

Conceptualizing the Roles of Information and Digital Technologies in Digital Global Climate Governance

Tove Engvall

Mid Sweden University

tove.engvall@miun.se

Abstract

Digital governance research has primarily focused on national or local settings, but as societal challenges are increasingly global in nature, it motivates greater attention as to how digital governance may enhance global governance (Engvall, 2024). Empirical research has shown how digital global governance initiatives may contribute to climate governance (Engvall, 2021; Engvall & Flak, 2022a, 2022b). However, there is a need for a deeper theoretical understanding of the ways in which information and digital technologies can support climate governance, in order to effectively direct digital governance initiatives.

Information and digital technologies have significant roles in global climate governance. The core of the climate treaty, the Paris Agreement, is a reporting mechanism, i.e., the Enhanced Transparency Framework (ETF). The information generated through the ETF can be used for various purposes, and digital services can be developed to support different governance activities. From a structuration theory perspective, this paper discusses and conceptualizes the roles of information and digital technologies in digital global climate governance. The paper articulates how interpretative, facilitative, and normative roles of information and digital technologies can support understanding, action and accountability, and proposes this as the basis for further research and development of digital services.

Keywords: Digital global governance, information, digital technology, structuration theory, conceptual paper

1. Introduction

Scholars have requested more conceptual papers to build a scientific foundation for the digital governance field (Charalabidis et al., 2022). The core of theory development is conceptualizations and

articulation of relationships among concepts, within some boundary assumptions (Bacharach, 1989). Moreover, digital governance research has scarcely addressed the global governance context, why theoretical contributions are particularly needed concerning digital global governance (Engvall, 2024). It is further argued that digital governance can support the implementation of the sustainable development goals (Janowski, 2016), but more guidance and conceptualizations are needed (Medaglia, Misuraca & Aquaro, 2021). The objective of this paper is to conceptualize the roles of information and digital technologies in digital global climate governance. This is both a conceptual contribution to digital global governance, as well as it provides guidance for further development of digital climate governance initiatives.

Climate change is one of the most critical challenges mankind is encountering. To mitigate severe effects of climate change, there is a need for far greater measures (IPCC, 2021). Global governance of climate change centers around the international treaty, the Paris Agreement (Paris Agreement, 2015). The central mechanism of the Paris Agreement, is the Enhanced Transparency Framework (ETF), which stipulates that countries should regularly report on their greenhouse gas (GHG) emissions, commitments, and measures, to the United Nations Framework Convention on Climate Change (UNFCCC) (Paris Agreement, 2015). Reporting guidelines and standards for reporting formats have been adopted, as well as reporting platforms, IT artefacts, and organizational arrangements, which has established an information infrastructure for climate governance (Engvall & Flak, 2022b). The information infrastructure enables monitoring of greenhouse gas emissions, transparency of government policies and measures, follow-up on implementation of the Paris Agreement, coordination and collaboration, as well as innovation. Moreover, digital technologies enable an efficient information management and support quality assurance of the reports (Engvall, 2021; Engvall & Flak, 2022a).

The information provided through the reporting, is an important source to inform decision making, evaluate policy implementation, support accountability and enable participation. The reports are publicly accessible at the UNFCCC website, and various actors are encouraged to use the reports to support analysis and climate action (Engvall, 2021). In a context where climate governance is characterized by voluntary commitments, polycentric governance and the involvement of a variety of actors, the climate reports are key governance tools (Jernäs, 2023). Through the ETF, information and digital technologies are at the center stage of governance, and might even be viewed as a mode of governance, in line with what has been conceptualized as ‘information-based governance’: “the process by which information is used to steer society and the economy towards collectively negotiated objectives” (Bullock, 2016, p. 281), or ‘governance by disclosure’ (Gupta & Mason, 2016, p. 83). The ETF can also be viewed as a manifestation of digital global governance, i.e., “digital technology ingrained in structures or processes of global governance and their reciprocal relationships with global governance objectives and normative values (...) [which also] involves a transformation of structures, processes, or normative values” (Engvall, 2024, p. 45).

