The role of information systems in global governance: The case of climate reporting

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Abstract

We live in a globally interconnected and interdependent world, where societal challenges are increasingly global in character. States and local communities cannot effectively address such challenges by themselves, which is why there is a need for global coordination and collaboration. However, global governance has challenges in responding effectively to the problems. In that context, I explore what role information systems have in supporting global governance to steer towards a sustainable future, bringing us to the domain of digital governance.

Digital governance includes the use of digital technologies in governance structures and processes. Extant literature shows that digital governance, if adequately applied, may improve structures, processes, and qualities of governance, such as transparency, accountability, efficiency, effectiveness, and ways to interact with stakeholders. Furthermore, scholars argue that digital technologies can improve the implementation capability for the Sustainable Development Goals, through for instance strengthening institutional capacities and governance innovation, but there is a need for further conceptualization and directions on how to utilize digital technologies. Unfortunately, the research on the application of digital governance in global governance structures and processes is very scarce, leaving us unknowing of how information systems could support global governance. As global governance has conditions that are different from national and local governance, it requires both theoretical and empirical foundations that consider its characteristics, to address its challenges appropriately. To understand digital global governance, we must both understand global governance and its challenges, as well as the use of digital technologies in such settings.

This thesis identified climate change as the focal area of global governance to study. The Paris Agreement, the current international climate agreement, was adopted in 2015, with the goal to limit global warming to well below 2°C, preferably 1,5°C, compared to pre-industrial levels. Under the Paris Agreement, countries make voluntary commitments, and every fifth year, progress is evaluated in a Global Stocktake. Countries report regularly on their commitments, emissions, measures, and projections, which are used to inform decision-making, assess implementation, and evaluate progress. The reporting relies on an extensive use of digital technologies and is regarded as an example

of digital global governance. It has been selected as the case for in-depth investigation of this thesis.

To develop a deeper understanding and theorize the role of information systems in this case of digital global governance, 'information infrastructure' was considered an appropriate analytical framework. Information infrastructures are a type of information system, reflecting a large sociotechnical network composed of technologies, organizations, social aspects, standards, and people. Climate reporting relies on the use of digital technologies, it is regulated by global standards, implemented by organizations, carried out by people, and the information collected is then used to inform governance activities. Thus, 'information infrastructure' as an analytical lens reflects well the phenomenon of climate reporting and provides a comprehensive and holistic understanding of this large and complex information system, extending across multiple governance levels. The characteristics of information infrastructures as large and heterogeneous systems where there is no single authority in control of the entire infrastructure, is also aligned with the characteristics of global climate governance, which has multiple sites of authority and involves multiple actors with different roles and information needs. Moreover, an information infrastructure is a foundation for the development of digital governance and is thus a relevant focus in research that aims to gain a basic understanding of the development of digital global governance, and conditions for further development. The approach to II design can guide the development of digital global governance.

The overall objective for this thesis is to develop an improved understanding of digital global governance, and particularly, how information systems support global climate governance. Based on this understanding, the thesis will discuss pathways for further development of digital global climate governance. Three research questions address this objective:

RQ1: What is digital global governance?

RQ2: How do information systems support global climate governance?

RQ3: How can digital global climate governance be enhanced?

The conceptual foundation for this thesis is based on information infrastructures and digital governance literature and is informed by governance literature for a deeper understanding of governance and global governance. Based on literature reviews and integration of theoretical elements from these streams of research,

conceptualizations of 'digital global governance' and 'global governance information infrastructure' are proposed, and 'global governance information infrastructure' (GGII) is established as a theoretical framework for understanding the dissertation´s case of digital global governance. A model, called the GGII model, is proposed, which illustrates the relationship between information infrastructure and global governance. This model is also applied to the case in the dissertation.

The thesis contains five publications: a literature review, three empirical studies, and a conceptual paper in the form of a research agenda. An exploratory, interpretive research approach was adopted in all studies, as well as for the thesis as a whole. Each of the five studies has contributed to the overall research objective from different angles. The initial literature review developed a more profound understanding of the meaning of digital governance and suggested a definition of 'digital governance'. This has been the foundation for the conceptualization of digital global governance. The paper contributes to the conceptual foundation for the digital governance field, which is important for further theoretical development. Empirically, climate reporting was investigated through case studies at three levels of governance: national (Sweden), supranational (European Union), and global (United Nations Framework Convention on Climate Change secretariat) levels. 34 interviews were conducted with 34 experts from the relevant organizational bodies at each governance level, with follow-up questions by e-mail or telephone to some of the respondents. Of the respondents, 14 experts represent the national level (Sweden), 8 are international experts (primarily from the UNFCCC secretariat), and 12 respondents are experts from the EU administration and EU member states, which relates to supranational governance. Interviews have been complemented by studies of relevant documents relating to concerned governance level for triangulation. The three case studies on international climate reporting provide empirical insights about the role of information systems at different levels of climate governance, which enrich our understanding of how information systems support global climate governance. Case study 1 uncovers the activities in the reporting process from national to global level and how digital technologies are used in those activities. It analyzes the information system for climate reporting as an information infrastructure and discusses its level of sophistication. Case study 2 investigates how digital technologies in the reporting process at the

national level support governance. Case study 3 investigates how the digital EU reporting platform Reportnet supports governance at a supranational level.

Findings indicate that the information infrastructure (II) for climate reporting supports governance activities and objectives of: monitoring; evaluation of progress; transparency; assessing implementation and compliance; analysis and communication of reports; and innovation. Additionally, the II supports administrative efficiency and information quality. The II further responds to some of the challenges in global governance. A major problem in global climate governance is weak implementation, and the II provides means for following up on implementation and exercising accountability. Another problem is weak coordination in a fragmented system. The II coordinates information on climate governance and thus supports coordination of actors and activities. A third problem is insufficient measures related to the real-world problem. The II provides a common source for verified information, which can be the basis for cooperation and collective action. Trustworthy information supports evidence-based policy making. A fourth challenge is power inequalities and trust issues. The II enables transparency of each party´s commitments and measures, which intends to build trust among actors. Reports on emissions, commitments, and measures can further be a basis for a discussion regarding responsibilities for measures.

The fifth publication situates climate reporting in the context of global climate governance interactions, illustrated by the Global Stocktake as an example. The paper proposes a research agenda for online interaction in digital global governance, based on a framework of three levels of interaction, including information sharing, cooperation, and collective action.

The thesis makes a conceptual contribution by defining key concepts such as 'digital global governance,' and 'global governance information infrastructure'. Global governance information infrastructure (GGII), illustrated by the GGII model, is established as a theoretical framework for deepening the understanding of the selected case of digital global governance, and is applied in further analysis of the findings of the publications. Moreover, based on the findings from the studies and the theoretical framework, directions for further enhancements of digital global climate governance, through cultivation of the information infrastructure, are discussed.

This thesis has important research implications related to the conceptual development of digital global governance and empirical insights into the role of information systems in global climate governance. The thesis theorizes the relationship between information infrastructures, digital governance, and global governance, and combines and synthesizes theoretical elements to define key concepts and propose the theoretical framework 'global governance information infrastructure' (GGII), illustrated by the GGII model. This offers new ways to understand digital governance in a global governance context and is a promising theoretical platform to further explore the phenomenon of digital global governance. The thesis also offers implications for practice in the form of guidance and suggestions for further enhancements of digital global climate governance, through cultivation of the climate GGII. Moreover, the conceptual frameworks can facilitate a common understanding of the relationships between information infrastructures and global governance, which can facilitate collaboration between different actors and a more accurate and faster development of digital global climate governance.

Swedish Abstract

Vi lever i en globalt sammankopplad värld, där många samhällsproblem också är globala. Länder och lokalsamhällen kan inte hantera sådana utmaningar på egen hand på ett effektivt sätt, utan det finns ett behov av globalt samarbete och koordinering. Mot bakgrund av det så undersöker denna avhandling vilken roll informationssystem har i att stödja global styrning mot en hållbar utveckling, med fokus på klimatfrågan. Detta anknyter till forskningsfältet 'digital styrning', vilket addresserar användningen av digitala teknologier i styrning och administration, primärt inom offentlig verksamhet.

Forskning visar att digital styrning kan bidra till att förbättra strukturer, processer och kvalitéer, som tex transparens, ansvarighet, effektivitet, och tillhandahåller verktyg för att interagera med intressenter. Forskare argumenterar också för att digitala teknologier kan förbättra förutsättningarna för implementering av de globala hållbarhetsmålen, tex genom att förstärka institutionella förutsättningar och innovation. Det behövs dock ytterligare konceptualisering och vägledning i hur digitala teknologier kan nyttjas.

Mycket lite av forskningen inom digital styrning berör globala strukturer och processer. Då förutsättningarna för global styrning skiljer sig från tex nationell eller kommunal styrning, så behövs både teoretisk och empirisk kunskap som kan ge förståelse och vägledning om vad digital styrning innebär i en sådan kontext. För att förstå 'digital global styrning', så behöver vi både förstå förutsättningar, egenskaper och utmaningar hos global styrning, likväl som användningen av digitala teknologier i den kontexten.

Den här avhandlingen har valt global klimatstyrning som fokusområde att studera. Parisavtalet, vilket är det nu gällande globala klimatavtalet, antogs 2015. Målet i Parisavtalet är att begränsa den globala uppvärmningen till väl under 2°C, företrädesvis 1,5°C. Parisavtalet bygger på att länder gör frivilliga åtaganden som bidrar till det gemensamma målet. Vart femte år så utvärderas utvecklingen i en global översyn (Global Stocktake) och ytterligare behov av åtgärder identifieras. Länder rapporterar regelbundet deras åtaganden, utsläpp, åtgärder och scenarier, vilket sedan används för att underbygga beslutsfattande, utvärdera utvecklingen och följa upp implementering. Det är denna rapportering som är föremål för fallstudierna i denna avhandling.

För att utveckla en djupare förståelse för och teoretisera informationssystemens roll i detta case av digital global styrning, så används 'informationsinfrastrukturer' som ett analytiskt verktyg. Informationsinfrastrukturer är en typ av informationssystem, som karaktäriseras av att vara stora, komplexa sociotekniska nätverk bestående av teknologier, organisationer, standarder, sociala aspekter, och människor. Klimatrapporteringen genomförs via en global informationsinfrastruktur, där digitala teknologier används för olika uppgifter i processen. Vidare är rapporteringen reglerad genom globala standarder, implementerad genom olika organisationer, och utförd av människor. Informationen används sedan för styrningsändamål. 'Informationsinfrastrukturer' är en lämplig teoretisk lins då den på ett bra sätt speglar klimatrapporteringen som fenomen, och ger en helhetsbild av detta stora och komplexa informationssystem, som sträcker sig över flera organisationer och styrningsnivåer. Egenskaperna hos informationsinfrastrukturer som stora och heterogena system utan en enskild auktoritet som har kontroll över hela infrastrukturen, är i linje med strukturen för global styrning som karaktäriseras av flera styrningscentra och involverar flera olika aktörer med olika roller och informationsbehov. Informationsinfrastrukturer är en viktig grund för utvecklingen av digital styrning, varför det också är ett relevant fokusområde för forskning som ämnar få en grundläggande förståelse för förutsättningarna för utvecklingen av digital global styrning.

Det övergripande syftet med denna avhandling är att utveckla en fördjupad förståelse för digital global styrning, och särskilt hur informationssystem stödjer global klimatstyrning. Utifrån den förståelsen syftar denna avhandling även till att diskutera hur digital global klimatstyrning kan utveklas. Tre forskningsfrågor addresserar detta syfte:
1) Vad är digital global styrning?
2) Hur stödjer informationssystem global klimatstyrning?
3) Hur kan digital global klimatstyrning utvecklas vidare?

Den konceptuella grunden för avhandlingen baseras på litteratur om informationsinfrastrukturer och digital styrning. Dessutom används litteratur om styrning och global styrning för att få en djupare förståelse för global styrning. Utifrån litteratur studier och integrering av teoretiska element från dessa fält föreslås konceptualiseringar av 'digital global styrning' och 'informationsinfrastrukturer för global styrning'. Vidare etableras

'informationsinfrastrukturer för global styrning' (GGII) som teoretiskt ramverk för att förstå avhandlingens case av digital global styrning. En modell, kallad GGII modellen, introduceras för att illustrera relationen mellan informationsinfrastruktur och global styrning, vilken sedan diskuteras mot avhandlingens case.

Avhandlingen innehåller fem publiceringar: en litteraturstudie, tre empiriska studier, och ett konceptuellt bidrag i form av en forskningsagenda. En explorativ, interpretativ ansats har tillämpats för alla studier och avhandlingen som helhet. Varje delstudie har bidragit till det övergripande forskningssyftet utifrån olika perspektiv.

Den initiala litteraturstudien utvecklade en grundläggande förståelse för innebörden av digital styrning och föreslog en definition av 'digital styrning'. Detta är sedan grunden för konceptualiseringen av digital global styrning. Publiceringen bidrar också konceptuellt till fältet digital styrning, vilket är viktigt för vidare teoretisk utveckling av området.

De tre fallstudierna om internationell klimatrapportering bidrar med empiriska insikter om informationssystemens roll vid olika nivåer av styrning: nationell (Sverige), överstatlig (EU), och global (FN) nivå, vilket berikar vår förståelse för hur informationssystem bidrar till global styrning. 34 intervjuer genomfördes med 34 experter från relevanta organisationer vid respektive styrningsnivå. Utöver det gjordes ett antal telefonsamtal och e-postväxlingar för klargöranden och frågor som upsptod vid analys av materialet. 14 av respondenterna verkar på nationell nivå (Sverige), 8 är internationella experter (i huvudsak anställda vid FNs klimatsekretariat), och 12 respondenter är experter från EU administrationen och rapportörer i EU medlemsländer. Intervjuer har kompletterats med studier av relevanta dokument relaterat till respektive styrningsnivå för triangulering. De tre fallstudierna om klimatrapportering ger empiriska insikter om informationssystemens roll vid olika styrningsnivåer, vilket ökar vår förståelse för hur informationssystem stödjer global klimatstyrning. Fallstudie 1 identifierar aktiviteterna i rapporteringsprocessen från nationell till global nivå, och hur digitala teknologier används i processen. Studien analyserar informationssystemens roll i rapporteringen som en informationsinfrastruktur och diskuterar i vilken grad teknologier nyttjas. Fallstudie 2 undersöker hur digitala teknologier i rapporteringsprocessen på nationell nivå bidrar till styrning. Fallstudie 3 undersöker hur EUs digitala rapporteringsplattform Reportnet bidrar

till styrning på en överstatlig nivå. Resultaten visar att informationsinfrastrukturen för klimatrapporteringen stödjer styrningen genom att skapa förutsättningar för övervakning, uppföljning av mål, transparens, uppföljning av policy implementering, ansvarighet, analys och kommunikation av informationen i rapporterna, samt innovation. Utöver det så stödjer informationsinfrastrukturen administrativ effektivitet och informationskvalitet. Informationsinfrastrukturen svarar vidare mot några av utmaningarna med global styrning. Ett stort problem är svag implementering, och informationsinfrastrukturen skapar förutsättningar för att följa upp implementering och ställa aktörer till ansvar. Ett annat problem är svag koordinering i ett fragmenterat system. Informationsinfrastrukturen koordinerar information för klimatstyrningen och stödjer därmed även koordinering av aktörer och aktiviteter. Ett tredje problem är otillräckliga åtgärder i förhållande till de reella behoven. Informationsinfrastrukturen tillhandahåller en gemensam källa för verifierad information, vilket kan utgöra grunden för samarbete och kollektiv handling. Pålitlig information stödjer också evidensbaserad policyutveckling. Ett fjärde problem är ojämlikheter och tillitsproblem. Rapportering av utsläpp, åtaganden och åtgärder tydliggör i vilken grad länder bidrar till problem och lösningar, och kan utgöra en grund för transparenta diskussioner om ansvar för åtgärder.

I den femte publikationen placeras rapporteringen i en global styrningskontext, genom en forskningsagenda för digital interaktion i global styrning, baserat på ett ramverk med tre nivåer av interaktion: informationsdelning, samarbete, och kollektiv handling. Forskningsagendan illustreras genom exemplet med den Globala översynen (Global Stocktake) som vart femte år genomförs i de globala klimatstyrningsprocesserna.

I kappan görs ytterligare litteraturstudier för att utveckla det konceptuella ramverket för avhandlingen och definitioner för 'digital global styrning' och 'informationsinfrastrukturer för global styrning' föreslås, liksom en konceptuell modell för informationsinfrastrukturer för global styrning (GGII modellen). Det teoretiska ramverket och GGII modellen används sedan för att fördjupa anlysen av avhandlingens case i digital global styrning (klimatrapportering). Utifrån resultaten i publikationerna och det teoretiska ramverket så diskuteras sedan möjligheter för vidareutveckling av digital global klimatstyrning genom att

kultivera informationsinfrastrukturen som ligger till grund för klimatrapporteringen.

Sammantaget bidrar avhandlingen konceptuellt till digital global styrning; tillhandahåller empiriska insikter om digital global klimatstyrning, specifikt informationssystemens roll i global klimatstyrning; samt föreslår vägar framåt för vidareutveckling av digital global klimatstyrning. Avhandlingen teoretiserar relationen mellan informationsinfrastruktur, digital styrning och global styrning, och kombinerar och syntetiserar teoretiska element för att definiera centrala begrepp och föreslå ett teoretiskt ramverk för 'informationsinfrastrukturer för global styrning', illustrerat genom GGII modellen. Detta ger nya möjligheter att förstå digital styrning i en global styrningskontext och är en lovande teoretisk plattform för att vidare undersöka digital global styrning.

Ur ett praktik perspektiv, bidrar avhandlingen med förslag på vidare utveckling av informationsinfrastrukturen för global klimatstyrning. Det konceptuella ramverket som utvecklas I denna avhandling kan också skapa en gemensam förståelse för digital global styrning, vilket kan bidra till en snabbare och mer riktad utveckling av digital global klimatstyrning.

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List of abbreviations

ICT	Information and Communication Technology
IT	Information Technology
IS	Information Systems
MIS	Management Information Systems
DSS	Decision Support System
TPS	Transaction Processing System
II	Information Infrastructure
GGII	Global governance information infrastructure
OC	Online Communities
IPCC	Intergovernmental Panel on Climate Change
UN	United Nations
UNFCCC	United Nations Framework Convention on Climate Change

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1. Introduction

We live in a globally interconnected and interdependent world, with global markets, mobility, and information exchange. Societal problems are also increasingly globally interconnected and interdependent (Weiss & Thakur, 2010). Issues like pandemics, financial vulnerabilities, climate change, migration, and cyber security are global in character and cannot be effectively managed by individual countries or local communities themselves, which drives the need for global governance (Weiss & Wilkinson, 2014). Global governance is justified by transnational issues or the global common good, and implies an exercise of authority across national borders (Zürn, 2018a). Governance implies a steering of society according to common goals, through collective action (Ansell & Torfing, 2016). Steering mechanisms aim to move societies in desired directions and implement agreed goals (Rosenau, 2017). As the world is facing severe global challenges, the motivation of this thesis is to explore how information systems can be part in improving global governance to respond to such challenges, focusing on how information systems support global climate governance.

According to Sarker et al., (Sarker, Chatterjee, Xiao, & Elbanna, 2019) the very essence of the information systems discipline is a sociotechnical perspective, which means that both technical artifacts and the social context in which they are developed and used are addressed. It is the interaction between the technical and the social that comprises the sociotechnical view. Thus, to grasp the role of information systems in a global governance context, we need to understand both the use of information systems and the global governance context and its challenges.

Digital governance is the field that researches the use of digital technologies in governance. Digital governance is in this thesis defined as "digital technology ingrained in structures and processes of governance and their reciprocal relationships with governance objectives and normative values. Digital governance includes the utilization of digital capabilities and involves a transformation of structures, processes, or normative values" (Engvall & Flak, 2022b, p. 44).

Initially, research in the field focused on administrative issues in the public administration and development of digital public services but has then increasingly also advanced towards a broader approach to the societal

implications of applying digital technologies in various governance structures and processes (Dawes, 2009). Functions such as service-delivery, decision-making, coordination, and interaction with stakeholders, as well as new methods, means, and mechanisms for governance can be innovated with the support of digital technologies. Research further indicates that qualities, such as transparency, accountability, effectiveness, and responsiveness can be strengthened with digital governance solutions (Engvall & Flak, 2022b). Scholars argue that digital governance can support the implementation of the sustainable development goals (Estevez, Janowski, & Dzhusupova, 2013; Janowski, 2016; Medaglia, Misuraca & Aquaro, 2021), but conceptualization and guidance for that purpose are needed (Medaglia, Misuraca & Aquaro, 2021).

Infrastructural issues related to the role of digital technologies in supporting governance for sustainable development, are particularly emphasized for further investigations (Larsson & Grönlund, 2014). Due to its emphasis on practical improvements, digital governance research has tended to have a quite practical approach, and a more robust scientific basis for the digital governance field has been requested (Charalabidis & Lachana, 2020b). In light of that, this thesis aims to make conceptual contributions to the digital governance field, and also to theorize the role of information systems in digital governance in a global governance context, i.e., in digital global governance.

To analyze and deepen the understanding of the characteristics and role of information systems in this dissertation′s case of digital global governance, the theoretical lens 'information infrastructures' (II) is applied. Information infrastructures are a type of information systems, which can be understood as large sociotechnical networks (Hanseth & Lyytinen, 2016). Information infrastructures encompass interrelated technological, social, and organizational elements, as well as standards and people (Bowker, Baker, Millerand, & Ribes, 2009), which reflects the characteristics of international climate reporting. Furthermore, IIs are the underlying foundations for digital services and functions (Beconytė, Balčiūnas, & Andriuškevičiūtė, 2022). An understanding of the information infrastructure for global climate governance provides a theoretical understanding of the foundation of digital global climate governance, as well as a theoretical basis for guiding further development. As an infrastructure, an II is open and shared among many users, supports development of different services, and consists of a variety of interconnected components and linked networks

(Hanseth & Monteiro, 1998). Since IIs are intertwined with and coevolve with work practices and organizational structures (Aanestad, Grisot, Hanseth, & Vassilakopoulou, 2017), information infrastructures have a profound role for structural transformations (Tilson, Lyytinen, & Sørensen, 2010a), which is requested in global climate governance (Klein et al., 2021; Rosenau, 2017). An information infrastructure furthermore encompasses both a common foundation, as well as local variability (Hanseth & Lyytinen, 2010b), which is appropriate in a global climate governance context where there is a need for global coordination but also local adaptation, since implementation of global policy is conducted by multiple actors in various different settings. Information infrastructures are thus considered an appropriate theoretical lens for analyzing the case of digital global governance in this thesis.

So far, research in the digital governance field has primarily addressed the national and municipal levels, and research regarding the global governance setting is scarce. A prominent theme in the literature with an international dimension is comparisons of national efforts in different countries (Evans & Yen, 2006; Moon, Welch, & Wong, 2005), or comparisons of different topics between countries, such as eDemocracy (Lidén, 2018) or digital divide (Ayanso, Cho, & Lertwachara, 2014; Molina, 2003). What we can learn from these studies is that countries have very different conditions related to digital governance (Evans & Yen, 2006; Jreisat, 2004). The development of digital governance looks different in different countries, due to sociocultural and economic conditions (Manoharan, Ingrams, Kang, & Zhao, 2021). Hence, local context and the possibility of different development pathways are important to consider in digital global governance solutions. Moreover, heterogeneity in the global context can be a barrier for global information exchange, collaboration, and coordination (Su et al., 2004), and interoperability is advocated to be central for effective implementation of global governance goals (Wisitpongphan & Khampachua, 2017). Although these studies give an understanding of the diversity in a global context, they do not investigate digital governance initiatives in global governance structures and processes. An emerging topic though, related to the international arena, is 'digital diplomacy', which addresses the use of digital technologies for diplomatic conduct and foreign policy objectives (Almuftah, Weerakkody, & Sivarajah, 2016; Sotiriu, 2015). However, research on the subject is still scarce (Al-Muftah, Weerakkody, Rana, Sivarajah, & Irani, 2018), and

scholars request an improved conceptualization of ICT and digital governance in the area of diplomacy (Wihlborg & Norstedt, 2017).

Because global governance has differences compared to national governance, there is a need for a conceptual foundation and theoretical approaches to digital governance in a global governance context, i.e., digital global governance, that encompasses the characteristics of both digital governance and global governance. It is crucial to understand the characteristics and challenges of the global governance context to develop digital solutions that adequately respond to global governance challenges. Moreover, insights on how information systems can support global governance are needed, to provide an understanding of possibilities available and guidance for further development pathways where digital capabilities are used to support global governance. There is thus a need for both a conceptual foundation and empirical insights on digital global governance.

The focus area of global governance investigated in this thesis is climate governance. Climate change is a typical example of a critical societal challenge, where both the causes and effects have global interconnections and interdependencies. Climate change is caused by greenhouse gas (GHG) emissions, generated by activities in key sectors of transportation, industry, energy provision, and agriculture (IPCC, 2021c). Such activities are embedded in global production, consumption, and transportation chains, and the greenhouse gas (GHG) emissions are not confined to their place of origin, and are hence not constricted within national borders (Bulkeley & Newell, 2015). Activities in one place of the world can affect social-ecological systems in other parts of the world, with both direct and distant effects (Folke, Haider, Lade, Norström, & Rocha, 2021). According to the Intergovernmental Panel on Climate Change (IPCC) (IPCC, 2021a), emissions from human activities have caused an unprecedented climate change. Since 1970, the global surface temperature has increased faster than in any other 50-year period. This generates several effects, such as extreme weather, forest fires, droughts, and increasing sea levels, which have extensive socio-economic implications (IPCC, 2021a). If it continues on the current path, global warming will rise to levels which would have devastating consequences (IPCC, 2021a). According to IPCC, it is urgent to quickly reverse the trend, stating that agreed temperature goal will be exceeded during the 21st century unless comprehensive reductions of greenhouse gases are made in the coming decades (IPCC, 2021a).

