Luna-Reyes, L.F., & Gil-Garcia, J.R. (2011). Using institutional theory and dynamic simulation to understand complex e-Government phenomena. *Government Information Quarterly*, 28(3), 329-345.
- MacAskill, W. (2022). *What we owe the future*. New York: Basic books.
- Malhotra, A., Melville, N.P., & Watson, R.T. (2013). Spurring impactful research on information systems for environmental sustainability. *MIS Quarterly*, 37(4), 1265-1274.
- Medaglia, R., Misuraca, G., & Aquaro, V. (2021). Digital Government and the United Nations' Sustainable Development Goals: Towards an analytical framework. *DG.O2021: The 22nd Annual International Conference on Digital Government Research*, pp. 473-478.
- Meijer, A., & Bekkers, V. (2015). A metatheory of e-government: Creating some order in a fragmented research field. *Government Information Quarterly*, 32(3), 237-245.
- Meijer, A., Boersma, K., & Wagenaar, P. (Eds.). (2009). *ICTs, citizens and governance: After the hype!* Amsterdam: IOS Press.
- Meijer, A.J., Lips, M., & Chen, K. (2019). Open governance: A new paradigm for understanding urban governance in an information age. *Frontiers in Sustainable Cities*, 1(3).
- Meijer, A., & Potjer, S. (2018). Citizen-generated open data: An explorative analysis of 25 cases. *Government Information Quarterly*, 35(4), 613-621.
- Meyer, J.W., & Rowan, B. (1977). Institutionalized organizations: Formal structure as myth and ceremony. *American Journal of Sociology*, 83(2), 340-363.
- Mooney, H., Larigauderie, A., Cesario, M., Elmquist, T., Hoegh-Guldberg, O., Lavorel, S., & Yahara, T. (2009). Biodiversity, climate change, and ecosystem services. *Current Opinion in Environmental Sustainability*, 1(1), 46-54.
- Morozov, E. (2014). To save everything, click here: The folly of technological solutionism. *J. Inf. Policy*, 4(2014), 173-175.
- Mosannazadeh, F., Bisello, A., Vaccaro, R., D'Alonzo, V., Hunter, G.W., & Vettorato, D. (2017). Smart energy city development: A story told by urban planners. *Cities*, 64, 54-65.
- Muench, S., Stoermer, E., Jensen, K., Asikainen, T., Salvi, M., & Scapolo, F. (2022). *Towards a green and digital future*. Luxembourg: Publications Office of the European Union.
- Murugesan, S. (2008). Harnessing green IT: Principles and practices. *IT Professional*, 10(1), 24-33.
- Nardi, B.A., & O'Day, V. (2000). *Information ecologies: Using technology with heart*. Cambridge MA: MIT Press.
- Noam, E.M. (2005). Why the Internet is bad for democracy. *Communications of the ACM*, 48(10), 57-58.
- Orlikowski, W.J. (1992). The duality of technology: Rethinking the concept of technology in organizations. *Organization Science*, 3(3), 398-427.
- Orlikowski, W., & Scott, S. (2008). Sociomateriality: Challenging the separation of technology, work and organization. *The Academy of Management Annals*, 2(1), 433-474.
- Ostrom, E. (1990). *Governing the commons: The evolution of institutions for collective action*. Cambridge: Cambridge University Press.
- Parfit, D. (1984). *Reasons and persons*. Oxford: OUP.
- Perrow, C. (1979). *Complex Organizations: A Critical Essay*. Glenview IL: Scott, Foresman and Co.
- Rothenberg, J. (1995). Ensuring the longevity of digital documents. *Scientific American*, 272(1), 42-47.
- Rukanova, B., Tan, Y.H., Hamerlinck, R., Heijmann, F., & Ubacht, J. (2021). Digital Infrastructures for Governance of Circular Economy: A Research Agenda. *EGOV-CeDEM-ePart*, 191-198.
- Saetra, H.S. (2023). *Technology and Sustainable Development: The Promise and Pitfalls of Techno-Solutionism*. New York: Taylor & Francis.