In light of the above, the objective of this paper is to conceptualize the roles of information and digital technologies in digital global climate governance, to gain a deeper understanding and guide further research and development of digital global climate governance. The conceptualization is based on structuration theory (Giddens, 1984) and exemplified by findings from case studies of climate reporting (Engvall, 2021; Engvall & Flak, 2022a, 2022b).

A conceptual paper, which this is, does not usually have as strict format as a research paper. The objective of a conceptual paper is to propose links and relationships between selected theoretical constructs in a selected body of literature (Gilson & Goldberg, 2015), along with some creative reasoning (Rivard, 2014). Structuration theory and structuration approaches to information (Oliver, 2004) and technology (Orlikowski, 1992; Orlikowski, 2000) were selected as an appropriate conceptual foundation due to their theorization of the relationship between institutional structure and human agency, and the roles of information and technology in such dynamic. In a climate governance setting, this theoretical approach is appropriate to understand the roles of information and technology in steering the societal transformation that the climate transition requires.

The paper will first present the conceptual foundation, followed by a description of the

information infrastructure for global climate governance and how it supports climate governance, and thereafter propose a conceptualization of the roles of information and digital technologies in global climate governance.

2. Conceptual foundation

The conceptual foundation for this paper is based on structuration theory (Giddens, 1984), as well as applications of structuration theory on theorization of information (Oliver, 2004) and technology (Orlikowski, 1992; Orlikowski, 2000).

2.1 Structuration theory

The articulation of structuration theory aimed to bridge the opposing perspectives of either a structural perspective or an agency perspective, and take a more holistic view on how structure and human agency interact and influence each other (Giddens, 1984). Structure refers to “the structuring properties (...) which makes it possible for discernibly similar social practices to exist across varying spans of time and space and which lend them ‘systemic’ form (Giddens, 1984, p. 17). A structure can be viewed as a virtual order, and often refer to rules and resources. Agency, on the other hand, refers to action. Social structures are the result of institutionalized actions, which in turn enable and constrain action. Rules and resources are drawn upon in social action, and are means of production and reproduction of structure (Giddens, 1984). Rules reflect the constitution of meaning and imply a sanctioning of social conduct. Resources are “the modes whereby (...) relations are actually incorporated into the production and reproduction of social practices” (Giddens, 1984, p. 18).

Agency refers to the capability of actors of doing something. It implies an exercise of power since it produces some effect (Giddens, 1984). However, there are also unintended consequences of actions, i.e., effects of actions that was not intended when an act was conducted. An exercise of power implies that an actor has a capability to deploy resources to change a pre-existing state of affairs or course of events (Giddens, 1984). Power can be described as “the capacity to achieve desired or intended outcome” (Giddens, 1984, p. 15). In a climate governance context, on the one hand, power implies the ability of the collective to effect change in desired direction and achieve agreed governance goals (i.e., the goals in the Paris Agreement). On the other hand, there are tensions of power between contradictory agendas and agency by actors with opposing agendas.

Structuration theory implies that human action is influenced by its institutional context, but the institutional context is also influenced by human actions, which can lead to change (Giddens, 1984).

Structuration theory consists of three dimensions of structure: signification, domination and legitimation; and three dimensions of agency: communication, power and sanctions. Three modalities mediate the spheres of structure and agency, which are: interpretative schemes, facilities and norms (Giddens, 1984). The analytical elements of structuration theory are depicted in Figure 1.