Given this urgency, there is arguably a need for effective global climate governance. Unfortunately, global climate governance has not been very effective in ensuring that commitments are implemented. Actions have been too small, too slow, and poorly rooted (Rosenau, 2017). One key challenge is related to the informal nature of governance, and to get actors to comply with environmental standards (Rosenau, 2017). Compared to the national level, in global governance there is no global authority to enforce decisions (Zürn, 2010). A second key challenge is that global environmental governance is a disaggregated and minimally coordinated system, encompassing various formal and informal systems of governance and spheres of authority, involving multiple governance levels, actors, and agencies assigned with responsibilities in different policy areas (Rosenau, 2017). A third key challenge is related to the United Nations Framework Convention on Climate Change (UNFCCC) processes. Since all decisions require consensus, it is a rather slow process that does not deliver enough compared to the severity of the problem. There are also challenges with lack of trust due to unfulfilled promises and power inequalities (Klein et al., 2021). As the UNFCCC process is currently moving from negotiations towards a focus on implementation and follow-up on progress, there is an opportunity to rethink procedures. In light of that, digital transformation is suggested as a means to transform UNFCCC processes to be more fit for purpose (Klein et al., 2021). However, to develop digital solutions that support a more effective and responsive global climate governance, we need to understand global climate governance, current use of digital technologies and the conditions for digital global governance.

Global governance of climate change is orchestrated within the United Nations, centered around global treaties (the United Nations Framework Convention on Climate Change, the Kyoto Protocol, followed by the Paris Agreement). A central element of the international climate governance framework has been that governments report on their country´s emissions and measures. With the Paris Agreement (Paris Agreement, 2015) this has been further standardized since all countries now report according to the same standards. Reporting makes it possible to monitor emissions and progress towards the goal set in the Paris Agreement, and it is transparent concerning what countries commit and what measures they implement. Every fifth year (starting 2022-2023), there will be a Global Stocktake to evaluate progress and inform further need for action

(UNFCCC, 2018). Thereby, reporting has an important role in global governance by supporting decision-making, following up on the implementation of international agreements, as well as evaluating progress towards the goals in the Paris Agreement. Climate reporting under the UNFCCC framework (including applicable UN climate agreements) is the phenomenon that is empirically studied in this thesis.

Climate reporting is supported by digital technologies that enable the collection, management, and use of information for governance purposes, shaping a global information system. However, given that the characteristics of this sociotechnical system and how it supports governance are at best superficially understood from an information systems perspective, there is a need for deeper analysis and theoretical development. This thesis demonstrates how information infrastructures can be applied to this end. A better understanding of the information infrastructure for global climate governance can both provide knowledge of how digital global governance of climate change is emerging, and also be used as a basis for further research on improvements of digital global governance of climate change. Moreover, in a scientific context, central in creating understanding of phenomena is conceptualizations. According to Merriam Webster´s Dictionary, conceptualizing means to form a concept of a phenomenon, to interpret a phenomenon conceptually (Merriam-Webster.com Dictionary, 2023a). In this thesis, the phenomenon is digital global governance, with a certain focus on global climate governance.

In light of the above, this thesis aims to conceptualize digital global governance and provide a deeper understanding of how information systems support global climate governance. Based on this understanding, the thesis will also discuss possible pathways for further research and development of digital global climate governance.

1.1. Research questions

The overall objective for this thesis is to develop an improved understanding of digital global governance, and particularly, how information systems (IS) support global climate governance. Based on this understanding, the thesis will discuss further development of digital global climate governance.

Digital governance is suggested to, if adequately applied, improve structures, processes, and qualities of governance (Engvall & Flak, 2022b). Scholars further advocate that digital governance can support the implementation of the sustainable development goals (Estevez et al., 2013; Janowski, 2016; Medaglia, Misuraca & Aquaro, 2021), but that further conceptualizations and directions are needed (Medaglia, Misuraca & Aquaro, 2021), particularly regarding infrastructural issues (Larsson & Grönlund, 2014).

Research in the digital governance field has primarily focused on the national and local contexts, and the global governance context deserves particular attention due to its unique characteristics and challenges. Both conceptual and theoretical foundations, as well as empirical insights, are needed to develop a body of knowledge for digital global governance. The objective of this thesis is thus to contribute conceptually, theoretically, and empirically to the understanding of digital global governance. Particularly, the thesis investigates how information systems support global climate governance.

Three research questions are formulated to address the research objective:

RQ1: What is digital global governance?
RQ2: How do information systems support global climate governance?
RQ3: How can digital global climate governance be enhanced?

1.1.1. What is digital global governance?

As there is limited research on digital governance in the global governance setting, conceptual development is needed to develop a robust understanding of the phenomenon of digital global governance.

This research question is addressed through literature reviews in the digital governance field and literature on governance and global governance. The empirical studies of international climate reporting add an empirically based understanding of how digital global governance can manifest.

1.1.2. How do information systems support global climate governance?

To gain an understanding of how information systems support global climate governance, empirical studies are required.

The case studies in this thesis empirically investigate how information systems in international climate reporting under the UNFCCC framework support climate governance. Reporting is a central part of the global climate governance framework, which engages both national, supranational, and global governance levels. Countries report on their emissions, commitments, and measures, which is central in monitoring climate change and progress towards the goals in the Paris Agreement, as well as it makes countries efforts transparent. The reporting requires extensive management of information, which gives information systems an important role. Hence, the case studies investigate the role of information systems in the case of climate reporting, studied at both national, supranational, and global levels, and analyze how that contributes to climate governance. The reporting is in this thesis considered to be an example of digital global governance.

1.1.3. How can digital global climate governance be enhanced?

Global climate governance does not sufficiently respond to the real-world problem of climate change (Rosenau, 2017). The question is thus how digital global governance can contribute to improvements.

Based on the understanding of the meaning of digital global governance (RQ1), the theoretical framework developed in the thesis, empirical insights from the case studies on how information systems contribute to global climate governance (RQ2), and a research agenda on online interaction in digital global governance (publication five), the thesis discusses possible pathways for further development of digital global climate governance.

1.2. Dissertation structure

The structure of the remaining dissertation is as follows:

Chapter two is a literature section, which situates the thesis in the information systems and digital governance fields and develops the conceptual foundation for the thesis. This includes literature reviews on governance & global governance, digital governance, and information infrastructures. Based on the understanding developed in those literature reviews, digital global governance and global governance information infrastructures are conceptualized. This chapter also provides a scientific understanding of climate change, to provide an understanding of the selected global governance problem. The structure of this chapter is as follows: 1) climate change, 2) governance and global governance, 3) digital governance, 4) digital global governance, 5) information infrastructures, and 6) global governance information infrastructures. This chapter makes conceptual contributions to the research objective and research questions 1 and 2. This includes: 1) a definition of 'digital global governance', 2) a definition of 'Global Governance Information Infrastructure' (GGII), and 3) the GGII model, which is a conceptual model of the relationship between information infrastructures and global governance.

Chapter three describes the research design of the thesis, which is based on a hermeneutic interpretive approach. It outlines philosophical stance, method, case description, overview of data collection and analysis, and discusses quality issues, limitations, and challenges.

Chapter four summarizes the findings from each publication and their main contributions to the research objective of the thesis.

Chapter five discusses and theorizes the findings from the publications towards the conceptual framework developed in Chapter 2. This chapter is structured according to the following subsections:
1) What is digital global governance;
2) The information infrastructure for global climate governance;
3) Pathways for further enhancements of digital global climate governance through cultivation of the GGII.
The literature review on digital governance as a scientific concept (Engvall & Flak, 2022b) is discussed in the first section. The case studies (Engvall, 2021; Engvall & Flak, 2022a, 2022c) are discussed in Section 2, where the GGII model

proposed in Chapter 2 is applied to the cases of climate reporting. Section 3 discusses development pathways for further enhancements of the climate GGII and digital global climate governance, based on the fifth publication (Engvall, Flak, & Sæbø, 2022) which is a research agenda for online interaction in digital global governance, and the conceptual foundation of the thesis.

Chapter six includes conclusions, theoretical and practical implications, reflections, and suggestions for further research.

2. Literature and conceptual foundation

This section includes the conceptual and theoretical foundation. For this thesis, it is important to first have a basic understanding of the selected real-world problem (climate change) that global governance seeks to respond to. Second, to understand the challenges in global governance that digital technologies are intended to contribute with solutions to, there is a need to understand governance and global governance. Third, the thesis is situated in the digital governance field and the third part of this section is thus about digital governance and what research has been done about the global level in this field. Fourth, to develop a deeper understanding and theorize how information systems can support global governance, information infrastructure is applied as a theoretical lens. The theoretical elements: governance & global governance, digital governance, and information infrastructures, are used to build the conceptual foundation for the knowledge development in this thesis.

The structure of this chapter is as follows: in Section 2.1 the scientific basis of the problem of climate change is described, based on the global synthesis reports by the Intergovernmental Panel on Climate Change (IPCC). In Section 2.2, drawing on governance literature, the meaning of governance and global governance is discussed. Section 2.3 discusses the meaning of digital governance and reviews digital governance research with a global approach. Based on these two sections, a conceptualization of digital global governance is suggested in Section 2.4. Section 2.5 includes a literature review on the theoretical lens 'information infrastructure'. Based on the understanding of key characteristics of global governance (Section 2.2) and information infrastructures (Section 2.5), in Section 2.6, the novel concept 'global governance information infrastructure' is conceptualized, and a model to illustrate the global governance information infrastructure (GII) is proposed; the GGII model.

2.1 Climate change

This section outlines the real-world problem of climate change, which is the focal global governance issue in this thesis. This explanation is based on synthesis reports by the Intergovernmental Panel on Climate Change (IPCC).

IPCC was established in 1988 by the World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP), which consists of governments that are members of the WMO or the United Nations. IPCC assesses and compiles the science on climate change to provide scientifically based recommendations for policymakers on climate policy. IPCC reviews and compiles research on climate change globally, including assessments of the scientific basis of climate change, its drivers, impacts, and risks, how adaptation and mitigation options can reduce such risks, and different scenarios. IPCC regularly publishes assessment reports based on recent research publications on climate change, which thousands of experts across the globe contribute to. The assessments identify areas of strong scientific agreement and gaps that need further research, but IPCC does not conduct research itself (IPCC, 2023a).

IPCC has confirmed that climate change is caused by increased levels of greenhouse gas (GHG) emissions. The increased levels of GHG emissions are a result of human activities. According to IPCC

> "Human influence has warmed the climate at a rate that is unprecedented in at least the last 2000 years" (IPCC, 2021a, p. 7).

Emissions from, for instance, fossil fuel combustion and land use that change the conditions for the natural environment to handle emissions, such as deforestation, are important reasons for an increased level of GHG emissions in the atmosphere. Consequences are, for instance, melting glaciers and increased sea levels, ocean acidification, droughts, and extreme weather such as cyclones, heat waves, forest fires, and heavy precipitation. Even though there can be some cyclical variations in temperature over time, global temperature has increased faster in the last 50 years than any other 50-year period over the last 2000 years.

> "The scale of recent changes across the climate system as a whole and the present state of many aspects of the climate system are unprecedented over many centuries to many thousands of years." (IPCC, 2021a, p. 9).

IPCC has developed scenarios depending on the GHG emission levels. The temperature levels are relative to the period 1850-1900. Unless deep reductions in GHG emissions are made in the coming decades, the goal in the Paris Agreement of a global warming of maximum 1.5°C compared to pre-industrial levels, will be exceeded during the 21st century (IPCC, 2021a). Table A. illustrates the scenarios of global warming, related to different levels of

emissions, going from a scenario (SSP1-1.9) with very low levels of GHG emissions, to a scenario (SSP5-8.5) with very high levels of GHG emissions.

Scenario	Near term, 2021–2040		Mid-term, 2041–2060		Long term, 2081–2100	
	Best estimate (°C)	Very likely range (°C)	Best estimate (°C)	Very likely range (°C)	Best estimate (°C)	Very likely range (°C)
SSP1-1.9	1.5	1.2 to 1.7	1.6	1.2 to 2.0	1.4	1.0 to 1.8
SSP1-2.6	1.5	1.2 to 1.8	1.7	1.3 to 2.2	1.8	1.3 to 2.4
SSP2-4.5	1.5	1.2 to 1.8	2.0	1.6 to 2.5	2.7	2.1 to 3.5
SSP3-7.0	1.5	1.2 to 1.8	2.1	1.7 to 2.6	3.6	2.8 to 4.6
SSP5-8.5	1.6	1.3 to 1.9	2.4	1.9 to 3.0	4.4	3.3 to 5.7

Table A. IPCC temperature scenarios (IPCC, 2021a, p. 18)

In comparison, a temperature 2.5°C higher than the years 1850–1900 last occurred over 3 million years ago. In the scenarios with high and very high emissions (SSP3-7.0 and SSP5-8.5), global warming of 2°C would be exceeded in the 21st century (IPCC, 2021a). Figure A. shows the relationship between emissions and global warming.

Figure A. IPCC illustration of emissions and global warming (IPCC, 2021a, p. 37)

The black line shows the observed temperature increase from 1850 to 1900 due to cumulative carbon dioxide (CO_2) emissions. The grey range is a

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corresponding estimate of historical human-caused surface warming. The colored sections are the assessed range of global surface temperature projections. The thick colored lines are median estimates due to cumulative CO_2 emissions from 2020 to 2050 for the scenarios discussed above (IPCC, 2021a).

The effects of global warming, such as heavy precipitation, droughts, and extreme weather, increase in frequency and intensity for every increased increment of global warming. Every additional 0.5°C will make a significant change in the climate system. Natural carbon sinks of land and the ocean's absorption of GHG emissions also become less effective when emissions increase. There are further tipping points in the climate system which are difficult to predict scenarios for (IPCC, 2021a).

To meet the goal in the Paris Agreement on limiting global warming to 1.5°C compared to pre-industrial levels, there has to be a rapid decline of GHG emissions towards net zero (IPCC, 2021c). Based on the pledges countries have made, the report states that

> "Current national pledges under the Paris Agreement are insufficient to limit warming to 1.5°C with no or limited overshoot, and would require an abrupt acceleration of mitigation efforts after 2030 to likely limit warming to 2°C. (…)
> Many net zero targets are ambiguously defined, and the policies needed to achieve them are not yet in place. Opposition from status quo interests, as well as insufficient low-carbon financial flows, act as barriers to establishing and implementing stringent climate policies covering all sectors" (IPCC, 2021c, p. 11).

2.1.1. IPCC suggestions

The Technical Summary of the IPCC Sixth Assessment Report (IPCC, 2021c) advocates for active work with policies, investments, technologies, institutional factors, and behavioral change to open more sustainable development pathways. The report states that there are close links between development pathways, pursuit of sustainable development goals, and climate change mitigation, and they should be addressed concurrently. Considering climate change, poverty eradication, equity, and development aspirations of a country concurrently will be more accepted, effective, and sustainable. Moreover, a global transition to a low-carbon, climate-resilient and sustainable development requires policymaking and coordination across multiple sectors, actors, and scales of governance at global, national, and local levels, as well as local adaptation (IPCC, 2021c).

"Accelerating mitigation globally would imply strengthening policies adopted to date, expanding the effort across options, sectors, and countries, and broadening responses to include more diverse actors and societal processes at multiple – including international – levels. The effective governance of climate change entails strong action across multiple jurisdictions and decision-making levels, including regular evaluation and learning. Choices that cause climate change as well as the processes for making and implementing relevant decisions involve a range of non-nation state actors such as cities, businesses, and civil society organizations. At global, national, and subnational levels, climate change actions are interwoven with, and embedded in, the context of much broader social, economic, and political goals. Therefore, the governance required to address climate change has to navigate power, political, economic, and social dynamics at all levels of decision making" (IPCC, 2021c, pp. 7-8).

This illustrates that the climate transition requires coordination across policy areas, governance levels, and actors. That is an arena for innovation that information systems can contribute to by coordinating information and facilitating interaction.

The problem is not only that there is a gap in commitments compared to what is required to meet the temperature goal, there is also an implementation gap, and many policies fall short of effectively achieving mitigation objectives. Globally, GHG emissions have continued to increase, particularly in the transport and industry sectors. Energy systems, transport, buildings, industry, urbanization, agriculture and food systems, forestry, and land use are highlighted as key areas for taking measures (IPCC, 2021b). The IPCC report (IPCC, 2021b) states that international cooperation has had a positive impact and is crucial for achieving climate change objectives. But, to achieve mitigation targets in the Paris Agreement, international cooperation needs to be strengthened in several ways. For instance, promises on financial and technology transfer to developing countries must be delivered, and policies more effectively implemented. The IPCC report (IPCC, 2021b) further suggests that digital innovation has the potential to leverage action, support system transformation and shift development pathways. However, in order to utilize the potential of digital innovation, system functions such as knowledge, capabilities, resource mobilization and governance of digitalization must be considered, to not further deepen the digital divide and inequality (IPCC, 2021c).

The challenge of climate change has motivated the development of global climate governance frameworks, leading to the most recent, the Paris Agreement

(Paris Agreement, 2015). Thus, after this overview of the challenge of climate change, the next section will be about the meaning of governance and global governance.

2.2 Governance & global governance

The first publication in this thesis (Engvall & Flak, 2022b), concerning digital governance as a scientific concept, revealed that there is a limited theoretical understanding of governance in the digital governance field. Conceptually, digital governance consists of 'digital' and 'governance'. Hence, in order to understand digital governance, we must understand both the digital and the governance elements. To understand digital governance in a global governance context, we must understand what characterizes global governance, which is even less theorized in the digital governance literature. This is crucial in order to understand how digital governance can support improvements and facilitation of global governance.

In light of the above, this section turns to governance literature to gain a deeper understanding of governance and global governance, to better understand the setting in which digital technologies are employed. Furthermore, it is a central element in developing the theoretical foundation for digital global governance.

2.2.1 Governance

The concept of 'governance' can be applied at various levels; local, national, regional, and global, and it embraces a variety of social systems. Governance includes activities and steering mechanisms for goal framing, issuing of directives, and pursuance of policies (Weiss, 2000). There are various definitions and descriptions of governance. Some of the descriptions of governance include:

> "The process of governance is the process whereby an organization or society steers itself" (Rosenau, 1995, p. 14).

> "Governance is the process of steering society and the economy through collective action and in accordance with common goals" (Ansell & Torfing, 2016, p. 4).

> "Governance is the general exercise of authority, (…) and the process by which a society or an organization steers itself. (…) At the level of the sovereign state, governance generally

denotes a complex mix of institutions (executive, legislative, judiciary) as well as interactions, behaviours, and processes" (Jreisat, 2004, p. 1004).

"(A) way to think about governance is as purposeful systems of rules or norms that ensure order beyond what occurs naturally" (Weiss & Thakur, 2010).

"Governance refers to the entirety of regulations – that is, the processes by which norms, rules and programs are monitored, enforced and adapted, as well as the structures in which they work – put forward with reference to solving a specific problem or providing a common good (…). While government refers to an actor, governance describes an activity independent of the kind of actor carrying it out (…). The term governance thus encompasses structures, processes and policy content" (Zürn, 2010, p. 80).

"governance can thus be understood as the structures and processes that enable governmental and non-governmental actors to coordinate their interdependent needs and interests through the making and implementation of policies in the absence of a unifying political authority" (Krahmann, 2003, p. 331).

These different definitions reflect different perspectives on governance; embracing a process view or a system-oriented view that includes both structures, processes, and policy. However, in the context of this thesis they are not viewed as opposing or contradictory, but depending on the focus of a research study, different aspects are relevant to highlight. Some scholars make a distinction between process and structure, whereas governance processes include activities such as agenda setting, policy development, decision-making, implementation, and evaluation, while organizational structure is the normative structure which regulates roles, responsibilities and influence, as well as how things should be done and when (Egeberg & Trondal, 2018).

Governance has a constitutive element of how rules are set and by whom, and a distributive element relating to how resources are allocated (Jreisat, 2004). Governance mechanisms, as a term, implies some differentiation in power which will also have different implications for different actors (Zürn, 2018a). At the core of governance is to achieve common goals and regulate collective problems (Zürn, 2010). Governance is crucial to societies´ development, and trusted and capable political and administrative institutions, as well as effective and participatory governance systems, are imperative to foster societal prosperity (Jreisat, 2004). It is about developing societies in intended directions.

Formal and informal mechanisms

Central for governance are rule systems and steering mechanisms (Rosenau, 2017), as well as communication and control mechanisms (Rosenau, 1995). While governments have rule systems based on formal and legal procedure, 'governance' also includes informal rule systems (Rosenau, 2017). This is also why, in governance, goals and principles must be accepted by the majority or at least the most salient stakeholders of those it concerns (Rosenau, Czempiel, & Smith, 1992). As Roseneau describes:

> "The rule systems of governments (local, regional, national, and international) can be thought of as formal structures, as institutions for addressing diverse issues that confront the people within their purview. Governance, on the other hand, is a broader concept. It refers to any collectivity, private or public, that employs informal as well as formal steering mechanisms to make demands, frame goals, issue directives, pursue policies, and generate compliance" (Rosenau, 2004).

Norms, shared goals, standards, informal agreements, negotiations, and other practices lead actors to contribute to common goals (Rosenau, 2004). Governance thus includes both formal and informal systems, as well as multiple types of actors.

Governance involves various stakeholders

Governance connotes a shift from centralization of authority within governments, to a greater inclusion of actors in society and a fragmentation of political authority. Governance requires structures and processes that enable coordination of both governmental and non-governmental actors in the development and implementation of policies. Fragmentation entails a move of authority to another political level (both upwards and downwards), or to private or voluntary actors (Krahmann, 2003). The means for implementation of policies also differ between government and governance. While governments are typically centralized and authoritative, and if needed coercive in implementation of policies, governance is typically decentralized and voluntary where policies are implemented by self-enforcement, by multiple actors that have the resources required for the implementation of a policy (Krahmann, 2003).

In summary, governance is about steering societies through collective action according to common goals (Ansell & Torfing, 2016). I further adhere to the

view that governance includes both structures, processes and policies, aiming to solve common problems or to ensure a common good (Zürn, 2010). Considering the characteristics of governance, there are vast opportunities to use information systems to support and facilitate various processes and structures. For instance, to support both formal and informal governance mechanisms, coordination of actors, and sharing of information.

As societal challenges are increasingly globally interconnected, it requires and legitimizes global governance.

2.2.2 Global governance

Although international cooperation has quite a long history, 'global governance' as a phenomenon is a response to an increased global interdependence and interconnectivity, i.e., globalization, which has challenged the capacity of states to solve societal problems on their own. Globalization often refers to the global interconnectedness and expansion of markets, global businesses, financial flows, as well as travel, cultural exchange and global flow of information (Weiss & Thakur, 2010). However, globalization has also increased the global interconnectedness of societal challenges, such as environmental pollution, terrorism, or migration, and has generated even greater gaps between rich and poor, and risks and possibilities. The rapid growth of global markets has not had a sufficient social and ecological response (Weiss & Thakur, 2010). The increased global interdependency has diminished the states´ abilities to handle things within their borders and has driven the need for global cooperation (Krahmann, 2003). For instance, environmental problems such as global warming, do not stay within national borders, which has motivated the need for global environmental agreements (Jreisat, 2004).

For a long time, governance in the international arena was based on an intergovernmental system, with interaction between sovereign states (Das, 2020; Kahler, 2009; Weiss & Thakur, 2010). However, in a complex and globally interconnected world, states alone will not solve societal problems, which is why collaborations with various actors are sought (Weiss & Thakur, 2010). There are also those who argue that a discourse that seeks market-oriented solutions and the privatization of public services has increased the involvement of private actors in governance in general (Krahmann, 2003). Global governance, as it has emerged

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after the Cold War, is characterized by the development of networks of governments, international organizations, NGOs, and private actors (Krahmann, 2003). Global governance thus involves cooperation of many actors and international agencies (Finkelstein, 1995). International organizations have an important role in global governance, as they facilitate states, and other actors, to cooperate towards common goals and manage conflicts and competition. Furthermore, the United Nations has significant roles in knowledge management, norm setting, making recommendations, and institutionalizing ideas (Weiss & Thakur, 2010). Non-government actors also have different roles related to formulating, implementing and monitoring policies (Krahmann, 2003). For instance, civil society movements and Non-Governmental Organizations (NGOs) have an important role in the mobilization of civil society (Teegen, Doh, & Vachani, 2004), and democratization and accountability (Scholte, 2002), where transnational civil society organizations have a monitoring function (Zürn, 2010), acting as "watchdogs" of what governments and private actors do. To implement global environmental policies, various actors need to be involved and coordinated (Rosenau, 2017). Some further argue that because the private sector is often the cause of environmental problems, they are also important to involve in the implementation of environmental policies (Wälti, 2010).

In the following section, the meaning of the concept of global governance will be further discussed.

Meaning and definitions of global governance

Global governance is governance at the global level. Global governance has emerged from the need that nation states cannot solve some critical problems on their own within their boundaries, but have to cooperate on common global societal problems (Kaul, 2010). As Zurn expresses:

> "In my use, 'global governance' points to the exercise of authority across national borders justified with reference to common goods or transnational problems" (Zürn, 2018a, p. 138).

The use of the term global governance has increased since the 1990s, and some would refer to it as the increasingly regulated international and transnational relations, stemming from a need to create order and reliable responses to global issues through global cooperation (Krahmann, 2003). This ensures that states are

not only driven by self-interest but show some obligations towards the global common good (Zürn, 2010).