- Sana'a, Y. (2016). A critical review of models and theories in field of individual acceptance of technology. *International Journal of Hybrid Information Technology*, 9(6), 143-158.
- Schweik, C.M., & English, R.C. (2012). *Internet success: a study of open-source software commons*. Cambridge MA: MIT Press.
- Scott, W.R. (1987). The adolescence of institutional theory. *Administrative Science Quarterly*, 32(4), 493-511.
- Selznick, P. (1957). *Leadership in Administration: a sociological interpretation*. New York: Harper and Row.
- Taffel, S. (2018). Hopeful extinctions? Tesla, technological solutionism and the anthropocene. *Culture Unbound*, 10(2), 163-184.
- Thornton, P.H., & Ocasio, W. (2008). Institutional logics. *The Sage Handbook of Organizational Institutionalism*, 840(2008), 99-128.
- Tomor, Z., Meijer, A., Michels, A., & Geertman, S. (2019). Smart governance for sustainable cities: Findings from a systematic literature review. *Journal of Urban Technology*, 26(4), 3-27.
- Trondal, J. (2021). Public administration sustainability and its organizational basis. *International Review of Administrative Sciences*, 87(2), 399-415.
- UK Department for Environment Food & Rural Affairs. (2020). Policy paper 'Greening government: ICT and digital services strategy 2020–2025'. Retrieved from: <https://www.gov.uk/government/publications/greening-government-ict-and-digital-services-strategy-2020-2025/greening-government-ict-and-digital-services-strategy-2020-2025> (1 March 2023).
- United Nations. (2017). *Transforming Our World: The 2030 Agenda for Sustainable Development*. Berlin: Springer Publishing Company.

- Van Dijck, J., Poell, T., & De Waal, M. (2018). *The platform society: Public values in a connective world*. Oxford: Oxford University Press.
- VijayaVenkataRaman, S., Iniyar, S., & Goic, R. (2012). A review of climate change, mitigation and adaptation. *Renewable and Sustainable Energy Reviews*, 16(1), 878-897.
- Volkskrant. (16 December 2022). Minister: krimp Schiphol is tijdelijk, vanaf 2027 ongelimiteerd vliegen met 'schone' vliegtuigen. Retrieved at: <https://www.volkskrant.nl/nieuws-achtergrond/minister-krimp-schiphol-is-tijdelijk-vanaf-2027-ongelimiteerd-vliegen-met-schone-vliegtuigen~b20be8f9>, (1 March 2023).
- Wang, X., & Lo, K. (2021). Just transition: A conceptual review. *Energy Research & Social Science*, 82, 102291.
- Wesseling, J., Hendricx, W., de Ruiter, H., van Ratingen, S., Drukker, D., Huitema, M., & Tielemans, E. (2021). Assessment of PM2.5 exposure during cycle trips in the Netherlands using low-cost sensors. *International Journal of Environmental Research and Public Health*, 18(11), 6007.
- Winner, L. (1978). *Autonomous technology: Technics-out-of-control as a theme in political thought*. Cambridge MA: MIT Press.
- Winter, S., Berente, N., Howison, J., & Butler, B. (2014). Beyond the organizational 'container': Conceptualizing 21st century sociotechnical work. *Information and Organization*, 24(4), 250-269.
- World Commission on Environment and Development. (1987). *Our common future, from one earth to one world*. Retrieved from <http://www.un-documents.net/our-common-future.pdf>.
- Wut, T.M., Lee, D., Ip, W.M., & Lee, S.W. (2021). Digital sustainability in the organization: Scale development and validation. *Sustainability*, 13(6), 3530.
- Zampou, E., & Pramatari, K. (2011). An approach to the assessment of the environmental impact of e-government services. *ECIS 2011 Proceedings*, 213.
- Zuiderwijk, A., Janssen, M., & Davis, C. (2014). Innovation with open data: Essential elements of open data ecosystems. *Information Polity*, 19(1-2), 17-33.