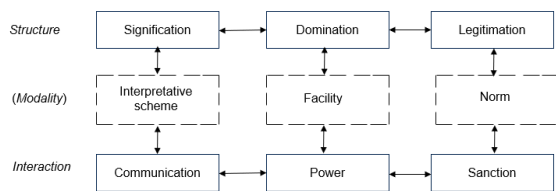


Figure 1. Analytical dimensions of structuration theory (Giddens, 1984, p. 29)

Meaning, power, and norms are three basic elements of social interaction. Meaning is communicated through interpretative schemes, which is knowledge that actors draw upon to shape a shared understanding (signification). Power is exercised through employing facilities - resources (authoritative and allocative) - to accomplish an outcome, which materializes in structures of power (domination). Norms are conventions and rules which guide what is considered appropriate conduct, thus creating structures for legitimation. There is an interaction between these elements. Structures of signification are manifested in societal discourses, and inform the other two structures of domination and legitimation. Structures of domination are manifested in political and economic institutions. Structures of legitimation are manifested in legal institutions. Human actors are viewed as knowledgeable, as they acquire and apply knowledge, and reflexive, as they continuously observe their context and activities (Giddens, 1984).

2.2. A structural view of information

Throughout history, a fundamental need of an organized society has been to regulate its relationships by means of objective, meaningful, consistent and useable documentation. Records of rules, decisions, transactions and agreements early had a key role in governance administrations (Duranti, 1993). A record is "information created, received and maintained as evidence (...) and as an asset by an organization or

person, in pursuit of legal obligations or in the transaction (...) of business" (ISO, 2016). Records are thus documentation of actions and transactions that can be used as assets and/or as evidence of those actions and transactions. The climate reports are examples of records; they are information created as evidence of emissions, commitments and measures, which are also used as assets in climate governance.

The creation and preservation of records contribute to the structuring of societies, and have an important role for what Giddens points to as 'memory traces', "features of a social system which stretch across time" (Upward, 1997, p. 23). Records of an act enables a remembering of that act across time and space, which is central in the construction and reconstruction of structures (Upward, 1997). Records qualities as evidence and memory traces, enable important qualities such as transparency, accountability, organizational continuity and social memory (Upward, 1997). Records can also gain new meanings when they are used in new contexts (McKemmish, 2001).

Departing from the view that structures are not inherent in institutions, but emerge when acted upon, it is when records are created and used that they are part in shaping and re-shaping structures of significance, domination and legitimation (Upward, 1997). Records roles as an asset and evidence, relates to the three analytical functions of significance, domination and legitimation. The creation and use of records have an important role in communicating meaning and shaping structures of significance. Records are key in managing authoritative and allocative resources across time and space. Records are also assets in themselves, which can be drawn upon to incentivize action. Records have a significant role in structures of legitimation, by providing evidence of actions and transactions (Upward, 1997).

Oliver (2004) focuses on the modalities of information, and proposes that information serves as a link between structure and agency when actors interact with it. She suggests that:

"The "interpretative" modality is where participants interpret the meaning of the information situations in which they are involved. Intrinsic to this is the existence of a knowledge base shared by all participants. The "facilitative" modality is the means by which power is exercised and resources deployed (...). The "normative" modality consists of the rules and protocols, including policy, legislation and standards, which govern action" (Oliver, 2004, p. 294). These three modalities of information represent three roles that information (i.e., records) can have in governance. Related to the *interpretative* modality, information has an important role in creating a

common understanding of a topic and shaping meaning, which influences goal-setting, exercising of power, and normative sanctions. A common source of climate governance information is the basis for coming to agreements on a topic and formulate common goals. Records quality as evidence (ISO, 2016) is an important basis for evidence based governance and building trust among actors.

The *facilitative* modality refers to information (i.e., records) that supports the exercise of power, such as policy-making and resource allocation. Records as assets and authoritative evidence of decisions, transactions and measures (ISO, 2016) have important roles to inform policy making and resource allocation. This include informing decision makers on a topic, such as the severity of a problem, progress towards goals, the effect of measures and policy instruments, where the main gaps are and what to prioritize.

Related to the *normative* modality of information, records have a crucial role in providing evidence of actors' decisions and actions, which informs accountability. Sanctions may then include both/either legal and/or political means (Hurley, 2005).