There are various descriptions of global governance, with some examples highlighted in Table B. below:

Definitions of global governance
"global governance is conceived to include systems of rule at all levels of human activity - from the family to the international organization - in which the pursuit of goals through the exercise of control has transnational repercussions. The reason for this broad formulation is simple: in an ever more interdependent world where what happens in one corner or at one level may have consequences for what occurs at every other corner and level, it seems a mistake to adhere to a narrow definition in which only formal institutions at the national and international levels are considered relevant." (Rosenau, 1995, p. 13) Dingwerth & Pattberg (2006) add to this description that such systems of rule exist when there are mechanisms that impact or regulate norms and behaviours of actors (Dingwerth & Pattberg, 2006).
"In my use, 'global governance' points to the exercise of authority across national borders justified with reference to common goods or transnational problems" (Zürn, 2018a, p. 138). "Today's global governance system is defined by three distinct but interlinked 'layers': These include normative principles that are general and sector-spanning; a dense set of specific institutions that contain patterns of authority and legitimation, and; the interactions between different spheres of authority within the system that reveal severe legitimation deficits". (Zürn, 2018a, p. 139).
"'global governance' is the sum of laws, norms, policies, and institutions that define, constitute, and mediate relations among citizens, society, markets, and the state in the international arena—the wielders and objects of international public power. Even in the absence of an overarching central authority, existing collective arrangements bring more predictability, stability, and order to transboundary problems than we might expect" (Weiss & Thakur, 2010, p. 6).
"We define global governance as the sum of laws, norms, policies, and institutions that define, constitute, and mediate transborder relations between states, citizens, intergovernmental and nongovernmental organizations, and the market. It embraces the totality of institutions, policies, rules, practices, norms, procedures, and initiatives by which states and their citizens (indeed, humanity as a whole) try to bring more predictability, stability, and order to their responses to such transnational problems as warfare, poverty, and

environmental degradation that go beyond the capacity of a single state to solve and that are increasingly recognized as such." (Weiss & Thakur, 2010, pp. 31-32).
"global governance is "the way in which global affairs are managed. As there is no global government, global governance typically involves a range of actors including States, as well as regional and international organization. However, a single organization may normally be given the lead role on an issue (WHO, 2015). (…)" In short the purpose of global governance is to solve any problem that arises within the international system" (Das, 2020, pp. 15-16).
"Global governance refers to the authoritative allocation (by a variety of means) of values in policy areas that potentially affect the world as a whole and its component parts." (Overbeek, 2006, p. 2).
"Global governance is governing, without sovereign authority, relationships that transcend national frontiers. Global governance is doing internationally what governments do at home. This definition is concerned with purposive acts, not tacit arrangements. It emphasizes what is done rather than the constitutional basis for doing it. It is neutral as between the activities and their outcomes (…). The definition accommodates both governmental and "sovereignty free" actors. And it accommodates both ad hoc and institutionalized, as well as both informal and formal, processes" (Finkelstein, 1995, p. 369).

Table B. Examples of definitions of global governance

These descriptions and definitions entail meanings of global governance, which all contribute to an understanding of the concept. However, this thesis primarily uses the description articulated by Zürn that "'global governance' points to the exercise of authority across national borders justified with reference to common goods or transnational problems" (Zürn, 2018a, p. 138), while also acknowledging that global governance includes both formal and informal aspects, it implies governing without sovereign authority (Finkelstein, 1995), and encompasses institutions, rules, practices, procedures, policies, and norms (Weiss & Thakur, 2010). Global governance differs from national governance, as there is no global government.

> "All forms of governance beyond the nation state lack a central authority or a 'world state' equipped with a legitimate monopoly of the use of force. Thus global governance cannot take on the form of governance by governments; rather, it needs to be a form of governance with governments such as we see in intergovernmental institutions, or governance without government as in the case of transnational institutions" (Zürn, 2010, p. 80).

The use of the term 'global' in global governance emphasizes the increased global cooperation in response to global problems. It further entails the change

from an intergovernmental or interstate form of cooperation to one that includes both state and non-state actors. Global governance is characterized by a horizontal coordination of heterogeneous actors, oriented towards polycentric governance with decentralized collaboration, rather than a hierarchical form, and has a high level of complexity and operate at different levels (Das, 2020).

Multi-level governance with various spheres of authority

Often, global challenges need to be addressed at multiple governance levels. Global governance can thus imply multilevel governance. A multi-level governance system implies that there is a differentiation of authority between different levels of governance, and that there is an interplay between those levels. The global level must also have some form of autonomy. With increased global integration, governance functions are increasingly assigned to different governance levels which also interact. This means that global, regional, national and local levels can be connected and respond to both global and local needs and conditions (Zürn, 2010). In this way, actors at different governance levels can be involved in working towards common goals, while policies can be adapted to local conditions (Enderlein, Walti, & Zurn, 2010). Environmental problems are examples of societal problems that often span across jurisdictional boundaries and governance levels. Environmental governance has also, in many cases, implied multi-level governance (Wälti, 2010). In a multi-level governance system, where different governance levels must be coordinated, there is a need to exchange information between levels, which gives information systems an important role. Moreover, implementation of global policies is usually carried out primarily at the national level, which also requires an information exchange between levels to follow up on implementation.

Global governance is thus often a multi-level system where processes at different levels are linked. Various forms of governance also exist parallel to each other, which also makes it very complex. As Dingwerth & Pattberg express

> "There is no single organizing principle on which global governance rests, no emergent order around which communities and nations are likely to converge. Global governance is the sum of myriad - literally millions of - control mechanisms driven by different histories, goals, structures, and processes. ... In terms of governance, the world is too disaggregated for grand logics that postulate a measure of global coherence" (Dingwerth & Pattberg, 2006, p. 192).

New spheres of authority may also emerge independently of sovereign states because of the variety of actors and steering mechanisms (Dingwerth & Pattberg, 2006, p. 196). Global governance is thus complex, which also implies various tensions and challenges.

Global governance challenges

Some of the critique towards the notion of global governance is that it does not reflect relations of *power and accountability* (Whitman, 2002), it is *dominated by strong states* such as the USA (Acharya, 2017), and it is *ahistorical*, i.e. not relating to its historical context (Overbeek, 2006). It is argued that the normative and institutional structure that world politics is embedded in is dominated by power inequalities, which creates conflicts (Zürn, 2018b). The strong influence by powerful states risks an institutionalization of inequality and legitimation deficiency. It also implies a risk that common problems will not be addressed effectively if countries are focused on pursuing their individual interests, which will end up in tragedy of the commons (Zürn, 2018a). In governance models where power is distributed to various actors, it also raises issues related to power and accountability of non-state actors and their exercise of power (Whitman, 2002). These aspects are imperative to consider in the development of digital governance in the global governance context, to not further deepen established power inequalities or generate new ones that disadvantage some, but instead be a means for change towards more equal conditions and to foster a holistic approach that focuses on the global common good.

Some key challenges related to the operation of global governance are related to *effectiveness of global policies, implementation of global policies, responsiveness to real-world needs, conflicts, and global governance architectural issues*. There is a tension between national sovereignty versus global regulation. Global regulation may improve effectiveness in responses to global problems, but it challenges the sovereignty of the state (Zürn, 2010). Furthermore, scholars state that current governance mechanisms do not generate desired effects and that global governance for the planet is weak (Weiss & Thakur, 2010). Challenges related to implementation of global policies are proposed to relate to structural constraints of the global system, and that the steps taken are "too small, too slow or too poorly rooted" (Rosenau, 2017, p. 12). Implementation of global policies

and allocation of resources are primarily within the authority of the states, and increased cooperation is suggested to facilitate solutions and therefore enhance implementation (Zürn, 2010). A major problem of global governance is the inadequacy of global governance mechanisms to address critical challenges and crises, and to defend global common goods (McKeon, 2017). Current mechanisms for governance do not sufficiently respond to the complex societal problems that we face (Rosenau, 2004). Regarding environmental governance in particular, there have to be mechanisms that foster more action and not just words (Rosenau, 2017). Intergovernmental institutions are considered as lagging behind in facilitating sufficient responses to collective problems of global dimensions (Weiss & Thakur, 2010). Moreover, conflicts within and among states can create stalemates, which lead to incapacity to act sufficiently (Rosenau, 2000). An architectural challenge is the complexity and fragmentation of global governance due to the number of actors and institutions involved, overlaps and gaps, and lack of an overarching organization of public and private actors. There are those who promote a fully integrated architecture, while others prefer a more decentralized one that promotes self-organization (Pattberg, Widerberg, Isailovic, & Dias Guerra, 2014). The disintegrated nature of global governance further poses challenges to implementation of global policies (Rosenau, 2017). Scholars suggest that the architecture of global governance should be enhanced to better respond to global challenges, include more actors, and to ensure that a few powerful actors do not dominate (Acharya, 2017).

Challenges in global governance have also been formulated in relation to the roles of United Nations institutions, explicated as *knowledge gaps, normative gaps, policy gaps, institutional gaps,* and *compliance gaps.* Knowledge gaps relate to gaps in agreement on the "nature, causes, gravity and magnitude of a problem" (Weiss & Thakur, 2010, p. 8), as well as ideas for solutions. This is also about bridging the gap between science and experience and reaching agreements on the aspects of a problem in ways that reflect the real-world situation. Normative gaps refer to nurturing norms that support principles that guide actors´ actions based on knowledge about a problem. Policy gaps refer to the development and implementation of policies that address problems effectively. Institutional gaps are about establishing appropriate institutions to coordinate policy processes, with resources and authority to follow up on implementation of policies. Compliance gaps concern mechanisms which detect and punish

defiance from agreed norms and decisions, and which have incentives for cooperation and compliance (Weiss & Thakur, 2010). Difficulty in ensuring compliance is addressed as a particularly critical point that illustrates the challenges with global governance, which does not have mechanisms to enforce decisions. Scholars suggest that the United Nations has had an important role in generating knowledge and norms but lacks teeth in making decisions and acting upon them. Some scholars argue that a key problem is that there is no central authority to make global policy choices or mobilize required resources for implementation of policies and decisions, and compliance mechanisms of public shaming are weak (Weiss & Thakur, 2010). While others promote a polycentric governance model which does not have a centralized authority, but instead is decentralized among actors (Pattberg et al., 2014). Climate change is a typical example of this governance challenge. Global climate governance is characterized by network-oriented polycentric governance, where actors take voluntary measures that contribute to the goal in the Paris Agreement. The emphasis is on mobilizing states and non-state actors for ambitious actions (Jernnäs, 2023). However, so far, the measures are not sufficient related to the problem (IPCC, 2021c).

Global governance of an issue like climate change poses additional challenges due to its systemic nature, with interconnections between ecological, social, and economic systems. Governance of the planet and connected socio-economic systems involves challenges related to governance architecture, stakeholder arrangements, adaptiveness of governance mechanisms to respond to changes, accountability and legitimacy, and allocation of resources and values (Biermann, 2007). Governance systems must be designed to be able to respond to emergencies and rapid transformations in the environment in the future, which will likely increase. The handling of uncertainties and interdependencies between environmental, social and governance systems, as well as potential extreme effects of environmental transformation will be critical. As Bierman (2007) explicates

> "how to create a global and effective architecture for earth system governance that is adaptive to changing circumstances, participatory through involving civil society at all levels, accountable and legitimate as part of new democratic governance beyond the nation state, and at the same time fair for all participants: this research and governance challenge still lies ahead." (Biermann, 2007, p. 335).

2.2.3 Summary

The understanding of governance and global governance contributes to the digital governance field with an understanding of the characteristics and challenges of global governance, which is crucial to understand in the development and use of digital solutions in this context.

Governance is "the process of steering society and the economy through collective action and in accordance with common goals" (Ansell & Torfing, 2016, p. 4). It is thus about deliberately creating a common future according to values and objectives that are commonly agreed upon. In this thesis, I further adhere to the notion that governance includes both structures, processes and policies, aiming to solve common problems or ensure a common good (Zürn, 2010). Governance is crucial when addressing societal problems, and its capacity to operate with integrity is considered to be a foundation for a society's development (Jreisat, 2004). As societal challenges are increasingly globally interconnected and of a global character, global governance is the means through which global common problems can be addressed and conflicts resolved in a peaceful manner (Barnett & Duvall, 2005). It implies an exercise of authority across national borders and is justified by the global common good or global problems (Zürn, 2018a). Global governance is the sum of laws, norms, policies, procedures, practices and institutions that constitute transborder relations between states and other actors to address transnational problems that are beyond the capacity of a single state to solve (Weiss & Thakur, 2010).

However, global governance does not respond sufficiently to current real-world problems (McKeon, 2017). There are challenges with the implementation of policies (Weiss & Thakur, 2010), and power inequalities and insufficient accountability frameworks are problematic (McKeon, 2017). There is a need to design governance architectures for transformation and adaptation to extreme changes in the future, due to transformations of environmental and social systems (Biermann, 2007). Furthermore, it is a challenge to have an overview of global governance, with multiple spheres of authority, a scattered system (Dingwerth & Pattberg, 2006), and fragmentation between a high number of institutions and actors, which creates a very complex system (Pattberg et al., 2014). This

disintegrated nature of global governance also poses challenges to the implementation of global policies (Rosenau, 2017). Hence, various scholars call for a reform of global governance (Acharya, 2017; Jreisat, 2004; McKeon, 2017; Rosenau, 2017).

The above-mentioned challenges are "problem areas" for the digital governance field to innovate solutions for, to enhance global governance to better respond to global challenges and implementation of global policies. This brings us to the next section, concerning digital governance and how the global dimension is addressed in this field. With several architectural challenges in global governance, it is relevant to investigate fundamental, infrastructural aspects, which, after the section on digital governance, lead us to information infrastructures.

2.3 Digital governance

Digital governance involves the use of digital technologies in governance structures and processes (Engvall & Flak, 2022b), typically to enhance the quality of services, reduce costs, and facilitate collaboration with internal and external stakeholders (Sukhwal & Kankanhalli, 2022). Digital technologies are thus used to bring about some change, both in how things are carried out and related to the qualities of governance (Engvall & Flak, 2022b). In the first publication of this dissertation, a literature review on the meaning of 'digital governance' as a scientific concept was conducted and the following definition was proposed:

> "Digital governance is defined as digital technology ingrained in structures or processes of governance and their reciprocal relationships with governance objectives and normative values. Digital governance includes the utilization of digital capabilities and involves a transformation of structures, processes or normative values" (Engvall & Flak, 2022b, p. 44).

Along with the term 'digital governance', closely related terms are 'digital government', 'eGovernment' (electronic government), and 'eGovernance' (electronic governance), which are often used interchangeably. This thesis uses the term 'digital governance', except when referring to literature where other terms are applied, so as not to risk distorting the meaning of the original source

Regarding the difference between government and governance, a government is considered to be "an actor in the process of governance" (Bannister & Connolly, 2012, p. 8). Others suggest that a government is an institutional structure, while governance relates to processes of governing (Grigalashvili, 2022). Hence, eGovernment and digital government focus on the use of digital technologies in government administration and development of online services for citizens, while eGovernance and digital governance encompasses relationships between government agencies and various stakeholders throughout society (Bannister & Connolly, 2012; Grigalashvili, 2022). Based on a view of governance that includes both structures and processes, digital governance would in this context encompass the use of digital technologies in structures and processes in which governments and other actors operate towards common objectives.

Regarding the difference between electronic governance and digital governance, there is no significant difference in meaning between the terms 'electronic' versus 'digital' (Charalabidis, Lachana, & Alexopoulos, 2022), but the use of

'digital' is recognized to be an evolution of 'electronic' with a more prominent emphasis on the utilization of digital technologies and their capabilities (Misuraca & Viscusi, 2014; Sukhwal & Kankanhalli, 2022).

In their effort to define the concept of eGovernance, Bannister & Connolly (2012) make the distinction between structural and normative governance. Structural governance is about the structures and processes of governance, i.e., how things are carried out, and normative governance is about the values and objectives of governance, such as transparency, accountability, and efficiency. They further advocate that e-governance implies a change in either structure, processes or normative values, and if a digitalization effort does not bring about some change, it is not considered to be e-governance (Bannister & Connolly, 2012). Other scholars, such as (Scholl, 2022), also emphasize the transformative nature of digital technologies, and that the intention is often to bring about a transformation. In an overview of the evolvement of digital government, Scholl (2002) writes that *digitization,* primarily occurring in the 1990s, first referred to the conversion of analog information to digital form. This evolved into *digitalization,* which had two phases. The first phase was approximately between 1995-2015, which involved a digitalization of processes, online access to public information, e-services, and an increasing reliance on digital information. The second phase of *digitalization* (from 2015 and onwards) has a more transformative characteristic, which brings both increased possibilities and risks to the democratic functioning of societies. This phase has a more advanced use of digital technologies, involving disruptive technologies and data visualizations (Scholl, 2022). Lachana et al. (2022) suggest that three generations of digital governance can be identified. Gov 1.0 focuses on interoperability, processes, and services. Gov 2.0 includes e-participation, e-collaboration, e-voting, and use of social media. Gov 3.0 has a more advanced use of technology, including disruptive technologies such as AI, and the integration of data processing in policymaking and decision-making processes (Lachana, Charalabidis, & Keramidis, 2022). Distinctions have also been made between digitization, digitalization, and digital transformation, indicating different levels of change or transformation (Danielsen, Flak, & Sæbø, 2022). The use of digital technologies can consequently bring different levels of change to processes, structures, and values. Sometimes the intention is improvement of existing processes rather than

a more extensive transformation. Different levels of change can be desired and feasible in different contexts.

Research in the digital governance field has historically focused primarily on administrative functions and e-services, and more research on governance-related topics, broader societal impact, and conditions for governance in the digital era are suggested (Dawes, 2009). A topic of growing interest is the relationship between digital governance and sustainability.

2.3.1 Digital governance and societal challenges

Initially, digital governance research focused on administrative capacity. However, research on the broader societal impacts of digital governance has then been more frequently requested (Dawes, 2009). For instance, the potential of using digital technologies to drive social innovation to respond to societal challenges (Misuraca & Viscusi, 2020). To analyze and plan for how digital governance can contribute to the sustainable development goals, Estevez et al. (2013) have developed a conceptual framework for what they call EGOV4SD (electronic governance for sustainable development), which is defined as "the use of ICT to support public service, public administration and the interaction between government and the public while enabling public participation in government decision-making, promoting social equity and socio-economic development and protecting natural resources for future generations" (Estevez et al., 2013, p. 93).

The framework articulates sustainable development as the problem domain and eGovernance as the solution domain. The sustainability domain is conceptualized according to four dimensions: social, environmental, economic, and institutional (which has an emphasis on collaborative and participatory decision making). The EGOV domain has five dimensions: government, technology, interaction, customer, and society.

			EGOV				
			Government	Technology	Interaction	Customer	Society
			Solution Space				
SD	Social	Problem Space	Contribution Space				
	Environmental						
	Economic						
	Institutional						

Figure B. EGOV4SD Conceptual Framework (Estevez et al., 2013, p. 93)

The scholars (Estevez et al., 2013) further explicate that there can be intersections between different elements in the framework, for instance that technology is a solution to governance problems. Sustainable development (SD) will be the problem domain in all constellations, and IT will always be in the solution domain. Governance is a solution domain in relation to sustainable development, and a problem domain in relation to IT. Although the framework primarily has a national approach and is quite government – citizen centered, it is useful in clarifying the relationship between real-world challenges, governance challenges, and digital governance. In the context of this thesis, climate change would be in the sustainable development problem space, global governance would be a solution space in relation to climate change, but a problem space in relation to digital governance. Digital governance would be in the solution space in relation to global governance.

Although the possibilities and benefits of digital technologies, both in terms of administrative efficiency and the generation of societal values are often emphasized, digital technologies bring both possibilities and risks. Transformative technologies will also have a more disruptive potential, which can lead to solutions which strengthen public values, but also challenge them (Khanna et al., 2021). Digital innovation requires new governance models to promote benefits to society and develop democratic and inclusive approaches, to not result in the tragedy of the commons (Almeida, Filgueiras, & Gaetani, 2020). Moreover, as there is more reliance on internet and digital technologies for operation of various processes and structures, issues like the digital divide (Buyannemekh, 2021) and cybersecurity (Gupta, Pal, & Muttoo, 2020) are becoming increasingly critical.

After this discussion of digital governance, the next section will highlight digital governance research that addresses a global context.

2.3.2 Digital governance research in a global context

Digital governance is employed across the world, to different extent. To further discover what has been researched about the global context in the digital governance field, a literature review with this aim has been conducted, which is presented in the following section. The themes that emerged from the review were: global comparisons, digital global governance solutions, digital diplomacy, and governance of global technology. The review revealed that research on digital governance in the global governance context is very scarce, and thus yet to be developed. However, based on current publications, there are various aspects that can inform the shaping of digital global governance.

Global comparisons

The United Nations (UN) regularly conducts global surveys that compare UN Member States and rank them based on the United Nations eGovernment Development Index (UN EGDI) (United Nations Department of Economic and Social Affairs (UNDESA), 2022). Although it is called eGovernment Survey, during the regional launch of the survey at the ICEGOV conference 2022 (ICEGOV, 2022), it was suggested that they change the term to 'the UN digital governance survey'. This index is also applied in comparative research (Qian, 2010). However, the use of indexes is often critically discussed because it is difficult to agree on what should be measured and how (Moon et al., 2005). Furthermore, there are very different conditions across the globe. Economic conditions, political situations, infrastructure, cultural issues, and educational levels (Evans & Yen, 2006), as well as how digitally skilled the population is (Moon et al., 2005), influence the utilization of digital solutions. Manoharan et al. (Manoharan et al., 2021), have conducted research to identify patterns in growth and maturation of eGovernance through a global analysis. In their paper, they describe best practice cases for eGovernance in five categories: privacy and security, usability, content, services, and citizen and social engagement. They suggest that eGovernance development is not linear but follows different pathways depending on the context.

A central theme in the digital governance literature is the digital divide (Ayanso et al., 2014; Molina, 2003; Zhao, Collier, & Deng, 2014). A concern is that digitalization brings an increased divide in the world, and scholars advocate for a global e-inclusion movement (Molina, 2003). According to Ayanso et al. (2014) the digital divide is widening. However, when the researchers used the ICT Development index commissioned by the United Nations to assess the divide, they also found that some countries had advanced. The overall progress in these countries has been an important factor for this development, as well as policies and regulations that promote e-commerce, public–private partnerships, implementation of online government services, and general improvements to support an open society and civil liberties (Ayanso et al., 2014). Research further indicates that access to digital technologies is not enough for digital solutions to be used, and services should be developed in line with peoples´ digital skills (Adam & Dzang Alhassan, 2021).

Global comparisons of topics such as open government and digital democracy further strengthen the understanding that it is important to consider the variety of national contexts. Research by Schnell (2020) on global trends in open government and democracy, suggests that although there is a trend where governments join global transparency and openness initiatives, there is also a backward trend where some forms of transparency have decreased, and governments consult less with civil society. In worst-case scenarios, digital initiatives can be used to legitimize autocratic governments rather than increasing openness. The author stresses the importance of strong legal and institutional guarantees for openness (Schnell, 2020). Global comparisons of digital democracy (Lidén, 2018; Prins, Cuijpers, Lindseth, & Rosina, 2017), also indicate that the use of digital tools for citizen engagement and participation are very differently distributed across the world. Educational level, size of population, digital skills and proportion of internet users among the population, influence governments´ digital politics and the possibilities for digital democracy (Lidén, 2018).

Although comparisons between countries address the national level, they are useful in the sense that they sensitize us on how conditions differ across the globe, which is imperative to consider in the development of digital global governance. The digital divide, along with socio-economic and political differences, requires us to be humble concerning context. Public administrations

in different countries have different conditions in which to implement digital solutions that are part of global governance processes and structures, and the competence and possibilities for active participation in digital global governance policymaking varies. Digital global governance solutions must also enable different development pathways adapted to national and local contexts. However, related to global governance, the question is how digital technologies are applied in global governance structures and processes.

Digital global governance solutions

Digital governance research that addresses the use of digital technologies in global governance processes and structures seems to be very scarce, with a few notable examples. A study by Chandran et al. (2011) suggests that global information technology frameworks can facilitate the flow of information, which may support the monitoring of implementation and compliance of global environmental policies and agreements (Chandran, Krishnan, & Nguyen, 2011). Digital governance can also be part of global agendas, or programs, that are implemented at national levels. According to Navarra (2010) such programs are also part of global architectural development (Navarra, 2010).

Some digital governance initiatives are developed at national level but have global implications. An example of that is the Estonian e-residency. It is a transnational digital identity scheme that enables a global digital citizenship, which makes it possible for citizens from other countries to take advantage of their services (Tammpuu & Masso, 2019). The initiative is presented as a globally extensible service (Tammpuu & Masso, 2018). Research on how SMART cities handle sustainability challenges shows that digital solutions may support learning and collaboration among local communities across the globe. Although local communities have different challenges and conditions, and thus develop different SMART city solutions, they also have common challenges that can be addressed through collaboration (Hayat, 2016).

To work effectively towards global goals, various organizations have to coordinate their efforts. That requires interoperability of goals, processes, data, and technology at different levels (Wisitpongphan & Khampachua, 2017). Global information exchange, collaboration, and coordination across national borders, as well as between government agencies within a country, often bring

interoperability challenges of heterogeneity in data, technology, languages, working environments, policies and regulations, and inter-organizational collaboration. Information systems and web-service infrastructures can be developed to overcome challenges related to heterogeneity and thereby facilitate collaboration (Su et al., 2004). Standards and international policy guides are emphasized as an important element to facilitate global collaboration and information exchange (Estevez, Cenci, Fillottrani, & Janowski, 2021). In the EU, interoperability is a key issue to facilitate the digital single market and integration between EU member states. The European Interoperability Framework, eIDAS, the Digital Single Market Strategy and Single Digital Gateway promote digital cross-border integration in the EU and a seamless information exchange. In this context, interoperability at both legal, organizational, technical and semantic levels are considered (Krimmer, Dedovic, Schmidt, & Corici, 2021). In global information exchange, there are also cultural aspects to consider. A digital global governance context will be multicultural. In multicultural contexts, values, traditions, and attitudes influence peoples´ understanding of information provided by public authorities, which is crucial to understand in the development of digital services (Denman-Maier & Parycek, 2003b). Implementation of international frameworks further requires national public institutions to adapt to international standards and practices (Jreisat, 2004). Digital global governance solutions may span across the national and international levels and will thus impact both international organizations and national public administrations. Such solutions must consequently be open to differences in political, social, cultural, technological, and economic conditions.

Central features of global cooperation are interaction, relationship building, and diplomacy. As digital governance enables new means for interaction (Engvall & Flak, 2022b), this also opens up new means for diplomacy.

Digital diplomacy

Digital diplomacy is the use of digital technologies for diplomatic tasks and foreign policy objectives (Almuftah et al., 2016; Sotiriu, 2015). It brings digital governance into the area of diplomacy. However, the conceptualization of ICT and digital governance in the area of diplomacy is still weak (Wihlborg & Norstedt, 2017), and multiple terms are used quite interchangeably such as e-

diplomacy, cyber diplomacy, virtual diplomacy and network diplomacy (Gilboa, 2016).

Diplomacy has by Bull (1977:162) been defined as "the conduct of relations between states and other entities with standing in world politics by official agents and by peaceful means" (as cited by (Westcott, 2008, p. 4)). A central feature is the non-violent reconciliation of various interests among international actors (Bjola, 2015). Digital diplomacy attends to the impact of digital technologies on practices, norms, and traditions of diplomacy (Hayden, 2018).

According to Westcott (2008), the internet has three main impacts on diplomacy: it enables more actors to make their voices heard in international policymaking, it increases the dissemination of information, and it changes the way diplomatic services can be delivered (Westcott, 2008). The internet enables people to discuss and organize activities around a topic, despite geography, and for new actors to get involved in diplomatic processes. This has resulted in both multiplication and diversification of actors, along with an increased collaboration as well as polarization (Westcott, 2008). Information can be disseminated rapidly and extensively through the internet, which highlights the role of soft power. Soft power is about setting the agenda through persuasion of ideas and values, not military or economic coercion (Sotiriu, 2015). Soft power can be exercised by effective dissemination of ideas on the internet to influence opinions, and by participating in networks. The possibilities of sharing and accessing information also create demands for more openness (Westcott, 2008).

The global connectivity that digital technologies have enabled, both challenges and creates possibilities for innovation of diplomatic practices and interaction with broader audiences (Gilboa, 2016). Digital diplomacy provides new possibilities for diplomatic agency (Hayden, 2018), and digital structures for global diplomatic practices (Westcott, 2008). As both international politics and diplomacy are less formalized than national governance, there is even greater potential for the use of digital technologies, for new groups to get involved, and to raise new topics on the global agenda (Wihlborg & Norstedt, 2017).

Some scholars (Bjola, 2015) argue that diplomacy is a method of change management, and digital diplomacy is a strategy for change management (Holmes, 2015). Digital diplomacy is in this context defined as "a strategy of managing change through digital tools and virtual collaboration" (Holmes, 2015,

p. 15). In this context, change is conceptualized as two types: exogenous shocks and endogenous incremental shifts. Incremental changes occur through alterations in practices. Exogenous changes are more dramatic and are triggered by significant events and crises. Holmes suggests that digital diplomacy is primarily suited for endogenous change, which can take advantage of information analysis, knowledge management, process innovation, virtual collaboration, and online communities. Exogenous shocks, which are more crisis-oriented, primarily require relationship building, which is best suited for face-to-face interaction (Holmes, 2015).

The evolution of digital diplomacy can be described as diplomacy 1.0, 2.0, and 3.0. Diplomacy 1.0 included the use of e-mail communication and websites. Diplomacy 2.0 implied an increased interactivity, primarily through social media. It is now suggested that we are heading towards diplomacy 3.0, which has a stronger emphasis on international collaboration and multilateral digital diplomacy, rather than states proclaiming their interests in the global arena (Gilboa, 2016). Diplomacy 3.0 has also been termed 'transformational diplomacy', emphasizing collaborative practices and leveraging the use of digital technologies (Sandre, 2015). However, to achieve a collaborative environment, basic infrastructures first need to be in place (Al-Muftah et al., 2018).

It is important to be aware of the risks and challenges of digital diplomacy. With an open environment, disinformation and cybersecurity are frequent risks (Hayden, 2018). Underlying challenges such as cultural differences, and tensions between national conditions and active global participation, can be even more complex in a digital context, especially considering the digital divide (Antwi-Boateng & Mazrouei, 2021). As information spreads very fast on the internet, statements posted on social media can have vast implications (Gilboa, 2016). The heterogeneous context, with a vast number of actors, channels and information, is a complex environment to operate in (Wihlborg & Norstedt, 2017). Other challenges relate to privacy and confidentiality of information, political instability, and social differences. Additionally, technologies have unpredictable, unmeasurable risks that are difficult to grasp (Al-Muftah et al., 2018). There can also be various hinders to implementing digital diplomacy solutions, including organizational, political, legal, economic, social, and technological reasons, as well as human capabilities and motivation, nature of citizen interaction, and collaborative practices (Al-Muftah et al., 2018).

Scholars suggest that research on digital diplomacy is scarce and that it is an emerging field (Al-Muftah et al., 2018). To date, studies have primarily investigated the effects and impact of digital diplomacy, areas to apply digital technologies, the use of social media, and risks. Further research is suggested to gather more empirical insights and to theorize digital diplomacy further (Almuftah et al., 2016).

One topic related to the development of digital global governance concerns the need to reach agreements on digital global governance issues. Global governance of technology can provide some insights on challenges in this area.

Governance of global technology

Digital global governance requires global decision-making on common standards, policies, and solutions. Moreover, global digital solutions bring certain challenges, such as cybersecurity issues. The experiences from global governance of technological development can bring insights into decision-making related to digital global governance and highlight challenges in global technological development.

With technological innovations disseminated across the globe, and an accelerating global digitalization, multiple governance challenges occur (Jia & Chen, 2022). Topics such as transborder data flows, transnational digital platforms (Jia & Chen, 2022), digital currencies (Dimitropoulos, 2019; Scholl & Rodríguez Bolívar, 2019), cybersecurity (Bronk & Dewitte, 2020; Mishra, 2020; Romaniuk & Manjikian, 2020), and internet governance (Cogburn, 2009; Lips & Koops, 2005), have been increasingly discussed internationally. Global governance of this technological development is referred to as 'global digital governance' (Jia & Chen, 2022). As the internet has become a central space for many countries and governments to operate in, this raises new challenges and requires development of an institutional ecosystem and policies, at both national and international levels, as well as new mechanisms for response, in both the public and private sector (Choucri, Madnick, & Ferwerda, 2014). The cyber domain is a global security issue, and international law is emphasized as an important factor to ensure an open, secure, peaceful, stable and accessible ICT environment (Raymond, 2021). Capacity building in cybersecurity, particularly through scientific and technical knowledge, is advocated as a key factor to

enhance cybersecurity (Calderaro & Craig, 2020). There are concerns about how to govern the internet effectively, as there are challenges in reaching effective agreements internationally with many diverging opinions (Whitmore, Choi, & Arzrumtsyan, 2009). Voices have also been raised about the importance of including emerging economies in the variety of global forums for internet governance, including government meetings, technical bodies, dialogues with businesses and user groups, and development agencies, which form a "global architecture" for policy setting (Purcell & Hassall, 2017).

Summary

Based on the review of digital governance literature with a global dimension, the following themes were identified: global comparisons, digital global governance solutions, digital diplomacy, and governance of global technology. Topics within these themes are summarized in Table C. below.

Theme	Topics	Learning
Global comparisons	-Comparisons between countries, and ranking according to the United Nations eGovernment Development Index (Qian, 2010; United Nations Department of Economic and Social Affairs (UNDESA), 2022) -The context and conditions for digital governance varies between countries (Evans & Yen, 2006; Manoharan et al., 2021; Moon et al., 2005) -Digital divide (Ayanso et al., 2014) -Global comparisons of digital democracy (Lidén, 2018; Prins et al., 2017) -Global trends in open government and democracy (Schnell, 2020)	Global comparative studies sensitize us about differences between countries, which is important to consider when developing digital global governance solutions. Socio-economic conditions, political orientation and skills and knowledge vary and influence conditions for participation and application of digital technologies.
Digital global governance initiatives and challenges	-Global IT frameworks facilitate information collection and monitoring of global environmental policy implementation and compliance (Chandran et al., 2011) -Transnational initiatives, such as the	Digital global solutions can support global governance. Global frameworks enable global collection of information to support global governance.

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	Estonian e-residency (Tammpuu & Masso, 2019) - Collaboration and learning among SMART cities (Hayat, 2016) -The role of interoperability to enable global cooperation (Wisitpongphan & Khampachua, 2017) -The role of information systems (Su et al., 2004) and standards (Estevez et al., 2021) for interoperability -Cultural aspects in digital services (Denman-Maier & Parycek, 2003a) -The impact of global policies on national public administration (Jreisat, 2004; Khan, 2018)	Interoperability is a key issue to consider to enable global cooperation and common digital solutions. Due to the heterogeneity in the global context, there is also a high level of complexity. Digital technologies offer possibilities for global cooperation and coordination, but it is crucial to also develop appropriate policies and governance frameworks. The multicultural context must consider how digital services and information are perceived.
Digital diplomacy	-The use of digital technologies in diplomatic conducts and for the objectives of foreign affairs (Almuftah et al., 2016; Sotiriu, 2015). -Digital diplomacy opens up for new means of interaction, new actors and new topics, dissemination of information, and service delivery (Westcott, 2008) -Emphasizes soft power and ideological influence (Sotiriu, 2015). -Strategy for international change management (Holmes, 2015). -Diplomacy 3.0 has a strong emphasis on international collaboration and leverage of digital technologies (Gilboa, 2016). -Raises concerns of disinformation and cybersecurity (Hayden, 2018), as well as underlying tensions and digital divide (Antwi-Boateng & Mazrouei, 2021).	Digital technologies offer new venues for diplomacy, which opens possibilities for more actors to participate and raise topics of concern. However, the volume of information and heterogeneity of actors makes it a complex environment. The internet facilitates connection and collaboration but also polarization. Challenges of, for instance, cybersecurity, digital divide, capacity building and increased tensions and power imbalances have to be addressed.
Governance of global technology	-Global technology brings challenges and the need for global governance (Jia & Chen, 2022) -Need for institutional arrangements and policies for internet governance	Studies on governance of global technology offer insights on challenges related to global governance of digitalization. Institutional

	(Choucri et al., 2014) -Cybersecurity (Calderaro & Craig, 2020; Raymond, 2021) -Challenges of global policymaking in internet governance (Whitmore et al., 2009) -Inclusion of all countries in global policymaking (Purcell & Hassall, 2017)	ecosystem, policymaking procedures, standards, capacity building and inclusion are key aspects to consider regarding governance of digital global governance.

Table C. Themes and topics that address a global dimension in digital governance research

The literature review above has several implications for the further development of digital global governance. Digital governance has societal impacts and brings both possibilities and risks, which potentially increases in a global environment, that is highly heterogeneous and complex. Studies propose that digital governance can contribute to the implementation of sustainability goals, but it is crucial to build capacity in applying digital solutions to sustainability challenges (Hooda, 2020), and key risks such as digital divide (Buyannemekh, 2021) and cybersecurity (Gupta et al., 2020) must be considered.

The literature raises issues that are relevant to consider in both theoretical and practical development of digital global governance. Comparative studies elucidate that countries have very different conditions for digital governance (United Nations Department of Economic and Social Affairs (UNDESA), 2022), which requires us to be humble in the development of digital global governance solutions, and to be inclusive. Digital governance is also developed according to different pathways in different countries, due to the context (Manoharan et al., 2021), which requires an openness for local solutions and adaptation of digital global governance frameworks. Local challenges further affect which solutions are developed (Hayat, 2016). The manifestation of digital democratic practices also differs across the globe (Lidén, 2018), which is important to consider when exploring stakeholder engagement in digital global governance. Finally, to enable global coordination and cooperation, interoperability is a key issue (Wisitpongphan & Khampachua, 2017).

The use of digital technologies in diplomacy has opened up for more actors to participate and raise new issues (Wihlborg & Norstedt, 2017), and possibilities to disseminate information through the internet provides means for soft power (Sotiriu, 2015) and demands for transparency (Westcott, 2008). These changes create a complex context, which both facilitates collaboration and polarization,

access to information and risk of disinformation (Westcott, 2008). Internet governance highlights experiences in global governance of a global information infrastructure, which teaches us that there are challenges in coming to agreements (Whitmore et al., 2009), and to be inclusive due to different conditions and capabilities among countries (Purcell & Hassall, 2017). It is also important to bear in mind that global policymaking affects national public administration (Jreisat, 2004), which is why global standards and solutions have to be feasible in very varied contexts, and capacity building is required both at the global and national levels for digital global governance initiatives.

Even though we are living in a globally interconnected world, surprisingly little research has been done regarding digital governance and the role of digital technologies in global governance. With societal challenges becoming more global in character (such as climate change), it is highly relevant to develop this stream of research. The scarce research on the role of digital technologies in global governance leaves us with a poor understanding of how digital governance can support global governance in responding to global challenges. There are, however, limitations of this literature review, as it does not cover international relations or political science literature but is delimited to the digital governance field.

Additionally, digital governance as a research domain is deemed as needing a more robust theoretical foundation. Scholars propose that digital governance research traditionally has had an emphasis on applied research to improve and transform processes, structures and working practices, but there is a need for a scientific base for digital governance (Charalabidis, Lachana, et al., 2022; Lachana et al., 2022). Lachana et al. (2022) suggest that a scientific base for digital governance research should include both conceptual, theoretical, empirical, and methodological aspects, as well as envisioning of roadmaps for future research (Lachana et al., 2022). Consequently, there is a need for both theoretical development in the digital governance field, as well as empirical investigations into problems and solutions, and roadmaps for further research. This dissertation makes a conceptual and theoretical contribution and provides suggestions for future research to further deepen the theoretical foundations for digital global governance.

While the term 'global digital governance' refers to global governance of digitalization (Jia & Chen, 2022), a concept that addresses digital governance in

global governance processes and structures has not been found in the extant literature. In this thesis I therefore introduce the concept 'Digital global governance' for this purpose, which will be discussed in the next section.

2.4 Digital global governance

In this section, I introduce the term 'digital global governance' and propose a definition. Digital global governance refers to digital governance applied in global governance, and thus builds on the understanding of digital governance, governance, and global governance, as discussed in the previous sections.

In this thesis, digital governance is defined as:

> "digital technology ingrained in structures or processes of governance and their reciprocal relationships with governance objectives and normative values. Digital governance includes the utilization of digital capabilities and involves a transformation of structures, processes or normative values" (Engvall & Flak, 2022b, p. 44)

The definition of digital global governance builds on the definition of digital governance, with the difference that it explicates the "global" in digital governance, which is important to emphasize due to the characteristics of global governance compared to for instance national or municipal governance. In light of this, I propose the following definition of digital global governance:

> Digital global governance is defined as digital technology ingrained in structures or processes of global governance and their reciprocal relationships with global governance objectives and normative values. Digital global governance includes the utilization of digital capabilities and involves a transformation of structures, processes, or normative values.

Digital global governance entails the steering of society and the economy through collective action and in accordance with common goals (Ansell & Torfing, 2016), across national borders justified by transnational problems and common global goods (Zürn, 2018a). It includes both formal and informal steering mechanisms, including, for instance, rules, standards, norms, shared goals, informal agreements and practices that lead actors towards common goals (Rosenau, 2004). Global governance further encompasses structures, processes, and policies (Zürn, 2010). In practice, this can include both structures and processes that go across national borders, such as digital solutions, common standards, exchanges of information, or online collaborations.

Digital global governance can imply information exchange across multiple governance levels (national, supranational, and global), and thus become large and complex sociotechnical systems with multiple interwoven elements. The international climate reporting investigated in this thesis is one such example. The purpose of the climate reporting is to collect information from countries to

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aggregate at a global level, which is then used in global governance. This requires coordination of information from a vast number of sources, multiple interconnected IT artefacts, actors, and organizational and legal arrangements at different governance levels. To reflect this extensive system of interwoven social and technological elements, 'information infrastructure' is selected as an appropriate theoretical lens, which will be discussed in the next section.

2.5 Information infrastructure

An information system (IS) can be defined as

> "a system in which human participants and/or machines perform work (processes and activities) using information, technology, and other resources to produce informational products and/or services for internal or external customers" (Alter, 2008, p. 451).

The purpose of an IS is thus to process information, which is used for different processes and activities (Alter, 2008). An information system also reflects a sociotechnical view that considers both technology and the social context (Sarker et al., 2019).

Information infrastructures (II) are types of information systems, which are large-scale, complex, sociotechnical systems that are shared among a community or communities (Hanseth & Lyytinen, 2016) for the development and use of information services (Hanseth & Lyytinen, 2004). Information infrastructures are used within and across organizations (Monteiro, Pollock, Hanseth, & Williams, 2013). IIs encompass interrelated social, organizational, and technological parts (Bowker et al., 2009), and are intertwined and coevolve with organizational structures and work practices (Aanestad et al., 2017). They are thus embedded in social structures and are both part of shaping, and being shaped by, structures and practices (Vaast & Walsham, 2009). To understand information infrastructures, one has to take a holistic perspective (Hanseth & Monteiro, 1998). 'Information infrastructure' was first suggested in the 1990s as a political initiative, and later became a concept and theory in information systems research. The notion of information infrastructures has broadened the perspective from single systems and organizations to organizational networks and infrastructures. Theoretically, the II approach has, for instance, been used to theorize case studies and as an approach to IS design (Bygstad, 2008).

Information infrastructures are imperative for the development of digital governance (Krishnan & Teo, 2012), as a foundation for the development of digital services and products, and in enabling efficient sharing of information. Information infrastructures in the digital governance domain inform decision making and enable participation (Beconytė et al., 2022). Moreover, IIs strengthen transparency and accountability, which are further argued to improve governance systems, which in turn impacts socio-economic development (Meso, Musa, Straub, & Mbarika, 2009). Information infrastructures support solutions within

and across organizational boundaries. They provide information resources that organizations rely on in daily operations (Jansen, 2012), and enable exchange of information between agencies and across sectors (Hornnes, Jansen, & Langeland, 2010). A global information infrastructure enables information exchange and services across national boundaries (Bowker et al., 2009). An example of a global II is the internet (James, 2001). Exchange of information globally and across organizations, domains, and actors, are imperative in a global governance context, which requires coordination and exchange of information between governance levels, domains, and actors, and thus across organizational boundaries. IIs support virtual organization management functions such as communication, access to information, operational activities, interorganizational coordination mechanisms, decision making and innovation (Strader, Lin, & Shaw, 1998), which opens up to possibilities for the development of digital solutions in global governance. Through sharing of information, connecting people, and enabling common solutions, IIs support cross-organizational collaboration (Klievink & Janssen, 2014), which is imperative in a global governance context as it requires cooperation across organizational boundaries and jurisdictions. 'Information infrastructure' as a theoretical perspective highlights the complexity of digital governance, with its heterogeneous elements, stakeholders, relationships, and interactions (da Silva & Texeira, 2020). Global information infrastructures have an additional level of complexity, as it involves various languages, cultures, legislations, and ICT solutions.

Information infrastructure is, in this thesis, used as a theoretical lens to gain a deeper understanding of the role of information systems in digital global governance. As an information infrastructure is the foundation for the development of digital services and functions (Beconytė et al., 2022; Krishnan & Teo, 2012), 'information infrastructure' is a theoretical perspective that is appropriate when addressing foundational issues of digital global governance. Due to the scarce research on the global level in digital governance, there is a need to theorize the basics (i.e., infrastructure) for digital global governance.

2.5.1 Characteristics of information infrastructures

Information infrastructure comprises the terms 'information' and 'infrastructure'. An infrastructure can be explained as an underlying collective foundation on

which different activities are developed and depend on (Ole Hanseth, 2010). Infrastructures are "the basic physical and organizational structures needed for the operation of a society or enterprise" (Tilson et al., 2010a, p. 1). Information infrastructures are characterized by longevity, dynamism, and being relational (Tilson, Lyytinen, & Sørensen, 2010b). They develop over long periods of time, continuously evolving (Hanseth, 2010). An infrastructure is relational, as it exists in relation to practices (Star, 1999). The characteristics of infrastructures can be useful for understanding how IIs can serve as a basis for digital global governance.

An infrastructure has, according to Star (1999), nine characteristics. It is *embedded* in other structures and technologies; it is *transparent* to use and does not therefore have to be reinvented for each task that builds on it; it has a *reach and scope* beyond a single practice or event; it is a taken-for-granted arrangement in a social context, and it is *learned as part of membership* in a social context, through community of practices; it is shaped by and shapes conventions of communities of practice and hence *links with conventions of practice*; it *embodies standards*, which enables transparency and the ability to link with other infrastructures and tools; it is built on an installed base, i.e. what already exists, which sets conditions for further development; it *becomes visible when it breaks down* and presupposed services do not work; it is *fixed in modular increments and does not change all at once.* Infrastructures are large, complex, and layered; thus, change takes a long time and does not happen all at once. IIs are not changed from above and no one is in charge of the entire infrastructure (Star, 1999).

An *information infrastructure* is a shared resource for a community (or multiple communities) for developing and using information services (Hanseth & Lyytinen, 2004). Information infrastructures are a type of information system but have characteristics that are unique. According to the definition by Hanseth & Lyytinen (2016), an information infrastructure is "a shared, open (and unbounded), heterogeneous and evolving socio-technical system (which we call installed base) consisting of a set of IT capabilities and their user, operations and design communities" (Hanseth & Lyytinen, 2016, p. 109). Below are the characteristics typical for information infrastructures, departing from the principles articulated by Hanseth & Monteiro (1998):

1) "Infrastructures have a supporting or enabling function" (Hanseth & Monteiro, 1998, p. 41)

This aspect means that an II should support and enable a range of functions and activities, and also expand for new activities. In contrast, many information systems are designed for a single purpose and one way of working (Hanseth, 2010; Hanseth & Monteiro, 1998).

2) "An infrastructure is shared by a larger community (or collection of users and user groups)" (Hanseth & Monteiro, 1998, p. 41).

An infrastructure is used by many and cannot be split into parts, where different groups use different parts of the infrastructure independently, i.e., they are irreducible (Hanseth & Monteiro, 1998). Thus, the infrastructure has a scope beyond a single organization (Star, 1999). An information infrastructure is a shared resource (Hanseth & Lyytinen, 2004), and the responsibility is also shared among several organizations (Henningsson & Hanseth, 2011).

3) "Infrastructures are open" (Hanseth & Monteiro, 1998, p. 42).

The aspect of openness means that there are no limits in the number of users, technological components, applications, network operators or vendors involved in information infrastructures. The composition of the II and relationships will change over time, along with changing requirements and conditions for development, which makes IIs heterogeneous (Hanseth & Monteiro, 1998). Heterogeneity will also increase over time (Hanseth & Lyytinen, 2016), both in technologies and use. Furthermore, over time, different versions of the same standard will be used for sub-infrastructures, and there may be different standards that cover the same functionality (Hanseth, 2010). The open characteristics of information infrastructures imply that there is no fixed notion of who the "user" is; it is used for multiple areas and purposes, and they stretch across time and space, with a continuous evolution (Monteiro, Pollock, & Williams, 2014).

4) "IIs are more than "pure" technology, they are rather socio-technical networks" (Hanseth & Monteiro, 1998, p. 43).

Information infrastructures are not just the physical facilities to store, transmit and display information, but encompass both technologies, organizations, standards and people. IIs are thus heterogenous, and the composition of different elements will also change over time (Hanseth & Monteiro, 1998), such as technological components, governance and standardization bodies, users, operators, and designers (Hanseth & Lyytinen, 2010b). The heterogeneity is also

reflected in that infrastructures are layers that are built on each other with sub-infrastructures, different standards, and different versions of a standard (Hanseth, 2010).

5) "Infrastructures are connected and interrelated, constituting ecologies of networks" (Hanseth & Monteiro, 1998, p. 45).

Information infrastructures are layered, they link various networks, and integrate multiple components into an interdependent whole. Information infrastructures can also be interconnected to larger information infrastructures (Hanseth & Monteiro, 1998). Sometimes, individual applications get interconnected with others and grow into an information infrastructure (Hanseth, 2010). An II can also emerge if the number of users grows and a system changes from having limited reach into a large-scale II (Hanseth, 2014).

6) "Infrastructures develop through extending and improving the installed base" (Hanseth & Monteiro, 1998, p. 47).

Information infrastructures are large sociotechnical networks that consist of various interdependent components and develop incrementally over time. New requirements must consider what is already in place, and new components must be interoperable to be connected to the established II. This is referred to as the installed base, i.e., what is already in place in the information infrastructure. This is also why infrastructures are considered to always already be in place, and hence not develop from scratch. If a new infrastructure is developed, it will replace a part of or integrate with an existing infrastructure. A way to view the development of information infrastructures is as cultivation of the installed base, through improvements and extensions (Hanseth, 2010; Hanseth & Monteiro, 1998).

2.5.2 Installed base

Information infrastructures are the foundations for various activities and services and are thus deeply embedded in structures and processes. Technology, standards, work practices, regulations, and social conventions are closely intertwined, and coevolve over time. The concept of 'installed base´ illustrates such sociotechnical assemblages that are already in place and thus shapes the development of the II. This means that IIs are never built from scratch; they build on, modify, or extend the already existing, installed base (Aanestad et al., 2017). An installed base

should be viewed as a conceptual tool rather than a "thing", which reflects interconnected elements and the conditions that must be considered in II evolution (Aanestad et al., 2017). Information infrastructures are also entangled with other information infrastructures, embedded in a broader context (Monteiro et al., 2013). Due to their sociotechnical characteristics, development of IIs includes both technical social, political and institutional aspects, and implies an ongoing negotiation and coordination (Aanestad et al., 2017). When the installed base grows, further development can become self-reinforcing. Cultivation of the installed base thus implies creation and management of such self-reinforcing processes (Hanseth, 2010).