To sum, information, and specifically records as a particular type of information, have prominent roles in structuring relations in societies, and is a means to bind societies together across time and space (Upward, 1997). Through their qualities as assets and evidence, records have crucial roles in governance, in shaping collective understanding of a societal issue, to support the exercise of power, and sanction behaviors that abuse agreed objectives. Moreover, records have a key role in reflexivity, which in a climate governance context is imperative in order to continuously enhance effectiveness of strategies.

2.3 A structural view of digital technologies

Although structuration theory does not address the role of technology specifically, it provides explanations of the nature of social systems (Poole & DeSanctis, 2004), which in the information systems (IS) field has been useful to address the interactions between technology and its social context. In IS research, structuration theory has primarily been used to analyze or theorize a phenomenon, but not so much in a prescriptive sense (Rose & Scheepers, 2001). Structuration theory has for instance been applied to theorize topics such as system development, system failure, virtual teams, online relationships, technology mediation, implementation of information systems, and in research on organizational studies and information systems (Poole & DeSanctis, 2004).

One of the most prominent IS scholars that has used structuration theory is Wanda Orlikowski. In various articles (Jones, Orlikowski, & Munir, 2004; Orlikowski, 1992; Orlikowski, 2000; Orlikowski & Robey, 1991; Orlikowski & Yates, 1994; Yates & Orlikowski, 1992), she has applied structuration theory to theorize the relationship between IT and organizations, and the dynamic between human agents and organizational structure. Primarily two of her publications (Orlikowski, 1992; Orlikowski, 2000) will in this paper be drawn upon to conceptualize the role of digital technologies in digital global climate governance, and will be discussed further below.

'In adapted structuration theory', DeSanctis & Poole (1994) integrated ideas from structuration theory with decision making theory in research on decision support systems (DeSanctis & Poole, 1994). Structuration theory has further been used to discuss the relationship between IT and globalization, through enabling the stretching out of social relations across time and space (Barrett, Sahay, & Walsham, 1996). In a later publication, Walsham (2002) advocates that structuration theory is a fruitful lens to gain a deeper understanding of information systems and cross-cultural working (Walsham, 2002).

Two approaches to structural analysis have been identified in IS: the appropriation view and the enactment view. The appropriation view suggests that social structures are embedded in technology, and when the technology is used, users appropriate those structures. According to the enactment view, social structures cannot be inscribed in technologies, but emerge when it is used (Chisalita, 2006). Orlikowski (2000), who proposed the concept of *enactment of technology*, suggests that users may use technologies differently than was expected by designers.

Orlikowski proposes that technology is both the result of human action (through design, development and appropriation), but is also a medium for action and thus enable and constrain action through the provision of interpretative schemes, facilities and norms. Institutional properties, such as norms, knowledge, intentions and resources, influence human interaction with technology. Interaction with technology in turn influences institutional properties and reinforces or transforms structures (Orlikowski, 1992). Social actors draw on the knowledge related to the action at hand, the facilities available to them, and the norms that inform their practices, which structure current actions. When actors use technology, they draw on the properties of the technology, their skills, knowledge and experiences, as well as assumptions and intentions. In this way, the use of technology constitutes and re-constitutes structures of technology use (Orlikowski, 2000). Along the enactment

approach, Chisalita (2006) highlights the interpretive flexibility of development and use of technology, i.e., that it is open to agency (Chisalita, 2006).

A critique towards structuration theory is that the theory is very abstract, and a solution to that has been to use structuration theory as a metatheory and combine it with some theory that is empirically more operationalizable. Some criticize that the theory diminishes the role of structure in constraining actors and that it tends to conflate structure and agency. Moreover, the theory does not explain why some social patterns are institutionalized (Rose & Scheepers, 2001). It is important to remember that structuration theory articulates conceptual elements, which in reality are very intertwined, and can be emphasized in different ways. According to Poole & DeSanctis (2004), structuration theory is beneficial in studying change, through combining a functional analysis of a system, and constitutive analysis of relationships and interactions within the system (Poole & DeSanctis, 2004). The emphasis in structuration theory, that human actors can never fully comprehend the conditions for action, nor are the outcomes wholly intended, but also unintended (Jones et al., 2004), is an aspect that is very important to recognize in a context of digital transformation. The intention of this paper is to provide a high-level conceptualization of the roles of information and digital technologies in climate governance. This can be used as a framework to identify topics for in-depth investigations, for instance regarding how agents interact with information and technologies, and why and how certain patterns gain traction and become institutionalized. In such analysis, complementary theoretical perspectives can be used for more comprehensive analysis and elucidation.