In the context of digital global governance, the installed base includes established global governance processes, work practices, organizations, sociocultural conventions, technologies, standards, and regulations. A global governance information infrastructure enables exchange of information between national and international organizations and will thus have to consider both international organizations and global procedures, as well as national governance institutions and public agencies.

Scholars (Hornnes et al., 2010) suggest that the installed base of IIs in the public sector have particular characteristics, including legal, technical, political and organizational aspects as well as public practices and values, and argue that 'government information infrastructures' are a specific type of II, that should enable and support ICT-solutions in the public administrations (Hornnes et al., 2010). Government information infrastructures are also part of governance infrastructures, which can be explained as "the collection of technologies and systems, people, policies, practices, and relationships that interact to support governing activities" (Johnston, 2010, p. 122). Government information infrastructures comprises a vast number and diversity of stakeholders, including governments, agencies, politicians, citizens, NGOs, and businesses. The public sector is also diverse, with various independently working agencies in various issue-areas and multiple local architectures that are developed and maintained at various sites and levels (Hornnes et al., 2010). Although the concept of government information infrastructure refers primarily to the national level and has a government focus, similar aspects ought to be considered in a global governance context, recognizing global governance values, structures, and practices.

Information infrastructures need to be stable to reliably support activities and services over time, while also being adaptive to changing needs, practices, and new technological possibilities (Tilson et al., 2010b). In a global governance context, the II must both be stable to enable global coordination, as well as flexible to changing societal needs. There is a paradox that the installed base both has to be stable to connect with new activities and services, but also flexible to adapt to changes (Aanestad et al., 2017; Tilson et al., 2010b). Cultivation of the installed base both implies an adaptation to what is in place, but also a transformation of it (Aanestad et al., 2017). This can be managed through balancing standardization and generativity.

2.5.3 Standardization and generativity

An information infrastructure is based on standards, which is also the structure of the II (Hanseth, 2010). It is through standards and sociotechnical mechanisms that IIs are coordinated (Tilson et al., 2010b). Standards enable interoperability and compatibility of various components to be connected to and incorporated into a larger system, and seamless exchange of information (Bowker & Star, 1998). Standards are also important to align heterogeneous actors´ interests towards a common objective (Fomin, 2003). In a global governance context, this is imperative, since multiple countries with different cultural, political, technological, and economic conditions have to cooperate. Global governance requires coordination of information and actors from vastly different contexts, which requires some standardization as well as common goals. Likewise, implementation of global policies must be adapted to each particular context, which requires the possibility of local adaptation.

As user needs change over time, there must also be a level of flexibility, which is often achieved through modularization (Hanseth & Monteiro, 1998). Hence, standardization and flexibility that enables generativity are complementary qualities of IIs. Generativity can be understood as a "capacity for leverage across a range of tasks, adaptability to a range of different tasks, ease of mastery, and accessibility" (Monteiro et al., 2013, p. 600). Standardization ensures interoperability and is required to enable overall coordination and collaboration across boundaries. But standardization must not be so rigid that it hinders generativity and evolution of the II through local innovations and adaptation to new needs and possibilities. However, standardization can both enable and

constrain generativity. It can enable generativity through the possibility to re-use solutions, enable coordination across domains, and interoperability with the installed base. Standardization can constrain generativity through limiting innovation possibilities (Grisot & Vassilakopoulou, 2013). On the other hand, overly high flexibility can undermine social and technical stability, which is necessary for the durability of the II (Tilson et al., 2010b). Through both standardization and generativity, qualities of IIs to enable action, create connections and attain durability can be met (Grisot & Vassilakopoulou, 2013), which is illustrated in Table D.

Table 1 – Standardization and generativity as complementary qualities of information infrastructures.		Standardization	Generativity
Information infrastructures			
Enable action	By being relational and working in between groups	Allows universal coordination	Allows local fit
Create connections	By supporting ecologies of actions, tools and context	Allows stabilization of relationships	Allows evolution of the connections' grid
Attain durability	By cultivation of the installed base	Allows the exploitation of pre-existing arrangements	Allows the exploration of new configurations

Table D: Qualities of information infrastructures that meet both overall coherence and local needs (Grisot & Vassilakopoulou, 2013, p. 171)

The balance between standardization and flexibility becomes even more challenging as the II grows with an expanding number of heterogeneous users, activities (Constantinides & Barrett, 2015), and local applications (Vaast & Walsham, 2009). The larger a network becomes that implements a standard, the more difficult it is to change the II, and it becomes increasingly irreversible (Hanseth & Lundberg, 2001). Likewise, as the installed base grows, it becomes increasingly difficult to change standards (Hanseth, Jacucci, Grisot, & Aanestad, 2006). An increased heterogeneity of actors involved in the standardization and an increased speed of technological change will also make standardization more complex (Hanseth et al., 2006).

2.5.4 Growth and development of IIs

IIs are never complete, but continuously evolve (Tilson et al., 2010b), which implies a cultivation of the installed base (Aanestad et al., 2017; Hanseth & Monteiro, 1998). An II does not change entirely all at once, but gradually over time because of its size, complexity, and interwoven sociotechnical elements (Hanseth & Lundberg, 2001). A global governance context implies an even greater complexity. In a study on pan-European eGovernment solutions, Hanseth

(2014) highlights that the development of harmonized and integrated ICT solutions and services at the EU level is challenging because of the complexity that comes with the variety and number of ICT solutions, legislations, judiciary systems, actors, languages, and traditions due to the multiplicity of countries involved (Hanseth, 2014). A global context is even more heterogeneous.

There can be innovation of, in and on information infrastructures (II). Innovation of II means a new II is developed. Innovation in an II means that an established II is changed in the way that components of it are replaced or developed, while the constituting architecture remains. Innovation on an II means that the existing II is extended by new applications, or modules are added on top of the II. A central feature of innovation in or on an II is that it has to be compatible with the installed base (Grisot, Hanseth, & Thorseng, 2014). Relating to the view that IIs never develop from scratch, but always build on an installed base (Aanestad et al., 2017; Hanseth & Monteiro, 1998), my understanding is that even though a new II is developed, it has to relate to other infrastructures already in place. For instance, if an information infrastructure is developed for a particular governance topic, it is related to established procedures, other related policy areas, and other governance levels. Thus, there is always an installed base to relate to, even if a new II is developed.

The characteristics of IIs as open and socio-technically interconnected systems imply that change and development of IIs cannot be designed in regular ways. An II includes various actors, components, and elements with different origins, where different components and subnetworks may have different regimes of control. It will be impossible for one actor to have control of the entire II (Aanestad, Monteiro, & Nielsen, 2007). The control of IIs is distributed, where various actors can add and integrate components. This means that traditional top-down design methodologies are not applicable. Some suggest a polycentric governance approach with multiple governing units and distributed decision-making (Constantinides & Barrett, 2015). Some advocate for an approach of small-scale, bottom-up and incremental change is appropriate (Aanestad et al., 2007). Other scholars suggest a combination of top-down and bottom-up approaches (Osmundsen & Bygstad, 2022). Completely top-down efforts tend to fail, while distinctive bottom-up approaches tend to result in fragmentation (Bygstad, Iden, & Øvrelid, 2022).

Information infrastructures have inherent tensions because of their complexity, scope, and heterogeneity (Bygstad & Hanseth, 2016). This includes tensions between stability and flexibility, distributed or centralized control, short and long-term goals, and tight or loose coupling. How these tensions are balanced through architectural-governance configurations will affect the development and operation of the II. For instance, tightly coupled (integrated) architectures and centralized control may attract new users and expand scope, but may not be fruitful for establishing new services, while loose coupling, modularity and distributed control is more generative (Hanseth & Modol, 2021). On the other hand, centralized control enables large-scale generativity while distributed control is more local in scope (Bygstad & Hanseth, 2016). Table E. illustrates tensions to consider in architecture-governance configurations.

	Stability	Change
Architecture	Integration (efficiency)	Modularization (flexibility)
	Uniformity, standardization	Variation
	Centralized	Decentralized
Governance (strategy, organizing)	Consolidation	Local optimization, innovation
	Long term focus	Short-term focus
	Planned change	Emergent change
	Centralized control	Distributed control

Table E. Architectural and governance tensions between stability and change (Ole Hanseth & Modol, 2021, p. 134)

Information infrastructures do not have clearly defined goals or a defined user group but should rather enable various activities for multiple stakeholders and unanticipated use. An iterative and experimental development enables organic growth of the II. Through modularization, parts of the II can be designed for more specific use areas and user groups, while the overall II is open to multiple use areas and user groups (Aanestad & Hanseth, 2002). A major challenge is heterogeneity. Organizational and human components cannot just be "designed" (Hanseth & Lundberg, 2001), and as Hanseth & Lyytinen (2016) articulate,

> "From a technical viewpoint designing an II involves discovery, implementation, integration, control, and coordination of increasingly heterogeneous IT capabilities. Socially, it requires organizing and connecting heterogeneous actors with diverging interests in ways that allow for II growth and evolution" (Hanseth & Lyytinen, 2016, p. 105).

For IIs to generate value, there must be a large user base. An initial challenge is to design solutions for a rather small user group, and at the same time anticipate future needs. Then, as the number of users grows, the requirements will increase and become more diverse, which requires some flexibility. Emerging requirements and continuous growth and adaptation therefore needs to be taken into account in the development of IIs (Hanseth & Lyytinen, 2016). Hanseth & Lyytinen (2016) suggest five design principles for II development that take the complexity of IIs into account: 1) Initially, design for usefulness; 2) Build upon the existing installed base; 3) Use enrollment strategies to expand the installed base to gain momentum; 4) make the design as simple as possible; and 5) modularize the II (Hanseth & Lyytinen, 2016). Successful development of IIs further requires alignment of social, organizational, and cultural issues with technological solutions (Edwards, Jackson, Bowker, & Knobel, 2007). The characteristics of information infrastructures make it important to understand how they evolve, which will also impact how digital global governance can be developed.

2.5.5 Summary

Section 2.5 has established that information infrastructures (IIs) can be a suitable theoretical lens for analyzing the foundations of digital global governance (Krishnan & Teo, 2012). An information infrastructure is the underlying infrastructure for development and use of information services (Hanseth & Lyytinen, 2004). IIs are foundations for digital governance, such as the development of digital services and efficient sharing of information, which supports decision-making, facilitates stakeholder participation (Beconytė et al., 2022), and transparency (Meso et al., 2009). IIs enable cross-organizational exchange of information (Hornnes et al., 2010), collaboration (Klievink & Janssen, 2014) and learning (Vaast & Walsham, 2009). IIs are further suggested as enabling innovation on a large scale and scope (Tilson et al., 2010b). In a global governance context, an II can be the foundation for digital global governance, by providing information, enabling the development of digital services to support governance activities, facilitating global coordination, and enabling innovation.

Information infrastructures (IIs) are large, sociotechnical networks, encompassing technological, organizational, and human parts, including IT artefacts, standards, organizations, and people. They (IIs) are shared among a community – or multiple communities – and enable multiple functions and activities. IIs are heterogeneous due to their variety and number of developers, users, and technological parts, and requirements and use will change over time. As a foundation for digital services, it is imperative that all parts are interoperable within the established II, which is ensured through standardization. The components (both technical and non-technical) of an II that is established are called an installed base (Hanseth & Monteiro, 1998). Information infrastructures evolve through cultivation of the installed base, often in a combination of bottom-up and top-down manners. Understanding of how IIs evolve is important in the context of considering how digital global governance can evolve.

Since information infrastructures are embedded in broader social and technological structures (Aanestad et al., 2017; Hanseth & Monteiro, 1998), it is important to consider the conditions and characteristics of the context that the II should support. In a public governance context, there are regulatory, technological, and organizational conditions, as well as public values and political objectives that are part of the installed base (Hornnes et al., 2010). In a global governance context, there are both the global governance context, but also many differences between countries to take into consideration.

2.6 Global governance information infrastructure (GGII)

In a global governance context, the development of a common information infrastructure is central to the development of digital global governance and can also support improvements and innovation of governance (Hornnes et al., 2010). A conceptual and empirical understanding of information infrastructures in global governance is an important foundation for further knowledge development of digital global governance. Based on the definitions and discussions found in the previous sections, I suggest a conceptualization of global governance information infrastructures in this section.

An information infrastructure is a foundation for digital governance, underlying the development and use of digital services and functions (Beconytė et al., 2022; Krishnan & Teo, 2012). An information infrastructure has an enabling or supporting function (Hanseth & Monteiro, 1998) and has been defined as

> "a shared, open (and unbounded), heterogeneous and evolving socio-technical system (which we call installed base) consisting of a set of IT capabilities and their user, operations and design communities" (Hanseth & Lyytinen, 2010b, p. 109).

Information infrastructures enable the exchange of information across organizational boundaries. In a global governance context, global collection of information (which implies exchange of information across national borders) is imperative for global governance activities, such as monitoring of societal issues, assessing implementation, coordinating actions, informing decision-making, and shaping a common understanding and knowledge on a topic. This further implies an extensive management of information as well as dissemination to a designated community, which in the case of climate reporting is the public.

A central component of IIs is also standardization, which enables interoperability, and thus exchange of information, at different levels. Coordination and exchange of information resources at a global level is sufficient to develop digital global structures, processes, and services.

I suggest that the objective of a 'global governance information infrastructure' (GGII), is to be a foundation for the development of digital global governance, including the development of digital services and functions to support global governance activities. *Global governance* implies the steering of society through collective action according to common goals (Ansell & Torfing, 2016) and an exercise of authority across national borders motivated by transnational problems

or global common goods (Zürn, 2018a). To that end, it encompasses structures, processes, and policies (Zürn, 2010), and both formal and informal governance mechanisms, such as rules and norms (Rosenau, 2004).

'Digital global governance' is, in this thesis, defined as

> digital technology ingrained in structures or processes of global governance and their reciprocal relationships with global governance objectives and normative values. Digital global governance includes the utilization of digital capabilities and involves a transformation of structures, processes, or normative values.

A GGII should thus support global governance through an information infrastructure as a basis for the exchange of information and development of digital services and functions. A GGII will coevolve with global governance structures and processes and should facilitate transformation in line with global governance values and objectives. Development of a GGII has to consider the installed base (Aanestad et al., 2017; Hanseth, 2010) of standards, regulatory, organizational, technological, and social elements, as well as the extensive heterogeneity in a global context.

A global governance information infrastructure (GGII) should be grounded in global governance values and support the operation of global governance activities and structures. Since global governance implies relationships between the global and national levels, the GGII should support information exchange between governance levels. Moreover, a global governance information infrastructure must be open to use by various stakeholders and continuously evolve, based on new user requirements (Hanseth & Lyytinen, 2004).

Given this background, I propose the following definition of 'global governance information infrastructure' (GGII):

> A global governance information infrastructure is a globally shared, open, heterogeneous, and evolving sociotechnical system, built on an installed base encompassing standards, technology, organizations, and people. A global governance information infrastructure is ingrained in global governance structures and processes, with reciprocal relationships with global governance objectives and values. A global governance information infrastructure enables global exchange, management, and dissemination of information and the development of digital global governance services and functions.

Based on the characteristics of information infrastructures explicated by (Hanseth & Monteiro, 1998), a global governance information infrastructure should:

- Have a supporting and enabling function for global governance activities;
- Enable global exchange, management and dissemination of information, and development of digital services and functions;
- Be shared globally, without discrimination;
- Be open, concerning numbers of users, use areas, applications, and developers;
- Build on global standards and enable local innovation;
- Encompass technological, organizational, sociocultural, regulatory, and standardizing elements, as well as people;
- Enable interconnection between many ecologies of networks, to connect different governance levels and domains;
- Develop through cultivation of the installed base.

The notion of openness does not imply that anyone can do anything though. There will be certain standards and regulations that govern rights and obligations. In a global governance context, this means that governments may have certain obligations to report globally, which is then verified to ensure reliability of the information. That process should not be mixed with information from other actors, while dissemination of the reports can allow a use of the information in a broader context. Access to information will also vary and be different for different governance topics. Thus, the notion of 'open' may imply that the numbers of users, use areas and applications will vary between governance issues.

This conceptualization of 'global governance information infrastructure' contributes theoretically to the infrastructural foundation of 'digital global governance'. The characteristics of GGII articulated above reflect the role of IIs in global governance, which relates to research question 2 in this thesis: How do information systems support global climate governance? It is further the theoretical basis for research question 3: How can digital global climate governance be enhanced? I will, in the following section, propose a model that illustrates the relationship between global governance information infrastructure and global governance.

2.6.1 The Global Governance Information Infrastructure (GGII) model

In this section, I propose a model called the *Global Governance Information Infrastructure (GGII) model*, which illustrates the relationship between a global governance information infrastructure, global governance, and global societal challenges. The GGII model is depicted in Figure C. and will be explained below.
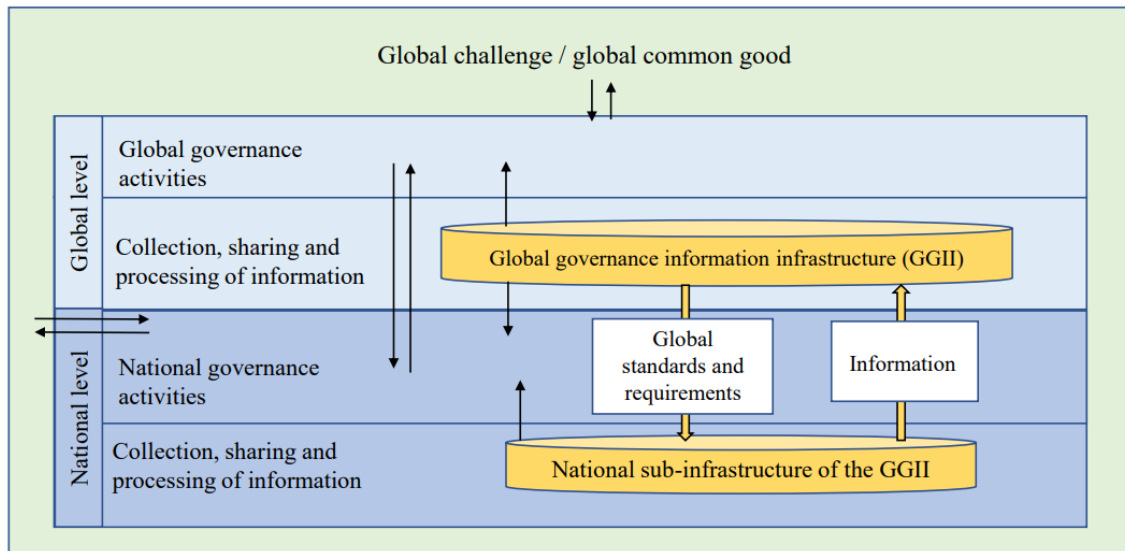
Figure C. The Global Governance Information Infrastructure model

The green area in the model represents the global challenge or global common good, such as climate change/a stable climate system. This challenge or common good sets demands for governance, which is represented by the arrows from the green area to both global governance and national governance (since it impacts and drives the need for measures at both national and global levels). The arrows in the opposite direction, from the areas for global governance activities and national governance activities towards the green area, represent how governance contributes to solving the problem or maintaining a global common good.

Information infrastructures can build on each other and there can be sub-infrastructures (Hanseth, 2010). IIs link networks and can be interconnected with larger information infrastructures (Hanseth & Monteiro, 1998). The GGII model illustrates this, as global governance information infrastructures also have national sub-infrastructures. A global governance information infrastructure (GGII) enables collection of information from countries across the world to be aggregated and disseminated at a global level. There are technological, regulatory, and organizational arrangements at the global level to manage and verify the information submitted by countries. There are also organizational,

technological, and regulatory arrangements to collect and submit information at the national level, which forms national sub-infrastructures of the GGII. Global governance decisions and standards place requirements on the national sub-infrastructures of the GGII to enable coordination and comparability of the information at the global level. For instance, information from various countries needs to be in the same standard format and have the same level of quality. Hence, global standards are operationalized and implemented at the national level.

However, the national sub-infrastructures are also part of each country´s information infrastructure. There is an overlap where some elements of a national sub-infrastructure of a GGII are part of the global governance information infrastructure, and some elements are specific for each country due to their installed base of national information infrastructure, including IT systems, organizations, work practices and sociocultural and political traditions. For example, global requirements may demand that countries submit certain information in a certain format and establish national arrangements for information collection and submission according to those requirements. But each country can choose which IT systems they use, which organizations are involved in collecting the information, and how these are regulated at the national level.

The degree of standardization and which elements that are standardized may also vary between governance topics. The global level sets requirements on national sub-infrastructures, but the global level of the GGII is dependent on national sub-infrastructures to collect information. They are thus interdependent. This relationship is illustrated in the model, with an arrow from the global level of the GGII to the national sub-infrastructure of the GGII representing the global standards and requirements. The national sub-infrastructures then provide information to the global level, which is represented by the arrow from the national sub-infrastructure to the global level of the GGII in the figure.

The arrow from the 'National sub-infrastructure of the GGI' to 'National governance activities' illustrates that the II supports governance at the national level, for example, by providing information to inform governance decision-making and policy evaluation. Likewise, the arrow from the 'Global governance information infrastructure' to 'Global governance activities' illustrates that the GGII supports global governance. At both national and global levels, the collection, sharing and processing of information provided by the information

infrastructure supports governance, at each governance level. There are further interactions between global governance activities and national governance activities, such as those regarding goal setting. The GGII can support such interactions.

Innovation and evolvement of the GGII can occur at the national sub-infrastructure level, or at the global level. Digital services and functions may be developed based on the GGII for governance activities, both at the national and global levels. For example, the development of digital services that operationalize information provided by the GGII to support and facilitate governance activities.

Related to the characteristics of a GGII, the GGII model illustrates that information provided by the GGII informs governance activities. The GGII enables global exchange of information and is also a foundation for the development of digital services and functions to support governance. The GGII model is shared globally since information is collected from all countries across the world and disseminated globally. The information collected in the GGII is also open for use by various users, use areas, applications, and developers, and is thereby open. Although, access rights may differ between different governance areas and be regulated in different ways. The GGII builds on global standards, which is also central in the governance of the GGII. However, further use of the information in the GGII enables local – and global – innovation, to support governance in various ways. Implicit in the model is that the GGII consists of multiple elements, such as technological, sociocultural, organizational, regulatory, and standardizing elements, as well as people and objectives, which is also part of the installed base that needs to be considered in further development and growth of the GGII. The model illustrates how national and global governance levels are connected and that there is a global dimension as well as interrelated national sub-infrastructures. In general, the model illustrates that the GGII is situated within global governance structures and processes.

This chapter has established the conceptual foundation for the thesis and situated it in the digital governance and information systems fields. The next section will outline the research design of the thesis.

3. Research design

This section will describe the philosophical stance and method for this thesis, and then discuss quality issues, limitations, and challenges of the selected approach.

3.1 Philosophical stance

The underlying research philosophy of a research project affects what types of research questions that are asked, how knowledge is acquired, the approach the researcher has in relation to the phenomenon under study, and the empirical material that is analyzed. The philosophical approach is like a red thread that makes the research coherent and affects which quality criteria are relevant. Key elements of research philosophy are ontology and epistemology. This research project has a constructivist ontology and an interpretivist epistemology. *Ontology* refers to beliefs about the nature of reality. It includes questions regarding what is seen as real and true, what we can know about reality and what exists. *Epistemology* refers to the nature of knowledge, how we acquire knowledge, and the relationship between researcher and what is studied. Epistemology is about how we know what we know (Killam, 2013).

3.1.1 Constructivist ontology

According to constructivism, social phenomena are socially constructed. This means that social reality is constructed through various practices, relationships, and how people assign meaning to things and understand the world (Alvesson & Sköldberg, 2017). Social phenomena are continuously evolving and shaped in social interaction. Social realities are perceived to be multi-layered, and cut across individual, social, and physical dimensions. Moreover, the context in which a phenomenon exists and is interpreted has an important role in how things are shaped and made meaningful (Chupchik, 2001).
Constructivist researchers study the processes in which social realities are constructed (Bryman, 2008), and seek to reveal and develop understanding of the meanings people assign to their experiences and phenomena in the world. Such meanings can vary between individuals, are affected by social context, and formed in social interactions; hence, they are affected by social norms (Creswell, 2007).

In contrast to a realist ontology, which holds that an objective reality exists and can be discovered, and that it exists independently of humans, a relativist approach (which as I understand, constructivism adheres to) emphasizes that reality can be interpreted in different ways and is influenced by culture and social context. Our understanding of reality thereby cannot be distinguished from perception (Killam, 2013). The constructivist approach aims to reveal and understand how a phenomenon is socially constructed. Related to this thesis, this includes developing an understanding of the phenomenon of climate reporting and what meanings are assigned to it, based on the understanding that it is socially constructed.

3.1.2 Interpretivist epistemology

Research based on constructivist ontology develops knowledge through empirical scientific investigations (Killam, 2013). From a constructivist view, social reality is socially constructed, and the aim of constructivist research is to understand a phenomenon from the perspective of the participants in the context in which it exists (Chupchik, 2001). In line with that, the epistemological stance in this research is interpretivism. Interpretivist research aims to develop understanding and make sense of social phenomena by developing understanding of the meanings assigned to a phenomenon by individuals and groups, which is also embedded in a historical and cultural context (Creswell & Creswell, 2018).

The empirical investigations in this research project are qualitative, which is suitable for interpretative research. Qualitative research is typically characterized by data collection in a natural setting, and the researcher is the main instrument for collection and analysis of data. There is continuous reflection and analysis throughout the process, and the research often has a holistic approach (Creswell & Creswell, 2018). Interpretivist research is also suitable for research in the IS field.

> "Interpretive research can help IS researchers to understand human thought and action in social and organizational contexts; it has the potential to produce deep insights into information systems phenomena including the management of information systems and information systems development" (Klein & Myers, 1999, p. 67).

A qualitative interpretive research approach was chosen for this project because it enables the development of an in-depth understanding of the phenomenon of

digital global governance. Through empirical investigations, including interviews with respondents and study of documents, the research seeks to develop understanding of the meaning that is assigned to climate reporting as an example of a digital global governance initiative. Through literature reviews, the research aims to develop understanding of the scientific meaning of digital global governance.

3.1.3 Hermeneutic approach

While the ontological basis of this thesis is constructivism, and the epistemological stance is interpretivism, the approach to analysis and interpretation is hermeneutical. Hermeneutics explains how interpretive understanding is attained (Gadamer, 2004), and is also the philosophical foundation of interpretivism (Klein & Myers, 1999). Hermeneutics, as the art of understanding and interpretation, originally developed along two paths: theological and philological. The theological tradition focused on the interpretation of sacred texts such as the bible, with the aim to reveal its original meaning. The philological tradition focused on the interpretation of classical literature. Both the theological and philological orientations involved a rediscovery of the meaning of texts, which had been hidden or become alien (Gadamer, 2004). In the twentieth century, social philosophers also started to apply hermeneutics in interpretations of speech and actions, not just texts. Hermeneutics have then come to be applied as an approach in social science, where it is about interpretation of the meaning of social settings, with the intention to clarify and make sense of a phenomenon (Myers, 2004). Interpretation can be understood as "unfolding the levels of meaning" (Myers, 2004, p. 109). In the information systems field, hermeneutic analysis has been used to develop understanding of the use and impact of IT in a certain social setting (Myers, 2004). Thus, hermeneutics aims to reveal meaning and develop understanding of a phenomenon. According to Gadamer (Gadamer, 2004), there is also an intention to establish agreement on a topic, or a reconciliation of understanding. In this thesis, hermeneutics is the approach to analysis in each study, as well as for the thesis as a whole. How understanding develops throughout the research process is explained through the hermeneutic circle.

The process of understanding – the hermeneutic circle

According to hermeneutics, understanding of a phenomenon develops according to the hermeneutic circle. The hermeneutic circle illustrates that understanding of a phenomenon is achieved by understanding of the whole as well as its parts and their relationships. It is an iterative process of understanding that goes from the whole, to its parts, to the whole again. It thus includes both a broad understanding and details about particular aspects of the phenomenon, as well as contextual elements and historical background (Gadamer, 2004; Klein & Myers, 1999).

> "We call the hermeneutical rule that we must understand the whole in terms of the detail and the detail in terms of the whole. (…) It is a circular relationship (…). The anticipation of meaning in which the whole is envisaged becomes actual understanding when the parts that are determined by the whole themselves also determine this whole (…). Thus, the movement of understanding is constantly from the whole to the part and back to the whole. Our task is to expand the unity of the understood meaning centrifugally. The harmony of all the details with the whole is the criterion of correct understanding" (Gadamer, 2004 p. 291).

It is when the understanding of the whole and its parts are in harmony that one has achieved understanding of the phenomenon. The hermeneutic circle is not a method, but describes the process of understanding (Gadamer, 2004). However, it also reflects how this research project was conducted; going back and forth between investigating the parts and relating that to the whole, such as how IT artefacts in the reporting process support governance and overall governance objectives and strategies. This makes it possible to connect the role of digital technologies to broader societal governance objectives and to theorize that relationship. The research also goes back and forth between theory and empirical data collection and interpretation. In this way, the research emerges and develops in an organic way, drawing on both previous research, empirical findings and developing further theoretical analysis.

Prejudice and horizons of understanding

Key concepts in hermeneutics are *prejudice* and *horizons of understanding*.

Prejudice means that the researcher always has some pre-understanding that influences the understanding of a phenomenon. There are always preconceptions that are used in the process of interpretation, which then change throughout the

process when knowledge increases (Myers, 2004). There is never complete knowledge. The interpreter has a certain *horizon of understanding* at a particular point, and when new or deeper understanding is acquired throughout the process, a new horizon of understanding emerges (Gadamer, 2004). "The horizon is the range of vision that includes everything that can be seen from a particular vantage point" (Gadamer, 2004 p. 301). Then we can expand our horizon or open up new horizons of understanding (Gadamer, 2004).

Understanding of a phenomenon can thus also be viewed as being productive rather than re-productive (Myers, 2004). Understanding is not just about re-creating the meaning of a phenomenon, but the interpretive process also opens up for new understanding and meaning (Gadamer, 2004). As the researcher, my pre-understanding is discussed in the section below on 'the researcher´s role and preunderstanding'.

According to hermeneutics, understanding emerges through a dialogical process, based on asking questions to reveal the meaning of a text or phenomenon. Thus, interpretation always relates to the questions that are asked (Gadamer, 2004). Such a dialogue enables new insights that were not pre-understood to emerge (Webb & Pollard, 2006). In this research project, questions about a phenomenon have been asked iteratively. First, questions were posed to the respondents during interviews. Then, the interview transcripts were analyzed through questions related to the role of information systems and how they support governance. In an interpretive research project, both research questions and interview questions evolve during the research process, as new understanding and meaning emerges (Crist & Tanner, 2003). This also reflects how the process of this thesis has developed, by continuously asking new questions based on the current horizon of understanding. Asking questions increases the possibility of broadening the perception of the phenomenon beyond what is currently known. Each study led to new horizons of understanding that contributed to deepening the understanding and increasing knowledge.

The researcher influences the research process and its outcomes through his/her prejudices, which questions that are asked and how the answers are interpreted, and his/her role in the research project.

The researcher´s role and pre-understanding

Interpretive fieldwork can be done with different levels of involvement, from doing interviews with an intention to understand, and observing from an "outside" perspective, to participating in activities with the participants and contributing to change as in action research (Walsham, 2006). This project does not include any interventions or participation in activities in practice. The level of involvement is interviews with practitioners in the field, with the aim of understanding the views of the participants. However, questions asked in the interviews may affect participants in the field as they contribute to raising awareness.

In interpretive research, the researcher interprets the participants´ views of a phenomenon. The participants´ constructions of the world can be called first-order data, and the researcher´s constructions, based on analysis of first-order data, can be called second-order concepts. Second-order concepts also rely on theory and analysis. The researcher then makes her/his interpretations available to readers (Walsham, 1995). Thus, this thesis is both influenced by the respondents understanding of the phenomenon, the theories and concepts applied in the analysis, as well as my pre-understanding and new horizons of understanding that have emerged during the process.

The researcher´s relation to the phenomenon and site under study can also color the interpretation (Creswell & Creswell, 2018). Pre-understanding can come from both theoretical and practical experiences. In my case, I have worked as a lecturer in archives and information science (focusing on digital records management) and have conducted some research in the Swedish public administration from an archives and information science perspective. This has contributed to an understanding of the role of information as well as challenges with digital information management in the public sector. I have also worked as an e-archivist in a Swedish municipality and in the Swedish E-Delegation project concerning e-archives and e-registries, which has contributed with insights focused on Swedish and EU digitalization strategies. My experiences in the Swedish public administration have further shaped a familiarity with the setting, which then facilitated later access to the field. Having Swedish as my native language also facilitated the interviews in Sweden. Related to climate governance, I have a background in non-governmental organizations (NGOs) for sustainable development. Twenty years ago, I participated in government

dialogues as an NGO-representative and was active in a national NGO network for the United Nations Rio+10 conference Earth Summit 2002. I also participated at a United Nations Conference for the least developed countries as an NGO-delegate in the Swedish delegation. I have long been involved in global sustainability challenges, which is an important motivation for this research. My intention is to develop knowledge that contributes to improve governance of global challenges. My view is that knowledge has a paramount role in our possibility to handle critical societal challenges. In addition, it has been noted that, "Education and knowledge are the most reliable means for change in any social system" (Jreisat, 2004, p. 1016). Knowledge impacts the common understanding of the world, how we are existing in the world as humanity, and it raises awareness on what courses of collective action are perceived as possible and adequate.

Knowledge interest

Research provides different types of theoretical contributions, such as analysis and description, explanation, prediction, and design and action (Gregor, 2006). This thesis falls primarily into the category of analysis and description. This type of theoretical contribution analyzes "what is", describes characteristics of a phenomenon, relationships between concepts, and develops generalizations of concepts and relationships. This type of theoretical contribution is needed when little is known about the phenomenon (Gregor, 2006). This research project aims to understand, describe, analyze, and conceptualize how information systems support global governance. It provides a conceptual understanding of digital global governance and global governance information infrastructures, and a model which illustrates the relationships between concepts. This type of theoretical contribution is useful in systematizing knowledge, which can occur through integrating previously separate elements of knowledge, generalizing knowledge or data to higher level constructs, or suggesting new propositions (Järvelin & Wilson, 2003). This thesis both integrate previously separate theoretical elements (such as digital governance, global governance and information infrastructure; and digital governance and online communities); generalize knowledge and data to higher level constructs through the development of the GGII model; and suggest new propositions through theorizing the relationship between digital governance, information infrastructure

and global governance. The project does not address causal relationships, predictions, or interventions. Additionally, theories can guide research by pointing towards relevant issues and new research avenues (Järvelin & Wilson, 2003). This thesis identifies key research areas for further development of digital global governance, in particular digital global climate governance.

3.2 Method

This thesis contains five publications. The first publication is a literature review. The second, third and fourth papers are based on empirical studies of international climate reporting. The fifth paper is a conceptual paper. The thesis further includes an extended literature review and discusses and theorizes the findings. All publications and the thesis as a whole have adopted an interpretive approach. Figure D. illustrates the different parts of the research process.

Research Question:

- What is digital global governance?

- How do information systems support global climate governance?

- How can digital global climate governance be enhanced?

Literature review

'Digital governance' as a scientific concept

Outcome Theoretical understanding of the meaning of digital governance as a scientific concept

Case studies of climate reporting at different governance levels

The climate reporting process

Outcome: Description of how IT artefacts are used in the climate reporting process, from national level (Sweden) to international level (UNFCCC), and to what level of sophistication.

Climate reporting at national level in the case of Sweden

Outcome: Affordances of IT artefacts at the national level in climate reporting

Climate reporting at supranational level in the EU

Outcome: Affordances of Reportnet in supranational climate governance

Outcome:

Empirical insights on how information systems support global climate governance

Conceptual paper

Situates climate reporting in a context of global climate governance.

Outcome: Research agenda for online interaction in global governance

Thesis

Further conceptual development, discussion, and theorization of findings

Outcome:

Conceptualization of digital global governance

Conceptualization and model of global governance information infrastructure (GGII)

Pathways for enhancing the climate GGII and digital global climate governance

Figure D. The research process

3.2.1 Literature reviews

The literature reviews of this work have been informed by both a hermeneutic approach and a systematic literature review approach. Overall, the hermeneutic approach means that the reviews are part of an iterative and interpretive process to develop a deeper understanding of existing knowledge in a field (Boell & Cecez-Kecmanovic, 2014). In each review, knowledge grows organically through two hermeneutic circles: literature search and acquisition, and analysis and interpretation. There is first an initial search and selection of material. When this is accomplished, new horizons of understanding occur which provokes a new search, followed by additional understanding when the material is read (Boell & Cecez-Kecmanovic, 2014). In each study, there has been a fusion of horizons, which has led to a deepening and broadening of the literature search for the next study. The hermeneutic literature review process is illustrated in Figure E. (Boell & Cecez-Kecmanovic, 2014).
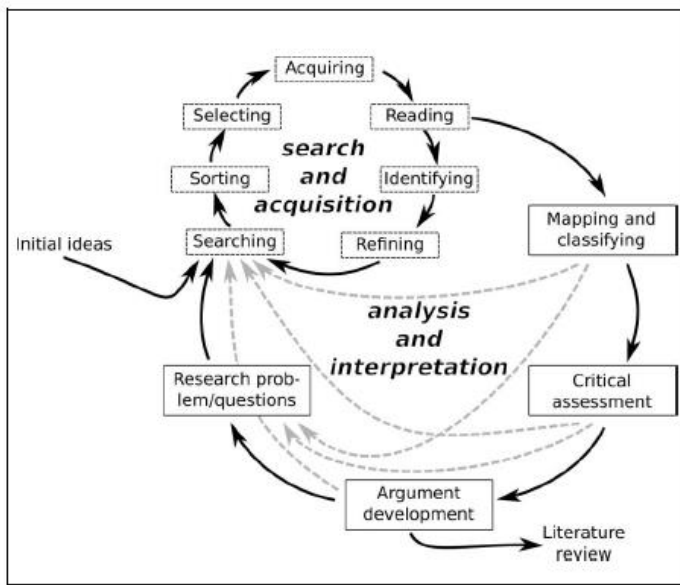
Figure E. The hermeneutic literature review approach (Boell & Cecez-Kecmanovic, 2014, p. 264).

A systematic literature review is a comprehensive method for identifying, evaluating, synthesizing, and reflectively interpreting an existing body of knowledge in regard to a specific question (Okoli, 2015). A systematic literature review adopts the following steps: identify the purpose of the review, draft a review protocol, apply a practical screen, search for literature, extract data,

appraise quality, synthesize studies, and write the review (Okoli, 2015). In the literature reviews of this thesis, the following steps have been conducted: formulate the purpose of the review, plan the review process, search for literature, and make a first selection of publications based on a practical screening of relevance, sort and organize publications that are retrieved, read, identify key themes and appraise quality, create a new search, and repeat the aforementioned steps. Finally, read the retrieved publications more thoroughly, code and identify themes, and finally refine themes and organize the results during the writing process. Literature reviews can be on a scale from more systematic to more adaptive. Some of the literature reviews in this thesis have been more systematic, and some have been more adaptive.

The literature reviews have been of different types. A standalone literature review was the basis of the first publication, shorter literature reviews were part of the other research publications, and then the thesis contains an extended literature review. However, all literature reviews included steps of formulating research objectives, planning, searching, selecting and sorting, reading, thematizing, analyzing and presenting the results (Boell & Cecez-Kecmanovic, 2014).

Digital governance as a scientific concept

The first publication in the thesis (Engvall & Flak, 2022b) is based on a literature review that aimed to gain a more in-depth understanding of the meaning of the concept 'digital governance' and to propose a consolidation of the understanding and use of the term. The review was a systematic literature review with an interpretive approach in the analysis.

The review served various purposes: to become familiar with the field and to situate the research project, to understand current knowledge on the topic, to provide a theoretical foundation, and to advance theory development (Levy & Ellis, 2006; Webster & Watson, 2002). The review provided an understanding of how the concept of 'digital governance' is currently defined and explained in the digital governance field. The review further consolidates this understanding into a novel definition of the concept and is a central contribution to the theoretical foundation and conceptual development in the thesis. According to Okoli (2012), theory-oriented literature reviews can have three types of theoretical contributions: to scope out a theoretical landscape (theory landscaping review),

building theory (theory building review), or to test a theory (theory testing review). The objective of a theory landscaping review is to identify existing theories in literature, identify gaps and provide new insights. A theory building review can be used to identify, specify, and define concepts and relationships between concepts. Theory building reviews are used to build new, extend or adapt existing theory. Theory testing reviews are used to test certain hypotheses (Okoli, 2012).

The literature review (Engvall & Flak, 2022b) is a theory building review that specifies elements of the concept of digital governance ('digital' and 'governance') and their relationship and suggests a definition that consolidates the understanding of the concept in the field. The contribution of a theory building review is to offer novel explanations and theoretical relationships which have hitherto not been satisfactorily explained (Okoli, 2012). A literature review of the meaning of concepts is relevant in creating a common understanding to build on and further advance knowledge (Khazanchi, 1996). A conceptual foundation is crucial in the development of a discipline. Conceptual systems are important for analyzing, structuring, organizing, describing, and disseminating knowledge (Nuopponen, 1996). Concepts are a means to create order, meaning and a common understanding. It is a way to make abstractions of reality, and it is, to a high extent, through concepts that human beings think (Takala & Lämsä, 2004). As it has also been articulated:

> "In essence, conceptual development provides a means of crisply defining and elaborating ideas regarding certain phenomena" (Khazanchi, 1996, p. 1).

The information systems field has challenges due to its continuously changing technological context and diverse, interdisciplinary foundations, but it is nevertheless important to continuously enhance its conceptual basis (Khazanchi, 1996). Scholars (Charalabidis & Lachana, 2020b) further argue that there is a need to develop a scientific foundation for digital governance, and conceptual development is a significant part of such a foundation. Interpretive literature reviews are suitable to reveal meanings and interconnections of concepts (Crowther, Smythe, & Spence, 2014). In this review, the material was coded and structured according to themes. Definitions, meanings, and explanations of 'eGovernance' and 'digital governance' in the selected literature were identified, which were synthesized to broader themes, and based on the interpretation of the meanings of the concepts, a definition of 'digital governance' was proposed.

Extended literature review in the thesis

Chapter two of this thesis includes an extended literature review, which has various objectives: to gain understanding of current research and situate the thesis in the digital governance and information systems fields, to provide the conceptual foundation for the thesis, and contribute to the conceptual foundation of digital global governance. The literature review is thus what Okoli (2012) describes as a theory building review. The concepts of governance, global governance, digital governance, and information infrastructure were identified as the relevant building blocks for the conceptual development of 'digital global governance' and 'global governance information infrastructure'. The concepts have been specified, some have been defined, and relationships between the concepts articulated. The conceptualizations are developed in line with a conceptual approach to literature reviews, where theoretical perspectives are linked and integrated (Gilson & Goldberg, 2015). Additionally, there is a section in this chapter on climate change, to provide a scientific basis for the selected real-world problem that global governance responds to.

The literature chapter has six sections in the following order: Climate change; Governance and global governance; Digital governance; Digital global governance; Information infrastructure; and Global governance information infrastructure.

Section one describes the real-world problem of climate change, and some governance challenges of climate change are highlighted. The objective of this section is to provide an understanding of the current challenge that global governance aims to respond to. This section is based on reports from the IPCC (Intergovernmental Panel on Climate Change), which is the United Nations body that synthesizes and assesses research on climate change and informs policy making (IPCC, 2023b).

Sections two to six include literature reviews concerning: 1) governance and global governance; 2) digital governance; and 3) information infrastructure. The reviews have been informed both by a systematic literature review procedure as well as a hermeneutic literature review approach. The review of digital governance was the most systematic, while the reviews for governance & global governance and information infrastructure had a more adaptive and iterative, i.e.,

hermeneutical approach. Key themes have been identified in the literature, which has then inspired additional searches (Boell & Cecez-Kecmanovic, 2014).

The overall objective was to gain more in-depth understanding of each concept (Boell & Cecez-Kecmanovic, 2014), which has then served as the basis for conceptualizing digital global governance and global governance information infrastructures. In applying an interpretive approach, the aim was to reveal the meanings of and to identify interconnections between concepts (Crowther et al., 2014). While reading selected papers analytically, key descriptions and findings were identified (Boell & Cecez-Kecmanovic, 2014). In line with the method of a conceptual paper, which is based on a selected body of literature on a certain topic, theoretical perspectives were linked, and relationships between concepts were integrated and proposed (Gilson & Goldberg, 2015). Thus, based on the understanding of each concept, a synthetization was made between the concepts that were related to each other. For 'digital global governance', the meanings of the conceptual elements 'global governance' and 'digital governance', were synthesized. For 'global governance information infrastructure', the meanings of 'global governance' and 'information infrastructure' were synthesized.

In *section two*, the meanings of governance and global governance were explored. In the literature review concerning digital governance as a scientific concept (Engvall & Flak, 2022b), it was identified that there was a shallow understanding of governance in the digital governance field, and thus advocated for the need of improved articulation of this part. To further conceptualize digital *global* governance, an understanding of global governance was also needed. Thus, the aim of this part was to deepen the understanding of the characteristics of governance, and particularly global governance.

This literature review has included literature by renowned scholars in the field. The selection of literature was based on suggestions from a scholar in the governance field, and backwards literature searches, as well as complementary searches in Google Scholar. The selection criteria were peer reviewed publications in English with descriptions or definitions of global governance, with the aim of finding key publications that captured the meaning of governance and global governance. The publications were downloaded to a folder in Endnote as well as OneDrive where they were organized. The selection of publications was read analytically and interpreted to gain an understanding of the meaning of governance and global governance. Themes were identified, and subsequently

used to organize the texts. The process was very iterative, as the reading informed additional searches.

Section three is based on a literature review on digital governance with a global dimension. The aim of this review was to gain an understanding of the research conducted in the digital governance field that relates to a global dimension. A plan for the procedure for the review was created, including selection of databases, search terms, selection criteria, and organization of the material. Searches were conducted in the DGRL database and Google Scholar, using the search terms: 'global governance', 'digital global governance', 'digital governance AND global governance'. A practical screen was done based on the requirement that publications should be English peer reviewed publications in the digital governance field which address the global dimension. Publications on both eGovernance and digital governance were included. Retrieved articles were downloaded to a folder in an Endnote library, as well as into folders in OneDrive where they were organized further. The publications were reviewed briefly and grouped according to themes. A more thorough reading of the articles was then conducted, and themes revised, while also assessing the quality of the publication. Structuring and classification of the findings were then refined throughout the writing process. This review was more systematic in approach compared to the other reviews in this chapter because the field was more known, which made it clearer as to what to search for (Boell & Cezec-Kecmanovic, 2011). However, a second round of searches were done on 'digital diplomacy', which was a term discovered later in the process.

Section four includes a synthetization of the understanding of global governance and digital governance, developed in the previous two sections. Moreover, the definition of digital governance that was suggested in the first publication in this thesis (Engvall & Flak, 2022b) is used as a foundation for suggesting a definition of 'digital global governance'. This section includes relating and integrating meanings of concepts (Gilson & Goldberg, 2015) to new concepts, i.e., the meanings of 'global governance' and 'digital governance' are integrated into an understanding of 'digital global governance'.

Section five is based on a literature review on 'information infrastructures', which provides the theoretical foundation for the IS perspective in the case of digital global governance in the thesis. This section creates a deeper understanding of information infrastructures, which is then used in the

conceptualization of global governance information infrastructures.

The selection of literature departs from a search on key scholars theorizing the phenomenon, as well as a key word search in Google Scholar. Based on a hermeneutic approach, the reading informed further searches on key themes in the II literature, such as installed base and standardization. A practical screen was that the publications should be in English and peer reviewed. Publications were downloaded to a folder in an Endnote library as well as into folders in OneDrive where they were further grouped and organized. The publications were read, and themes identified, which then formed the structure of the text. Throughout the writing process, themes were revised and synthesized.

Section six synthesizes the understanding of information infrastructure and global governance and proposes a novel definition of global governance information infrastructure, as well as a model of global governance information infrastructures (GGII). The GGII model illustrates a global governance information infrastructure, as well as the relationship between global governance and information infrastructure. In the discussion section of the thesis, this model was applied to the findings of the case studies, and the findings were discussed in respect to the aspects addressed in the literature section. Conceptually, the GGII model was developed based on literature, and was validated and further refined based on empirical findings. The case of climate reporting in this thesis also serves as an example of how the model can be applied. My suggestion is to further test the model on other governance areas.

3.2.2 Interpretive case study

The method applied for the empirical investigations was interpretive case study. The aim of case study research is to provide insights about a phenomenon (Shanks & Bekmamedova, 2013). A case is used to illustrate and develop understanding of an issue (Creswell, 2007). The objective of the case studies in the thesis was to gain insights about digital global governance. A case may be a group, organization, project, or process. A case has a bounded context and is the unit of analysis (Shanks & Bekmamedova, 2013). In this thesis, three case studies have been conducted: 1) the climate reporting process from national to global level (Engvall & Flak, 2022c), 2) the United Nations climate reporting at national level (Sweden) (Engvall, 2021), and 3) the EU digital reporting platform

Reportnet, which is used for climate reporting in the EU (Engvall & Flak, 2022a). All three cases are about international climate reporting but focus on different governance levels.

The aim of the case studies was to develop understanding of the role of information systems in a global governance context, and how information systems support governance. Interpretive case studies are a method that has been used by IS researchers in projects that aim to understand social issues related to information systems (Walsham, 1995). Case studies are well suited to gain understanding of interactions between information systems, actors, and organizational contexts. Case study is thus suitable for this thesis, since the objective is to develop an understanding of the role of information systems in a global governance context. Case study as a method enables us to focus on the dynamics of a phenomenon in a certain setting;

> "Case study research focuses on contemporary phenomena within real-world settings and includes the experiences of the stakeholders involved" (Shanks & Bekmamedova, 2013, p. 173).

Case studies can be qualitative or quantitative and they may investigate one or multiple cases (Shanks & Bekmamedova, 2013). In this thesis, the case studies are qualitative. Case studies typically answer questions of how, why, or what (Sarker, Xiao, & Beaulieu, 2013). The case studies in this thesis have investigated "what" and "how" questions. For example, they investigate which IT artefacts are used in the reporting process, how information systems support governance, and what can be improved.

Digital global governance is a very broad subject, and the selected phenomenon of climate reporting is also complex, involving multiple actors and governance levels. Case study research is an appropriate method for broad and complex phenomena that require both a holistic and in-depth investigation, and where the context has an important meaning (Shanks & Bekmamedova, 2013). Case study research is adequate for information systems research because it enables the study of the relation between digital technologies, people, and social context. In case study research, experiences of the actors are central. Interpretive case studies are based on the notion that reality is subjectively interpreted by people. People are social actors with value systems and beliefs, who act in a certain social and cultural context. This is the context that information systems are embedded in (Shanks & Bekmamedova, 2013). In this project, information

systems are embedded in global governance, where the governance contexts at different governance levels are considered as significant.

Case study as a method enables in-depth analysis of how information systems and governance are interrelated, in a real setting and at different governance levels (in this case national, supranational (EU), and global levels). The studies include systems, information, regulatory and institutional contexts, as well as the interpretations of the respondents involved in the reporting, which may capture dynamics and provide insights. This enables the development of a holistic understanding of the phenomenon. Case study as a method can embrace complexities and differences. This is also why case study is suitable for this project, as it is a complex phenomenon that covers multiple governance levels and includes multiple actors and types of systems.