3. The information infrastructure for climate governance

An information infrastructure (II) is a large, sociotechnical information system that is shared among a community or communities (Hanseth & Lyytinen, 2016). An II enables the development and use of information services (Hanseth & Lyytinen, 2004), within and across organizations (Monteiro, Pollock, Hanseth, & Williams, 2013). IIs are ruled by standards and encompass technologies, organizational arrangements and people (Hanseth & Monteiro, 1998), and are interrelated and coevolve with other structures and working processes (Aanestad et al., 2017).

The United Nations climate treaty, the Paris Agreement, has three main goals: to limit global warming to 1.5°C compared to prehistorical levels, to adapt to the effects of climate change, and to align

financial flows with the climate objectives (Paris Agreement, 2015). Measures that contribute to the Paris Agreement are voluntary and decided by each country. To achieve the systemic transformation that is required for the climate transition, multiple stakeholders are engaged. A central objective of climate governance is thus to encourage ambitious actions by multiple actors (Jernnäs, 2023).

The central mechanism of the Paris Agreement, is a reporting framework called the Enhanced Transparency Framework (ETF). The ETF specifies information that countries are required to report to the United Nations Framework Convention on Climate Change (UNFCCC) secretariat on a regular basis, including reports on: emissions, commitments, and measures. Reports are reviewed to ensure transparency, accuracy, completeness, consistency, and comparability (Paris Agreement, 2015). The reports are received and preserved as an archive at the UNFCCC secretariat, and publicly available at the UNFCCC website: www.unfccc.org.

The ETF has, through standards for reporting formats, guidelines and regulations, technologies and organizational arrangements established an information infrastructure for global climate governance (Engvall & Flak, 2022b). The reports are the foundation for evaluation of progress towards the goals in the Paris Agreement, which is conducted every fifth year in a Global Stocktake. This cycle of reporting and evaluation, serves to inform continuously increasing ambitions (UNFCCC, 2018), illustrated in Figure 2. The intention of the ETF is that various stakeholders will use the information as a basis for climate action and climate governance.

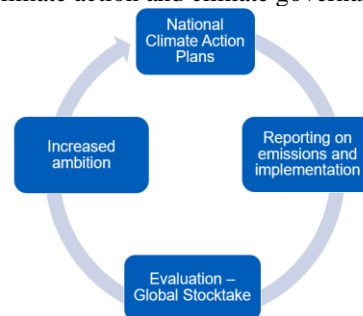


Figure 2. The cycle of reporting and increased ambitions

3.2 How information and technology supports climate governance

Case studies of climate reporting (Engvall, 2021; Engvall & Flak, 2022a) shows that the records and digital technologies in the information infrastructure supports governance in various ways, such as

- Monitoring of emissions and progress towards the goals in the Paris Agreement
- Transparency
- Informing and strengthening confidence in decision making
- Assess implementation of government commitments and inform accountability
- Coordination and collaboration
- Innovation
- Analysis and communication of measures and progress towards goals
- Efficient information management and information quality

Analysis of emissions and actions enables identification of successful strategies and gaps, which can inform further measures (Engvall, 2024).

The reports are assets to inform governance, and also function as evidence. It is crucial that they are authentic and reliable (ISO, 2016), to have an accurate account of emissions and what governments have conducted, to be able to hold actors to account for their deeds, or lack thereof. In a broader societal context of risks of misinformation and disinformation, it is imperative to provide a source of trustworthy information as the basis for climate governance.

Digital technologies are crucial to enable the reporting, manage and disseminate reports, support and conduct quality controls, and to convey the information in the reports to actors in comprehensible and actionable ways (Engvall & Flak, 2022a, 2022b).

The question is then how actors apply information and digital technologies in governance activities. The agency and capability of actors are key factors for the effectiveness of the ETF in regards to the implementation of the Paris Agreement.

4. Interpretative, facilitative and normative roles of information and digital technologies in global climate governance

This section suggests a conceptualization of the roles of information and digital technologies in global climate governance based on structuration theory. The information infrastructure (II) for climate governance is, on the one hand, a structure based on reporting standards, organizational arrangements and IT systems. Actors can then utilize the II to shape meaning, affect change, and legitimize actions, which operationalize climate governance. Important to remember is that transparency, information and technologies are not neutral, and the rationales for transparency will affect the outcome (Gupta & Mason,

2016). This paper will now proceed to examine the role of information and digital technologies in relation to the modalities of structuration theory. In particular, it will consider the interpretative, facilitative and normative roles of climate reports and digital technologies applied in the use of that information.

4.1 Interpretative, facilitative and normative roles of climate reports

Climate reports have both interpretative, facilitative and normative roles.

Interpretative role: Climate reports provide information on greenhouse gas emissions, and support monitoring of emissions related to the goals in the Paris Agreement. Climate reports also provide information on countries goals, commitments and measures, which can be compared towards what is required to achieve the goals in the Paris Agreement (Engvall, 2021; Engvall & Flak, 2022a). This common source of information, facilitates a shared understanding of the state of the problem and gap related to agreed governance goal, and is thus mediating meaning and the shaping of significance and collective understanding of the problem and need for measures. The standards for the content and format of the climate reports set requirements on what information to provide and in what format. This influences the development of interpretative schemes that mediates the shaping of significance. This is a site for contestation, and relates to questions on who should provide information about what, and thus be vulnerable to scrutiny (Gupta & Mason, 2016). Actors may also interpret and make information meaningful in different ways (Hosseini et al., 2018). In a broader societal re-use of information, there may also be unintended consequences of how the information is used to shape political discourses on climate policy.

Facilitative role: The climate reports contain information on measures and projections, which enables the evaluation of the effectiveness of measures, and indicate areas in need of further measures and allocation of resources, which can inform and facilitate decision making and priorities (Engvall, 2021; Engvall & Flak, 2022b). The reports could thus be a valuable asset that facilitates policy making and the allocation of resources, and thus mediate power and the formation of structures of domination. However, there are risks that important information is “drowning” in the vast volumes of information (Gupta & Mason, 2016), and that sensitive topics are hidden to avoid conflict with influential actors, or increased expenses. How interaction with

information and technologies relate to actions and relations of power ought to be investigated further.

Normative role: The climate reports are accounts of decisions and measures, which can be evaluated and assessed against accountability norms. One intention with the ETF is that transparency is vital in holding countries to account and build trust by making visible who is doing what, but there is no sanctioning if commitments are not met. There is no direct link between transparency and accountability, and the focus is more on procedural objectives (i.e., correct reporting) than the outcomes of climate action (Gupta & van Asselt, 2019). Moreover, there has to be structures and processes for accountability in place. The role of records (in this case climate reports) is to provide the evidence towards which actors can be held to account (Hurley, 2005).

It is crucial to ensure that reports are trustworthy, i.e. reliable (i.e., the content of the reports are accurate), authentic (i.e., the report is created by purported actor at the time purported), that the integrity of the reports are maintained (that the reports are complete and not manipulated), and that they are usable (ISO, 2016). If the reports are not trustworthy, it can have negative effects on both interpretive (generate a distorted or limited understanding), facilitative (inform insufficient, inadequate or inappropriate actions) and normative aspects (not discover the need to hold actors to account). Considering the tensions in climate governance, including contradictory and counterproductive interests (Engvall, Flak, & Sæbø, 2023), ensuring the trustworthiness of reports are crucial.