Case overview: climate reporting in a global governance context

The overall case selected for this thesis, in its study of the phenomenon of digital global governance, is international climate reporting under the UNFCCC framework. Both national governments and the EU report to the United Nations Framework Convention on Climate Change (UNFCCC). Global governance implies activities at different governance levels, and reporting under the UNFCCC framework includes activities at national, supranational, and global levels. Consequently, the role of information systems has been investigated at both national, supranational (the EU), and global levels. Implementation of the Paris Agreement (Paris Agreement, 2015) is primarily conducted at the national level, which makes the national level relevant. Moreover, the EU has the authority to implement supranational legislation and policies, which can strengthen the implementation of global policies. The EU in turn bases its reporting to the UNFCCC on reporting from EU member states. Three cases provided frames in which to investigate the roles of information systems in the reporting at different governance levels: 1) the climate reporting process from national to global level, 2) the United Nations climate reporting at the national level, and 3) the EU digital reporting platform Reportnet, representing a supranational governance level.

Global climate governance was established with the United Nations Framework Convention on Climate Change (UNFCCC) (United Nations Framework

Convention on Climate Change, 1992) and the following treaties, the Kyoto Protocol (Kyoto Protocol to the United Nations Framework Convention on Climate Change, 1997) and the Paris Agreement (Paris Agreement, 2015), built on that. This is the framework for the study representing the global level. The UNFCCC secretariat is the administrative office that manages the information reported to the UNFCCC and hosts the IT systems involved in the reporting at the global level (UNFCCC, 2022a). To study the implications of digital technologies in the reporting at the national level, Sweden was selected. It is a digitally advanced country and also a member state of the European Union (EU). Of practical reasons, it is also an advantage that I as a researcher speak the native language of the respondents. In the EU, the European Commission is responsible for the reports, and the European Environment Agency (EEA) administers the reporting from the EU member states. The reporting from EU member states to the EU serves two purposes; to compile the EU´s reports to the UNFCCC and to assess compliance with EU regulations. These are the settings for the cases, which will be described below, after a general overview of the climate governance framework.

The structure of the rest of this section is as follows: it begins with a description of the global climate governance framework and climate reporting frameworks at global, national, and supranational levels. Thereafter, the cases and method for the case studies are described.

Global climate governance framework

Historically, there have been three international treaties on climate change: the United Nations Framework Convention on Climate Change (UNFCCC) (often called the Climate Convention), the Kyoto Protocol, and the Paris Agreement. Reporting of greenhouse gas emissions and measures by countries have been a central part of all treaties.

The Climate Convention was adopted at the RIO Summit in 1992, and it entered into force in 1994. The objective of the Climate Convention was to stabilize greenhouse gas (GHG) concentrations at a level that would prevent dangerous interference with the climate system. The Convention established a system for measurement, reporting, and verification. This meant implementation of common methods to measure GHG emissions, reporting requirements, and

verification of reports through review. There are different reporting requirements for developed and developing countries. Developed countries should annually report GHG inventories and regularly register their climate change policies, measures, and projections. Developing countries should report on their emissions and actions, but not as often and stringently as developed countries (United Nations Framework Convention on Climate Change, 1992).

The Kyoto Protocol was adopted in 1997, but it was not until 2005 that it entered into force because of a complex ratification process. The Kyoto Protocol further operationalized the Climate Convention in limiting and reducing greenhouse gases. It set binding emission reduction targets for industrialized countries. The Kyoto Protocol also introduced market-based mechanisms, based on trading of emissions permits. The Kyoto Protocol established a rigorous system for monitoring, review, and verification, as well as compliance arrangements to ensure transparency and accountability. The Kyoto Protocol included stricter requirements in that countries had to establish national arrangements to monitor their emissions and keep accurate records of the trades of emissions permits. Registry systems to record transactions under the market mechanisms were established at the UNFCCC secretariat, which has verified that transactions are according to the rules of the Kyoto Protocol. The Kyoto Protocol required countries to report annual emission inventories and national reports, and a compliance system ensured that countries would meet their commitments (Kyoto Protocol to the United Nations Framework Convention on Climate Change, 1997).

The Paris Agreement was adopted in 2015 at COP21 in Paris and entered into force in 2016. The goal in the Paris Agreement is to limit global warming to well below 2°C, preferably 1.5°C, compared to pre-industrial levels (Paris Agreement, 2015). The Paris Agreement is a legally binding treaty, where countries are obliged to regularly report certain information to the UNFCCC, and to commit to a common cause of pursuing ambitious efforts. However, implementation is left for each country to decide on through individual measures. Countries make pledges as to what they aim to do, which is then followed up through reporting on measures. The Agreement operates on five-year cycles, where voluntary efforts should continuously increase (Jernnäs, 2023). Every fifth year, a *Global Stocktake (GST)* will evaluate collective progress towards the goals in the Paris Agreement and provide recommendations for further actions (Paris Agreement,

2015). The first Global Stocktake is being conducted between 2021-2023. There is no international body that decides what countries should do, or which imposes sanctions or penalties. What is emphasized is transparency and trust-building among parties to take sufficient action. The design of the Paris Agreement is in line with a broader trend in global environmental governance, oriented towards transparency, voluntary actions, polycentric network solutions and partnerships (Jernnäs, 2023).

The Enhanced Transparency Framework

The Paris Agreement has binding reporting requirements according to the 'Enhanced Transparency Framework' (ETF), which is further specified in the rulebook of the Paris Agreement (UNFCCC, 2018, 2022d; Paris Agreement, 2015). The ETF makes the actions countries conduct transparent with the intention to incentivize governments to continuously increase their commitments. The reporting builds on the arrangements established in the Climate Convention, but an important difference is that all countries should now report according to the same standards, although with flexibility for developing countries who need it. In the *Nationally Determined Contributions (NDC),* countries report on their goals and the actions they will take to reduce greenhouse gas emissions to achieve the goal in the Paris Agreement, both to mitigate and adapt to climate change. The *Long-term Strategy* expresses a country´s planned long-term efforts but is voluntary to report. According to the *Enhanced Transparency Framework (ETF)* countries must report the following: national inventories of GHG emissions; information to track progress in implementing their NDC; and actions taken, and progress made regarding climate change mitigation and adaptation. This is compiled according to the following reports:
- National Inventory Report (statistics of GHG emissions in a country)
- Nationally Determined Contribution (Commitments on national goals and efforts)
- Biennial Transparency Report (this includes reporting on measures, projections and scenarios, as well as tables to track progress) (UNFCCC, 2018).
- National Communication (describes the climate policy work in a country) (this reporting is regulated in the Climate Convention).

The Paris Agreement further includes a framework for financial, technological, and capacity building support, which also states that countries should report on

received or provided support. The ETF further includes procedures for international reviews of reports. The reports are then the basis of the analysis for the Global Stocktake (Paris Agreement, 2015).

The rulebook of the Paris Agreement states what information countries should report, at what time, in which format, and how the information should be reviewed to ensure its quality and reliability. The major parts of the rulebook were adopted at COP24 in Katowice 2018 (UNFCCC, 2018), and finalized at COP26 in Glasgow 2021 (UNFCCC, 2022d). Common reporting tables have been agreed on: GHG inventories; tracking progress of NDCs and climate finance, technology transfer and capacity building goals; biennial transparency report (BTR); and technical expert review reports. The reporting follows commitment periods, and the first Biennial Transparency Report under the Paris Agreement will be reported in 2024 (UNFCCC, 2018, 2021b). The Paris Agreement replaces the Kyoto Protocol, but the Climate Convention still applies. This means that countries will report both under the Climate Convention and the Paris Agreement. Reporting enables monitoring of emissions and actions taken by countries, which can be compared to a country´s plan as expressed in its NDC. At the global level, reports can be aggregated and collectively related to the goal in the Paris Agreement. Tracking of progress can thus be made for individual countries as well as collectively. Common methodologies for preparing and compiling the inventories of GHG emissions, standard reporting formats, and a standard for reviews, make the information comparable and possible to aggregate at the global level.

Review

Review by international experts verifies the reports according to certain criteria. This builds trust among countries and ensures that COP (the supreme decision-making body of the UNFCCC) has accurate information to assess the implementation of the climate treaties. The procedure for review relates to the reporting requirements for each climate treaty. There are different reviews for different types of reports. An important review is that of the GHG inventories, i.e., countries´ calculations of emissions. In 2003, review of the GHG Inventories became mandatory. This involved a more thorough review of inventories to provide COP with accurate and comprehensive assessments. The review of GHG inventories is conducted in two steps. First, an initial assessment is made by the UNFCCC secretariat where it is examined whether the report is consistent,

complete, in correct format and timely, and issues for further examination can be identified. Then, the reports are reviewed by expert reviewers regarding data, methodology, and procedures. A review report is created and published on the UNFCCC website. Three types of reviews can be made: desk reviews, centralized reviews, or in-country reviews. Expert reviewers are experts nominated by countries and intergovernmental organizations. The secretariat selects and coordinates expert reviewers. The review is also an important part in continuous learning and improvement of the reporting (UNFCCC, 2022e).

Institutional arrangements
The Conference of the Parties (COP) is the supreme governing body of the Climate Convention, which makes decisions and reviews implementation of the Convention and other legal instruments that the COP adopts. The COP also serves as the supreme governing body of the Kyoto Protocol (called Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol (CMP)), and the Paris Agreement (called Conference of the Parties serving as the meeting of the Parties to the Paris Agreement (CMA)). The states who are parties to the Paris Agreement are represented at CMA, while those who have not signed the Paris Agreement are observers. COP meetings are held annually.
Subsidiary bodies assist the governing bodies with scientific, technological, and methodological advice, and in assessment, they review and advise on the implementation of the Climate Convention, the Kyoto Protocol and the Paris Agreement (UNFCCC, 2022f).

The UNFCCC secretariat was established in 1992 when the UNFCCC was adopted. It is located in Bonn, Germany. The secretariat facilitates intergovernmental climate change negotiations, supports bodies within the UNFCCC framework that work with implementation of the climate treaties, and provides technical expertise and support in analysis and review of reports. The secretariat maintains systems for submission and preservation of reports, such as the registry for NDCs. The most important meeting that the secretariat facilitates is the annual COP meeting, but there are also annual meetings of the subsidiary bodies, and various meetings and workshops throughout the year. The secretariat also works with stakeholders, to encourage climate action from a broad range of actors. The secretariat publishes and communicates reports and relevant information through their website: www.unfccc.int and is present on social media (UNFCCC, 2022a).

National arrangements in the case of climate reporting in Sweden

The implementation of the Paris Agreement is primarily carried out at the national level. It is therefore relevant to study the implementation of reporting at the national level. Sweden was selected as an appropriate case as the country has actively worked on digitalization of public administration, and in 2018, Sweden adopted a climate policy framework. The framework includes climate goals, a climate act, and a climate policy council. The framework is a result of a national process, but it also supports the implementation of Sweden´s commitments under the Paris Agreement. The framework sets long-term goals on climate policy. Every fourth year, the serving government must adopt a climate policy action plan based on the climate goals and annually report to the Parliament on progress towards the goals, and climate policy and budget policy must be aligned. The climate policy council independently assesses how the government meets the climate goals in its overall policy and provides advice for further measures (Government Offices of Sweden, 2021; The Swedish Climate Act, 2017). Sweden has legislation regarding climate reporting, including which public agencies have the responsibility of providing data. The Environmental Protection Agency is responsible for compiling the reports, SMED (Swedish Environmental Emission Data) does the calculations and preparations of the annual GHG inventories (Government Offices of Sweden, 2019), and the Government Offices provide information on climate policy.

Supra-national arrangements in the case of climate reporting in the European Union (EU)

The EU represents a supranational governance level and reporting to the EU from EU member states serves two purposes: for the EU to assess compliance with EU regulation and for the EU to compile its reports to the UNFCCC (European Commission, 2022). The EU has implemented a digital reporting platform for environmental reporting called Reportnet. An enhanced version of Reportnet (Reportnet 3.0) has been developed to modernize reporting. It supports the implementation of both the climate and environment policy, the Green Deal, as well as the EU Digital Strategy. Reportnet is hosted by the European Environment Agency, which also coordinates climate reporting within the EU (European Union, 2021). The EU has adopted climate goals, stated in the Green Deal (European Commission, 2019), which is further legislated in the European

Climate Law (Regulation 2021/1119 ('European Climate Law')). How this should be shared between EU member states is legislated in the Regulation on binding annual greenhouse gas emission reductions (Regulation (EU) 2018/842). The reporting procedure is legislated through the Governance Regulation. The Governance Regulation states that EU member states should develop integrated energy and climate plans, which they report progress on. The reporting enables the European Commission to assess compliance of EU member states, evaluate progress, and to compile its reports to the UNFCCC (Regulation (EU) 2018/1999). The EU is a relevant case because it is at a supranational level with legal means for implementation of international agreements such as the Paris Agreement. The EU is also working on developing a digital single market among EU member states and has experience in digitalization across national borders. Reportnet also seems to be a digitally mature reporting platform which makes it an interesting case.

The next section will describe the data collection for the case studies, followed by a description of the data analysis.

Data collection

First, a plan for three different cases was made. Then, the data collection for each case followed a similar procedure, including: setting boundaries for the case; establishing what the setting and context include: purposefully selecting participants; developing an interview protocol and procedures for recordings; collecting the data; organizing and storing the data; and transcribing recorded audio data (Creswell & Creswell, 2018). This will be further described for each case.

Case study 1: ***The climate reporting process***
This case aimed to develop a deeper understanding of the reporting process from the national to global level, how digital technologies are used in this process, and how it can be understood from an information systems perspective. The outcome of this case study was a description of the reporting process and which IT artefacts were used in the process. Additionally, the sophistication of digital technologies is analyzed.

Regarding the scope of the case, it includes government reporting under the UNFCCC framework. Thus, other types of reporting were not studied, such as corporate reporting or municipal reporting, and not for political issues apart from climate change. The case was framed as the reporting process from national to global level, which included data collection at both the national and global levels. Thus, the parameters of this case study were the reporting process, governance level and geography, with data collection in one country (Sweden) to represent the national level of the reporting process, and the UNFCCC secretariat for the global level. One country representing the national level was considered sufficient, since the purpose was not to make any comparisons between countries, but rather to investigate a revelatory case in depth. Additionally, parameters were also related to the information value chain. The reporting process includes collection of information, compiling the report into the right format, and submitting the report, which is then reviewed, preserved, and disseminated. The information collected is in various forms and many sources are used. This research did not go into the creation-phase of this information but started at the collection phase. After the reports are published, they can be used by various actors, and this research did not investigate how external stakeholders are using the reports, except for the Swedish Climate Policy Council who assesses the Swedish government´s policies.

Before the interviews were conducted, a general understanding of the case and its context, including an understanding of the role of the reporting, what it means and how it is regulated, was gained by studying documents and websites. This informed the interview guide and identified which public administration bodies were relevant to contact for interviews. Respondents for interviews were purposefully selected based on their role related to the reporting. For the data collection in Sweden, appropriate organizations were contacted, and then the relevant experts at these organizations were contacted. During the interview process, respondents also suggested other people to contact, i.e., the snowball effect. Regarding the data collection for the global level, I was introduced by a climate policy researcher to relevant people at the UNFCCC secretariat, who could further guide me to people in relevant positions. There are a limited number of people working with the reporting, and the number of respondents was considered sufficient when relevant people had participated and provided insights on the topic, thus achieving saturation. The selection included people who work

with the reporting, review of reports, or management of reports, but not people lower in the data value chain (such as those producing national statistics), or external stakeholders.

Interviews were conducted with experts at the UNFCCC secretariat, an international expert, and an expert reviewer at the global level. For the national level, experts involved in the reporting and the global climate negotiations at the Environmental Protection Agency (EPA), SMED (Swedish Environmental Emission Data), and the Ministry of the Environment and Energy were interviewed. Additionally, interviews were performed with respondents from the Climate Policy Council and Panorama (which is a digital tool to visualize the climate transition in Sweden, owned by the EPA, the Climate policy council, and the Swedish Energy Agency). In total, eight people representing the global level, and twelve people representing the national level were interviewed, see Table F. Additionally, relevant documents related to the regulatory context in Sweden and globally have also been used, including the reporting regulation (Swedish Parliament, 2014), the climate policy framework (Government Offices of Sweden, Ministry of the Environment and Energy, 2018), and examples of climate reports from Sweden. For the global level, this included the Paris Agreement (United Nations, 2015), the COP protocol that contains the rulebook for reporting (UNFCCC, 2018), IPCC assessment report (IPCC, 2021c) and the UNFCCC website (www.unfccc.int).

Organizational body	Role of respondent
Swedish Environmental Protection Agency (EPA)	Project manager
EPA	Climate advisor
EPA	Senior advisor
Swedish Environmental Emissions Data (SMED)	Project manager for Sweden´s calculations of GHG emissions
EPA	Climate negotiator
EPA	Climate negotiator and legal expert
Government Offices Sweden, Ministry of the Environment and Energy	Ministry secretary
EPA	Climate analyst
EPA	Climate analyst
Panorama	Project manager
Swedish Climate Policy Council	Senior analyst

Government Offices Sweden, Ministry of the Environment and Energy, Sweden	Policy analyst
UNFCCC secretariat	Data and information expert
UNFCCC secretariat	GHG national inventory submissions expert
UNFCCC secretariat	Global Stocktake expert
UNFCCC secretariat	Global Stocktake expert
UNFCCC secretariat	Coordinator of technical analysis reports
Expert reviewer for the UNFCCC	Expert reviewer of climate reports
Anonymous	International expert
UNFCCC secretariat	Expert on national communications for developing countries

Table F. Respondents in case study 1.

The interviews for this case study were particularly asking for respondents´ experiences of the reporting, what is reported, what the reporting process looks like, which IT artefacts are used in the process, how they are used, and for what purpose, as well as contextual issues such as regulations and organizational arrangements. The general procedure for the interviews was the same for all three cases, which will be described below after the other case studies are presented.

Case study 2: *Affordances of IT artefacts and information in the UNFCCC reporting at national level in Sweden*

This case study aimed to investigate the relationship between the reporting, digital technologies used in the reporting, and governance at the national level. The study reveals the affordances national level IT artefacts (related to the reporting) and information in the UNFCCC reporting have, using Sweden as the case. Since implementation of international agreements is primarily carried out at the national level, it is relevant to understand the implications of the reporting at the national level, and what roles digital technologies have in such context.

The parameters of this case were geographic in terms of selection of country (Sweden). The unit of analysis was the role of IT artefacts and information in the UNFCCC reporting. Selection of respondents was also a parameter of the case. Public agencies and respondents working with conducting the reporting, policy development, international negotiation, and review were included, procedures in which the reporting information is potentially valuable, while external stakeholders were excluded. Interviews were conducted with experts involved in the reporting at the Environmental Protection Agency, SMED (Swedish

Environmental Emission Data), and the Ministry of the Environment and Energy, the Government Offices, the Climate Policy Council and Panorama. The Environmental Protection Agency is responsible for the reporting and provides the Government Offices with information, analysis, and policy suggestions. The Government Offices work with climate policies. The Climate Policy Council assesses government policies and provides advice to the government. External stakeholders were not included in this study. Selection of respondents was based on expertise related to the topic. In total, thirteen people were interviewed, see Table G.

Organizational body	Role of respondent
The Environmental Protection Agency (EPA)	Project manager
EPA	Climate analyst
EPA	Climate negotiator
EPA	Climate advisor
EPA	Senior advisor
EPA	Climate negotiator
EPA	Policy analyst
Government Offices Sweden	Information governance and system requirements specialist
Government Offices Sweden, Ministry of the environment and Energy	Ministry secretary
Government Offices Sweden, Ministry of the environment and Energy	Policy analyst
Climate Policy Council	Senior analyst
Climate Policy Council	Senior analyst
Panorama	Project manager

Table G. Respondents in case study 2

Interview questions for this case study focused particularly on what the reporting and the IT artefacts in the reporting enable, and how they support governance. Relevant documents related to the regulatory context in Sweden, as well as Sweden´s reports to the UNFCCC were also used to triangulate the researcher´s understanding of the case.

Case study 3: *Affordances of the digital EU reporting platform Reportnet*
This case study investigated the affordances of the digital EU reporting platform Reportnet, while taking into consideration that the EU is a supranational actor

that regulates EU member states, and that the EU has commitments to international climate agreements. Reportnet´s and the EU reporting´s roles are considered in relation to the assessment of EU member states´ compliance with EU regulations, as well as Reportnet's role in the EU´s international reporting. The outcome of this case study was identification and analysis of affordances of Reportnet in a supranational climate governance setting. The EU has been studied because of its unique role as a supranational body with legislative authority, which provides supranational means for global policy implementation.

Parameters for the case included: governance level (supranational EU level); a selection of respondents, which included participants from EU bodies involved in climate reporting and a selection of EU member states reporting to the EU; and the digital reporting platform Reportnet. The unit of analysis was Reportnet, and how it supports governance based on the information provided by the reporting. This case did not go into the compilation of reports but focused on the reporting in Reportnet and functions of Reportnet. Thus, the procedures used by EU member states to compile their reports were not included in this study.

Before the interviews were conducted, relevant websites and documents were studied to develop an understanding of reporting in the EU, including regulations and policies, and documentation on Reportnet. This informed the interview guide and which EU bodies to contact. Respondents for interviews were purposefully selected based on their role related to the reporting and EU climate governance.

Interviews were conducted with: an expert at the DG CLIMA unit at the European Commission administration; two experts at the European Environment Agency, which hosts the Reportnet and receives EU member states´ reports; reporters from 8 EU member states; and an expert reviewer. In total, twelve people were interviewed, see Table H.

Organizational body	Role of respondent
European Commission administration	Official from the European Commission working on climate policy
European Environment Agency (EEA)	Expert on Reportnet
European Environment Agency (EEA)	Expert on Reportnet
Swedish Environmental Protection Agency	Expert, reporting
Slovak Hydrometeorological Institute	Expert, reporting
Netherlands Enterprise Agency	Expert, reporting
Malta Resources Authority	Expert, reporting

Environment Administration Luxembourg	Expert, reporting
Environmental Protection Agency Ireland	Expert, reporting
Environment Agency of Iceland	Expert, reporting
Danish Ministry of Climate, Energy and Utilities	Expert, reporting
Expert reviewer	Expert reviewer for the EU

Table H. Respondents in case study 3

The relevant EU bodies were contacted by e-mail, who then responded with the contact details of appropriate experts. Even though there were few respondents from the EU administration, the experts were very competent in their subjects and could provide the information necessary to reach saturation.

To gain insights from the perspective of those who report through Reportnet, a selection of reporting experts in EU member states was included. Relevant organizations in EU member states were identified by searching on the internet, and subsequently contacted via e-mail. Those who responded and agreed to participate in an interview were then interviewed.

The selection of respondents was comprised of people who worked with Reportnet (at the European Environment Agency), expert review of reports, climate policy (at the European Commission administration), or reporting from EU member states, but not external stakeholders. Relevant documents have been studied to understand the regulatory and strategic context in the EU related to climate policy, climate reporting, and digital strategy, including the Green Deal, laws (such as the Climate Law (Regulation (EU) 2021/1119), the Governance Regulation (Regulation (EU) 2018/1999) and the regulation on binding annual greenhouse gas emission reductions (Regulation (EU) 2018/842), the EU Digital strategy (European Commission, 2018), the European Strategy for Data (European Commission, 2020), and the Business Vision for Reportnet (Kampa, 2018).

Questions in the interviews focused on how the reporting and Reportnet supports governance, what Reportnet enables, as well as challenges and further possibilities.

Interviews

The interviews in all three case studies were semi-structured. This means that they are not fully open, such as unstructured interviews, and they are not as

strictly specific as structured interviews are. Semi-structured interviews typically have an interview guide with quite broad questions that allow for the participants to formulate their concerns, while also ensuring that the discussion stays on a pre-determined subject. Semi-structured interviews are flexible, which enables us to adapt interview questions to each respondent and to gain a more in-depth understanding (Williamson, 2013). This is appropriate in interpretive research, as the aim is to gain understanding of the participants´ views. The interviews were more explorative in the beginning, and then more focused as more knowledge was gained. Interview protocols including themes for interview questions have guided the interviews, but there has also been an openness to what the respondents have highlighted. This has ensured that information that is relevant to the project has been collected, but it has also allowed participants to raise issues that concern them, and which might not have been considered beforehand by the researcher. Interview guides were also adapted to each respondent´s role related to the reporting.

Due to the pandemic and travel restrictions, interviews were carried out online via zoom or teams. Both zoom and teams have functionalities for recording, which were utilized. All interviews conducted on zoom and teams were recorded. Three respondents were interviewed by telephone and did not want to be recorded, and in that case, notes were taken. With the exception of two shorter interviews that lasted about 20 minutes, each interview lasted between 50-65 minutes, and some respondents were asked follow-up questions by e-mail or telephone. One of the EEA experts (in case three) was asked questions by email, and in that case, the email was included as an interview transcript. Recorded interviews were transcribed. Transcripts were anonymized and a scramble key was used to keep track of who was the participant in each transcript.

Ethical considerations related to interviews
Interviewing people for a research study includes some ethical issues to consider. Walsham (2004) highlights some of those considerations. It is important that the participants in interviews can trust the researcher´s statements on confidentiality, that they understand the agenda, and that it is honest and truthful.

Other ethical issues that may arise include the possibility of gaps in understanding of the researcher´s agenda and what is communicated to participants. There can be conceptual misunderstandings, topics can sometimes be implicit or difficult to grasp, which sensitizes the interpretation of the

researcher (Walsham, 2004). The procedure at the University of Agder for interviews is to first apply to the Norwegian Centre for Research Data, which handles data protection matters. This includes having a procedure for the management of the personal data of respondents and that a form is sent out to respondents to approve how their data will be managed. In this project, the respondents were sent a form with information about the project, and they could select whether they would approve to participate in an interview, whether their contact details could be stored after the project was finished in case of follow-up projects, and how they would like their professional role to be articulated in publications. A scramble key was used to ensure the safety of the respondents´ privacy. The project was approved by the Norwegian Centre for Research Data. In the interviews, it was also explained to participants how the interview data would be used. Another aspect was to be respectful of the participants´ time, thus the interviews were well-prepared.