4.2 Interpretative, facilitative and normative roles of digital technologies in the information infrastructure for climate governance

When actors interact with technologies, they have a mediating role between agency and structure. On the one hand, technologies enable and constrain action, and, on the other hand, when they are used, certain patterns are enacted which either reproduces or transforms structures (Orlikowski, 2000). In a climate governance context, digital technologies have important interpretative, facilitative and normative roles in a climate governance context.

Interpretative role: The climate reports contain vast volumes of information; both statistics and pdf reports. This information can be challenging to comprehend, and digital technologies have an important role in conveying the information in the reports in meaningful ways to different stakeholders (Engvall & Flak, 2022b). Thus, technologies have a

significant role in how the information is made meaningful. Interpretation of information also depends on the agent perceiving the information (Hosseini et al., 2018). Related to the interpretative role, technologies can support learning, understanding and shaping of collective visions, which informs an agent's exercise of power and sanctions. Digital technologies are powerful means to shape opinions (Engvall et al., 2023), and risks include that actors with counterproductive agendas utilize digital technologies to support their objectives to stall or sabotage the climate transition.

Facilitative role: The climate reports contain information that are useful in decision making processes. Climate change is also a challenge that has to be addressed in various policy areas. Digital technologies can enable an integration of information from the climate reports, and thus coordinate climate considerations, in various policy processes. Digital technologies are also used to, for instance, make impact assessments of policy instruments (Engvall, 2021), which informs governance to be more effective. However, incomprehensive information and the systemic complexity of climate governance, can lead to inadequate guidance and unintended consequences. Influence by actors with strong interests is also a risk for interest-driven measures that may not be the most effective from, or even counterproductive to, a climate perspective. It is crucial that measures are guided by scientific knowledge on effective solutions and environmental needs. Considering the advance of AI to support decision making, it is imperative to consider potential bias in algorithms and how environmental integrity can be ensured.

Normative role: Related to the normative modality, and to mediate sanctions and structures of legitimation, digital technologies have both a role to facilitate analysis and identification of overstepping norms and agreements, and also to disseminate the information to the right actors. Whether there are soft forms of accountability (political, i.e., blame and shame) or strict forms of accountability (legal, i.e., penalties) (Hurley, 2005), digital technologies are powerful means to identify and expose actors that are violating agreements. Digital technologies are further potent tools in disseminating information and shaping public discourse, thus mediating public scrutiny. There is a risk that information is hidden or manipulated to avoid accountability or conflict with influential actors. Capability of institutions to leverage the climate reports to ensure accountability is crucial.

Digital technologies support processes for understanding the problem of climate change, conducting measures, and detect deviations from agreed objectives. But it is actors that interpret the

information, conduct actions and enforce norms. It is thus crucial to gain a deeper understanding of how actors engage with the information and how digital services can support actors in implementing climate governance objectives, as well as how to respond to conflictual agendas.

4.3 Conceptual model of the roles of information and digital technologies in digital global climate governance

Together, information and digital technologies play significant roles in governance through interpretative, facilitative and normative modalities.

The *interpretive* role of information and digital technologies involves the shaping of understanding and reflexivity. The reports tell what measures have been conducted, which can be evaluated in terms of effectiveness. Digital technologies can support analysis to gain insights on how different measures impact the climate, what unintended consequences are generated, and to make adjustments accordingly. This is important to improve effectiveness and make course corrections. The information can also support common understanding in a broader societal context, in dialogues with stakeholders and to enable and incentivize a broad participation of stakeholders. As actors make sense of information, discourses are shaped around climate policy.

The reports can *facilitate* climate action. The information may continuously inform governance on the state of progress and the need for further action. The reports are thus valuable assets for informing policymaking and allocation of resources. This implies that the information is included in the information flows that inform policy development, budgeting and negotiations. The question to consider here, is how digital technologies can steer information flows to facilitate that.

Normatively, the climate reports have an important role as evidence of emissions, commitments and measures. Digital technologies have an important role in providing the right information to the right actors, and support the identification of violations.

The interpretative, facilitative and normative roles of digital technologies and information provided through the ETF support governance in three distinct ways, which is illustrated in Figure 3. The interpretative role of information and digital technologies supports understanding and reflexivity. The facilitative role of information and digital technologies can support and incentivize climate action. The normative role of information and digital technologies support accountability. However, to be

effective, these have to be in conjunction with appropriate governance structures and processes.

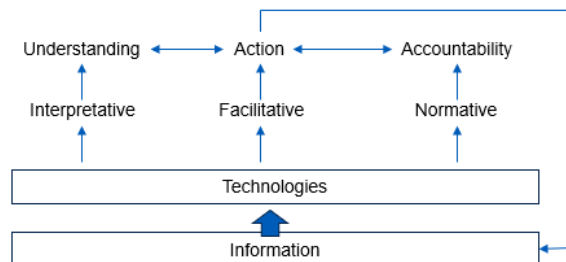


Figure 3. The roles of information and technology in digital global climate governance

Related to figure 2, illustrating the ambition cycle of the Paris Agreement, Figure 3 depicts the roles of information and digital technologies in the cycle of continuously increasing ambitions and evaluations of progress. Information, conveyed through technology, can support understanding, action and accountability. Actions then generate additional information, which in turn informs increased understanding, action and accountability. To further enhance digital global climate governance, digital services and functions can be developed to support these three aspects.

4.5 Implications and limitations

In this final section, implications and limitations of the approach in the paper will be discussed, as well as avenues for future research.

The paper deepens the theoretical understanding of the role of information and digital technologies in digital global climate governance. The paper contributes conceptually to digital global governance theory development, by explicating three distinct and interrelated roles of information and digital technologies, which is illustrated in a conceptual model. By using the concept of record, the paper deepens the theorization of information as an important element in digital governance, along with technologies and the governance context.

The conceptualization of the interpretative, facilitative, and normative roles of information and digital technologies, provide guidance for further research and innovation of digital global climate governance. Future research is suggested to make deeper analysis of how actors interact with information and digital technologies related to each of the interpretive, facilitative and normative roles, to gain a deeper understanding of how to effectively support actors working for climate governance objectives. This can inform the development of digital

services for analysis and evaluation of policy measures, informing policy development and allocation of resources, as well as assessment of government actions in accountability procedures, through strategic use of the information provided through the ETF. Given that we are short in time to turn around the trend of climate change, the paper is a crucial starting point for contributing to effective governance. However, transparency is also a site for contestation that reflects conflicts of interest and power (Gupta & Mason, 2016), which even makes digitalization of administrative practices debated (Engvall & Flak, 2022b). Consequently, further research is required to elucidate the manner in which conflicts manifest in digital climate governance and the means by which they may be transcended.

The role of information and digital technologies may also generate new relations of power. In one sense, power in a governance context implies the ability to affect change in a commonly agreed direction. However, governance will also imply struggles of power between actors. Information and digital technologies may deepen power imbalances (Klein et al., 2021), and may also generate consequences that oppose agreed objectives. Future research should investigate elements of actor capability related to the ETF in a digital global climate governance context, as well as how to navigate power imbalances.

The conceptualization in this paper focuses on the mediating roles of information and digital technologies in digital global climate governance. It is important to see this in conjunction with institutional conditions, societal context and capability of actors. Information and digital technologies are ingrained in governance structures and processes, with reciprocal relationships with values and objectives (Engvall & Flak, 2022). How information and technologies are embedded in climate governance structures and processes, as well as how individual actors draw on information and technologies to shape discourses, affect change, and legitimize certain patterns, will affect the transformative potential of information and technologies.

A limitation of the conceptualization in this paper is that it is on a quite generic abstraction level. A suggestion is therefore to deepen the analysis in more specific studies with additional theoretical lenses for a deeper understanding of the interaction between actors and information and technologies. Additionally, deeper analysis should be made on the role of digital technologies in relation to actors, particularly considering the role of AI.

12. References

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