Furthermore, it is important that the voice of the participants is highlighted and that participants are neither silenced nor marginalized. Trust and reciprocity between researcher and respondents are crucial to attend to, and that the researcher is responsive to the needs of their field (Creswell & Creswell, 2018). A challenge here is the limitation of how much space there is for including content from the interviews in the publications. By using quotes from the interviews, the voices of the respondents are highlighted. The respondents have also had the possibility to read drafts of the results and provide feedback before publication. This has both served as quality assurance to ensure that there are no misunderstandings and is also respectful towards the participants who have had the possibility to correct sensitive matters. In the context of global governance, it is important to take precautions to ensure diplomatic integrity.

Triangulation

In case study research, multiple sources for data collection strengthen the credibility of outcomes and enable different interpretations to be included in the analysis (Shanks & Bekmamedova, 2013).
In this research project, interviews have been the primary source of the empirical material and have provided insights from the participants. Documents have been used as a source to understand the phenomenon and the governance context. They have provided important contextual information and an official view of the

phenomenon, with details on, for example, regulations, strategies, and decisions. Together, the interviews and documents have enriched the understanding of the case. It has enabled triangulation where documents have confirmed what respondents have said, and respondents have explained and clarified elements in documents. Because there is limited space in research publications, a deeper account based on the documents has not been made, but the interviews have been prioritized as the primary empirical material.

Documents that have been used are legal acts, decisions, policy documents, reporting standards and guidelines, strategy documents, the business vision of Reportnet, information about reporting on the UNFCCC, EU and Swedish websites, and climate reports from Sweden to the UNFCCC. Documents have been available online, on the websites of the public authorities of UNFCCC, the EU and Sweden. A structure to store empirical data (including interview recordings and notes, and documents) was created for each case.

Feedback on ongoing research

Except the interviews that provided data for the publications, ongoing research was presented and discussed at a meeting at the Swedish Ministry of Environment and Energy, Government Offices of Sweden. This enabled relevant feedback on the findings and input for ongoing work.

Data analysis

Data analysis included organizing and categorizing collected data in a systematic way, analyzing, and making sense of data, identifying and interpreting patterns that emerge from the data, and theorizing the findings (Kirsty Williamson, Given, & Scifleet, 2013).

Analysis of data begins initially with the data collection, as certain patterns and things are noticed during the interviews, and while transcription of interviews is made. However, there are some general steps suggested by Creswell & Creswell (2018) that were followed for the data analysis. First, the data was organized, notes were written up and interviews transcribed. The material was read to get an overview, followed by a more in-depth study of the data through coding and generating of themes (Creswell & Creswell, 2018). The description of the

interpretative process by Crist & Tanner (2003) has also provided some guidance. They suggest that first, inclusion criteria are formulated for selection of the sample. Then, interpretation begins concurrently as the data collection begins and continues throughout the process. As more interviews are carried out, and literature read, understanding grows as a circular process, where new insights inform the next interview, which provides additional meaning, and so forth. Key themes and meanings are identified, and texts are often written and re-written multiple times, as additional understanding, connections, and relations within the data emerge from analysis in several phases. When research is then presented and published, readers will form their interpretations (Crist & Tanner, 2003). In this research project, the selection of samples was made as discussed above. Reflections were made throughout the process; during interviews, transcribing, coding, analysis, and writing and re-writing of the text. A growing understanding informed further questioning in subsequent interviews, and the knowledge built up throughout the process according to a hermeneutic approach.

Thematic coding and analysis

To analyze the interviews, transcripts were coded according to themes that were identified. Thematic coding and analysis are an appropriate data analysis technique in research with an interpretive approach that aims to create a deeper understanding. It is an inductive approach, as themes emerge during the interaction with the data. The understanding of the phenomenon increases as connections within the data and thematic patterns are identified. Identification of those kinds of linkages are thus significant in the analytical process. The interaction with the data included immersing oneself in the data, asking questions, relate it to theory and make reflections related to the research questions (Williamson et al., 2013).

The interview transcripts were coded inductively, where codes and themes emerged based on an interpretation of the data. For the first case of the reporting process, the intention was primarily to identify the process and which IT artefacts were used throughout the process. When that was done, a theoretical lens was selected to provide more depth to the analysis. In the second case of reporting in Sweden, questions were asked regarding how the IT artefacts in the reporting process contributed to governance. Affordance theory was identified as an

appropriate analytical lens during the coding as that reveals action possibilities. For the EU case, there was an intention from the beginning to use affordance theory, which was thus considered during the coding. In the coding of this material, questions were asked, for instance, concerning what affordances that could be identified. Nvivo12 was used in the coding of interview transcripts and organization of codes into themes. First, a preliminary coding of the interviews was conducted, and based on that, themes were identified. Then the themes were reviewed, and aggregated or revised, with which the material was coded a second time. Reflection was an integrated part of the process, for example what codes were chosen, how they were related, and how the case could be understood through the lens of the theory.

3.2.3 Conceptual paper

The fifth paper in the thesis (Engvall et al., 2022) is a conceptual paper. The paper has the form of a research note. Research notes typically aim to advance new ideas, theoretical perspectives or, as in our case, a research agenda, and usually do not follow a strict research method. Quality criteria are rhetoric and polemic clarity. The primary objective of research notes is not to justify a certain theoretical approach, but to provoke new ideas (Scandinavian Journal of Management, 2012). A conceptual paper typically links theoretical perspectives and concepts in literature. The objective is to offer new or to bridge perspectives. It neither builds on empirical data, nor reviews extant literature, but uses a selection of literature (Gilson & Goldberg, 2015). Additionally, the paper (Engvall et al., 2022) has a hermeneutic approach. The hermeneutic approach acknowledges that the researcher accumulates knowledge throughout a research process. Based on the empirical investigations and literature reviews, insights concerning the role of reporting as well as digital governance had been acquired, which informed the discussion in this paper.

In the paper (Engvall et al., 2022), research on online communities (OC) is used to relate climate reporting to global governance activities in a digital global governance context. The OC framework of three levels of online interaction including information sharing, cooperation, and collective action (Shirky, 2008), is used as a conceptual framework to formulate and structure research questions regarding the use of digital technologies in the process of the Global Stocktake.

The Global Stocktake is conducted every fifth year to evaluate progress towards the goals in the Paris Agreement and inform further decision-making (Paris Agreement, 2015). The Global Stocktake has three phases: information collection and synthetization, technical assessment, and negotiation and adoption of a declaration (UNFCCC, 2022b). The information used for evaluation in the Global Stocktake is the information reported by countries (UNFCCC, 2018). Thus, the reporting investigated in the case studies in this thesis is the basis for a global aggregation and synthetization of information to evaluate progress towards the Paris Agreement. The paper thereby relates climate reporting to global governance activities and interaction and identifies areas for further investigation.

In Section 5.3 in this thesis, further development of digital global climate governance is discussed based on the research agenda in this conceptual paper (Engvall et al., 2022), along with findings from the case studies (Engvall, 2021; Engvall & Flak, 2022a, 2022c) and the conceptual framework of the thesis. The research agenda provides a structure for different levels of digital governance, through the classification of information sharing, cooperation, and collective action. The case studies identify areas of improvement. The theoretical framework provides a theoretical basis and approach to further development of digital global governance.

3.3 Quality in interpretive qualitative research

Different criteria are used to evaluate the quality of research. In qualitative research, there has been discussion regarding whether it is appropriate to use the same concepts as in quantitative research. Some scholars argue for a translation of the terms to the qualitative context while other scholars prefer other concepts, and various terms have been suggested (Creswell & Creswell, 2018). However, it is important that the quality criteria are considered in relation to the particular research approach that is applied.

3.3.1 Quality criteria in interpretive case study

This research has an interpretive hermeneutic approach, and the empirical work is based on interpretive case study method. Thus, the principles for evaluating interpretive field research in information systems as outlined by Klein & Myers (1999) are particularly considered. Based on a hermeneutic approach, Klein & Myers (1999) suggest that the quality of interpretive field research can be assessed according to 7 principles. The *first principle* is the notion that understanding is gained by the iteration between parts and the whole of the phenomenon. The *second principle* is contextualization, where the social and historical context of the phenomenon is critically reflected upon, to understand the current situation. The *third principle* concerns the relation between the researcher and participants, and how the data collected has been constructed in this interaction. The *fourth principle* concerns how the interpretation is related to theoretical concepts to create further understanding. The *fifth principle* considers possible contradictions between the theoretical framework guiding the research and actual findings. The *sixth principle* includes reflections regarding interpretive differences among participants. The *seventh principle* addresses possible biases among participants (Klein & Myers, 1999).

In this thesis, the first principle suggested above is achieved by a continuous iteration between parts and the whole throughout the project. This includes acquiring an overall understanding of the role of reporting in a governance context, as well as going into questions concerning how particular IT artefacts are used, and relating those to each other, as well as relating the different studies to each other and how they contribute to the overall research objective. The second principle has been achieved through, for example, reading policy

documents, asking broader questions, and having conversations with researchers and negotiators in climate policy. Regarding the third principle, the respondents have had the possibility to read the interview sections in drafts of papers and provide feedback. Some of the respondents have been consulted additionally with follow-up calls or emails for clarifications or additional questions. Thereby, misunderstandings or sensitive overstepping have been avoided. Regarding the fourth principle, different theoretical lenses have been applied to analyze the data. If other theories had been applied, it would have highlighted other aspects. However, the theories selected were considered appropriate for the research objective. Limitations of the theoretical approaches will be discussed in Section 3.4 Limitations and challenges. The fifth principle, concerning possible contradictions between theoretical framework guiding the research and actual findings, has not appeared to be a problem in this research. The theoretical frameworks have been selected during the empirical analysis according to what was considered appropriate when interpreting the data. The sixth principle includes reflections on differences between respondents´ views. A contradiction was found revealing that reporters in EU member states could have a slightly different view of the changes implemented with Reportnet 3.0. Some thought that the automated quality controls were cumbersome, while others thought that they were very good. Principle seven concerns possible bias among participants. The main point here, I think, is that people involved in the reporting process and the international climate policy context have certain beliefs about what it will bring about. The risk is that there is an overly positive belief that is communicated in this research. Therefore, it is important to further investigate what conditions are required to fully actualize the possibilities raised, and approaches that conduct critical analysis of more narrow cases are welcome.

Rigor and relevance

In qualitative research, key criteria are rigor and relevance. Well-grounded practices, consistency and coherence contribute to rigorous research.

Well-grounded research means that the results are justifiable. This is strengthened by using trustworthy data, applying triangulation to confirm understanding, confirming findings with respondents, applying self-criticality and reflexivity. Triangulation means to use various sources of data, methods, and theories to corroborate findings in the development of understanding. The use of quotes

from the interviews will also strengthen the claims (Creswell & Creswell, 2018) and the chain of evidence (Williamson, 2013). Triangulation has been applied by using both interviews and documents and asking questions of respondents from different organizations and governance levels. Appropriateness and purposefulness are key aspects to consider for well-grounded qualitative research. This is ensured using appropriate methods, empirical material, and analysis techniques, and coordinating a purposeful sampling for interviews, which means interviewing people that can provide relevant insights into the matter in question (Leung, 2015). In essence, a key aspect that is relevant in qualitative research is whether the understanding developed by the researcher in the field is an accurate account of the phenomenon (Creswell & Creswell, 2018). This has been ensured by purposefully selecting respondents that have appropriate expertise, confirming my understanding of some aspects with respondents, asking the respondents for feedback on drafts, including quotes in publications, and continuously reflecting.

Consistency means that there is consistency throughout the research process (Leung, 2015), which strengthens the confidence in the results that the research develops. What strengthens consistency is recording and transcription or taking thorough notes during interviews. In that way, it is possible to go back to the data, and the traceability of results is ensured. The use of computer programs in coding and analysis of data can also strengthen traceability. Sending drafts of findings to respondents, which they can then comment on, strengthens the results and follow-up questions or interviews can be made to clarify what has previously been said or complement findings (Creswell & Creswell, 2018). In all case studies, interviews were recorded and transcribed, which made it possible to read and re-read them many times. Nvivo was used in the coding process, which also allowed for various alternatives and possible returns to previous versions of coding. If there were issues in an interview that were either unclear or raised new questions, follow-up questions were asked to the respondent in the interview.

Internal coherence means that there is a coherence between the parts in the thesis, including research question, ontological and epistemological approach, and quality criteria (Sarker et al., 2013). This has been considered in the design of the research project and each study, as well as throughout the research process, from formulation of research question, choice of method, data collection and analysis, and when deriving results and conclusions.

Relevance includes three aspects: relevance to the discipline, relevance of methodology, and practical relevance. In the information systems field, *relevance to the discipline* means that sociotechnical interactions have a significant role in the research conducted. *Relevance of methodology* means that the method chosen is appropriate for the research question. *Practical relevance* means that the research is not distanced from reality but engages with the practice (Sarker et al., 2013). This research project addresses sociotechnical interactions in a governance setting. The method is considered appropriate for the objectives of this research – to develop greater understanding of the phenomenon of digital global governance and how digital technologies support global governance policy implementation. Through the interviews in the case studies, the research engages with practice. The project further addresses a critical societal challenge and aims to develop greater understanding of how information systems can be part of the solution, and thus has a practical relevance.

Generalizability of the findings

Another aspect to consider relates to the generalizability of the findings, i.e., how the findings can be applied further. Four types of generalizations can be made from qualitative data: development of concepts, generation of theory, drawing on specific implications, and contribution of rich insights (Walsham, 1995).

This thesis makes a conceptual and theoretical contribution. Conceptually, the thesis proposes definitions of the concepts 'digital governance', 'digital global governance' and 'global governance information infrastructure'. The thesis theorizes how information systems support global governance. A conceptual model of global governance information infrastructure (GGII) is developed, which illustrates the relationship between information infrastructure and global governance. Specific implications can be drawn from the findings of the case studies, which may be relevant to global governance of other topics as well, such as how digital technologies are used in reporting processes, challenges in management of large volumes of information in international organizations and the challenge of making information meaningful to stakeholders in a governance setting. The findings further provide rich insights on the topic of international climate reporting.

3.3.2 Quality of concepts

To ensure the quality of conceptualizations, the criteria by Alter (2008) and Järvelin & Wilson (2003) for evaluating conceptual models serve as guidance. These criteria are *simplicity, clarity, scope, systematic power, explanatory power, validity, reliability,* and *fruitfulness.*

Simplicity means the use of uncomplicated definitions which are kept simple. Simpler is better (Alter, 2008; Järvelin & Wilson, 2003).

Clarity denotes the utilization of clear and explicit concepts (Alter, 2008).

Scope means that the definition covers the scope of the area of interest and does not overlook relevant issues (Alter, 2008). According to Järvelin & Wilson (2003), a broader scope is preferable since it subsumes narrower ones.

Systematic power refers to that the definitions should assist in organizing concepts, relationships and data in meaningful ways (Alter, 2008; Järvelin & Wilson, 2003).

Explanatory power implies that definitions should help to explain and predict phenomena (Alter, 2008; Järvelin & Wilson, 2003).

Validity signifies that the definitions should provide valid representations and findings (Alter, 2008; Järvelin & Wilson, 2003).

Reliability means that definitions should provide valid representations and relatively similar understandings when applied to different situations (Alter, 2008; Järvelin & Wilson, 2003).

Fruitfulness indicates that definitions should provoke relevant research questions and assist in answering such questions (Alter, 2008; Järvelin & Wilson, 2003).

Referring to the criteria above, the primary objective has been to capture the meaning of the phenomenon, i.e., provide valid representations (*validity*). The *reliability* of the concepts and definitions can be evaluated through applying the concepts and definitions in other contexts, which is suggested for future research. However, reliability has been considered by taking a broad *scope,* and thereby being inclusive of various representations of the concepts. For instance, digital global governance has a high level of abstraction, which suggests that it may manifest differently in different governance areas. There has been an emphasis on not only defining concepts, but also relating concepts to each other, such as 'digital' and 'governance', 'digital governance' and 'global governance', and 'information infrastructure' and 'global governance', and to theorize empirical

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data in regard to those concepts and definitions. Thus, systematizing concepts, relationships, and data in a meaningful way (*systematic power*) has been central in the thesis. The literature has provided theoretical understanding, and the empirical cases illustrate the relationships between concepts. Moreover, the GGII model was developed based on literature, and was validated and further refined based on empirical findings. The objective has not been to develop theoretical models for predictions (*explanatory power*). Regarding *fruitfulness*, the conceptual foundation developed in the thesis has both served to answer the research questions, as well as to provoke further research. The conceptualizations developed in the thesis are central in answering research question "1) what is digital global governance?". The conceptual foundation is further imperative in answering research question "2) How do information systems support global climate governance?" by providing a conceptual framework for theorizing the findings from the case studies. Chapter 5.3 responds to research question "3) How can digital global climate governance be enhanced?" by suggesting pathways for further enhancements of the GGII, based on the conceptual foundation and the fifth publication, and is thus a helpful tool for inspiring future development and research. In general, the objective has been to suggest concepts and definitions that are simple (*simplicity)* and clear (*clarity*).

3.4 Challenges and limitations

Challenges and limitations of this research project will be discussed both in relation to the empirical investigations and the conceptual framework.

3.4.1 Challenges and limitations regarding the empirical investigations

The case studies have investigated a particular global governance process and structure (climate reporting), related to a particular societal challenge (climate change). This provides empirical insights that highlight aspects in this setting. Such insights may be applicable in other international reporting situations, such as those concerning challenges with managing and making sense of large volumes of information. However, different policy issues will have different approaches in governance. Climate governance is different from, for example, security governance. The governance structures and processes are different for different policy issues, and the role of digital technologies will consequently be different. It would thus be relevant to test the GGII model in different global governance contexts that handle other societal challenges. However, I posit that the conceptualizations of digital global governance and global governance information infrastructure, as well as the GGII model are on an abstraction level that works for various governance areas. In some sense, there will be an information exchange between the different governance levels, although the application of the model might materialize in different ways. One aspect that will differ concerns who has access to what information and who is expected to act. In the case of climate governance, a broad stakeholder engagement is emphasized, while, for example, it will be more restricted in security governance.

3.4.2 Challenges and limitations regarding the conceptual framework

A challenge in the conceptual part of the thesis is that there is little conceptual coherence in the literature. For example, multiple concepts such as eGovernance, eGovernment, digital governance and digital government occur. Various definitions of governance and global governance also make the task of understanding the phenomenon of digital governance and digital global governance challenging. In this thesis, various definitions have informed the understanding of what governance and global governance entail and have been

considered complementary rather than contradictory. Moreover, incoherence between literature in the digital governance field and the governance field adds additional challenges. As this thesis is not a political science or international relations thesis, but an information systems thesis, the focus is on the information systems and digital governance literature, while the literature on governance and global governance is used to deepen the understanding of the setting that digitalization operates within. However, despite some inconsistencies, the field of digital governance benefits from contributions from the literature on governance and global governance to clarify concepts and provide a deeper theoretical understanding of the digital governance environment.

The lens of information infrastructure has been considered useful to theorize the sociotechnical system supporting climate reporting, and to guide further development of digital global climate governance.

The use of affordance theory has been useful in identifying how digital technologies support governance, but it has not elucidated to what extent affordances have been actualized, and what level of impact this has had. A further analysis of facilitating conditions could deepen the understanding of what conditions facilitate the actualization of proposed affordances. One suggestion is also to complement affordance theory with a framework that can help to reveal to what extent affordances are actualized and what the impact of actualized affordances are.

4. Findings

This chapter summarizes the publications, key findings, and contributions to the overarching research objective from each of the five studies in this thesis.

4.1 Summary of publications

This doctoral thesis is based on five studies on digital governance, of which four are in a global governance context. Each study is published in a peer-reviewed book, conference proceeding, or scientific journal within the digital governance field. Table I. offers an overview of the publications and a summary of findings:

	Research publication	Summary of findings	Type of study
1	Engvall, T. & Flak, L.S. (2022b). Digital governance as a scientific concept. In: *Scientific Foundations of Digital Governance and Transformation. Concepts, Approaches and Challenges* (Eds. Charalabidis, Flak & Viale Pereira). Springer	Develops understanding of the meaning of digital governance and provides a definition of the concept of 'digital governance'.	Literature review Conceptual contribution
2	Engvall, T.S. & Flak, L.S. (2022c). The state of information infrastructure for global climate governance. *Transforming Government: People, Process and Policy, vol. 16*(4), pp. 436-448	Conceptualizes the IS that enables the climate reporting as an information infrastructure. Uncovers elements of the climate reporting information infrastructure. Describes the reporting process, which IT artefacts are used and what roles they have in the process, and how advanced the use of digital technologies is.	Empirical study
3	Engvall, T. (2021). Exploring the impact of digital global governance through affordance theory: the case of climate reporting. *EGOV-CeDEM-ePart conference*, 7-	Identifies and discusses affordances of the IT artefacts in the climate reporting II at the national level, related to global governance policy implementation.	Empirical study

	9 September 2021, Granada, Spain		
4	Engvall, T. & Flak, L.S. (2022a). Affordances of e-reporting on a supranational level: the case of Reportnet. *EGOV-CeDEM-ePart conference*, 6-8 September, Linköping, Sweden	Identifies and discusses affordances of the EU reporting platform Reportnet, in the context of global governance policy implementation at a supranational level. Situates reporting in the digital governance field through literature on e-reporting.	Empirical study
5	Engvall, T., Flak, L.S. & Sæbø, Ø. (2022) Sharing, Cooperation or Collective Action? A Research Agenda for Online Interaction in Digital Global Governance. *EGOV-CeDEM-ePart conference*, 6-8 September, Linköping, Sweden	Develops a research agenda for online interaction in digital global governance. The paper contextualizes the role of reporting information in a broader context of stakeholder interaction in global governance, using the example of the Global Stocktake in global climate governance.	Conceptual paper Research agenda

Table I. Publications in the thesis and their contributions

Below, a summary of the findings from each publication and their contribution to the research questions of this thesis is presented.

4.1.1 Digital governance as a scientific concept

Engvall, T. & Flak, L.S. (2022b). Digital governance as a scientific concept. In: *Scientific Foundations of Digital Governance and Transformation. Concepts, Approaches and Challenges* (Eds. Charalabidis, Flak & Viale Pereira). Springer

This publication contributes to RQ1: '*What is digital global governance?'* through an investigation of the meaning of digital governance, which is used as a basis for the conceptualization of digital global governance.

The publication (Engvall & Flak, 2022b), which was published as a chapter in the book "Scientific Foundations of Digital Governance and Transformation" (Charalabidis, Skiftenes Flak, & Viale Pereira, 2022), is based on a literature review focused on the meaning of digital governance as a scientific concept. The literature review covers both the concepts of eGovernance (electronic

governance) and digital governance. Digital governance can be viewed as an evolution of eGovernance (Misuraca & Viscusi, 2014), therefore both concepts were relevant to include. Since the concept of eGovernance has been used for a longer time compared to digital governance, it is also more prevalent in the literature. Results of the analysis revealed that definitions and descriptions view eGovernance as

1) the use of ICT in governance/government services, and/or

2) outcomes of eGovernance as transformations (e.g., service improvements, or transformation in structures, processes, or interaction with stakeholders).

The literature review unpacked the concept of eGovernance, by reviewing how the 'governance' and the digital aspect of eGovernance are described in the digital governance literature. The study finds that theorization of both 'governance' and 'the digital' was rather shallow. In order to understand and theorize the role of digital technologies in governance, as well as to understand how they can support governance objectives, it is imperative to have a better understanding of both governance and digital technologies.

A common underlying assumption in the selected literature is that the use of digital technology enables a transformation to achieve some desired outcome. Outcomes are classified into two broad categories of structural and normative aspects of governance. Structural aspects are about how structures, processes, exercise of authority, communication, and more, are designed and conducted. Normative aspects are about values and qualities of governance, which governance intends to enable or deliver (Bannister & Connolly, 2012). The structural transformations that were identified in the literature related to service delivery; regulation; policymaking; governance mechanisms; relationships, interaction, and participation of stakeholders; coordination; and decision making. The normative transformations emphasized in the literature were related to efficiency, transparency, accountability, participation, effectiveness, responsiveness, democracy, good governance, SMART governance, and economic development.

No significant difference between the concepts of eGovernance and digital governance were found, except that 'digital governance' has more emphasis on digital capabilities and utilization of advanced forms of digital technologies (Kang & Wang, 2018), and accentuates the transformative impact of digital technologies (Barbosa, 2017).

The literature review revealed that there was no coherent definition of either 'eGovernance' or 'digital governance'. Based on the understanding that emerged from the literature review of the concepts of digital governance and eGovernance, we proposed the following definition of digital governance.

> "*Digital governance* is defined as digital technology ingrained in structures or processes of governance and their reciprocal relationships with governance objectives and normative values. Digital governance includes the utilization of digital capabilities and involves a transformation of structures, processes or normative values" (Engvall & Flak, 2022b, p. 44).

The literature review further concludes that the literature communicates a very positive view of digital governance and more critical approaches are needed, as well as investigations on what conditions are needed to actualize suggested benefits.

In summary, this literature review provides a deeper understanding of the meaning of digital governance, which has been used as a basis for the conceptualization of digital global governance.

The main contributions from this publication are:

- Definition of 'digital governance'
- In-depth understanding of the meaning of digital governance
- Understanding of which structural and normative transformations digital governance is perceived to potentially bring about

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4.1.2 The state of information infrastructure for global climate governance

Engvall, T.S. & Flak, L.S. (2022c). The state of information infrastructure for global climate governance. *Transforming Government: People, Process and Policy. vol. 16(4)*, pp. 436-448

This publication responds to *RQ2: How do information systems support global climate governance?*

The key contribution of this article is the understanding of the roles digital technologies have in the reporting process, and conceptualization of the information systems in climate reporting as an information infrastructure.

The article describes the reporting process and which IT artefacts are used in reporting at the national level, with Sweden as a case, and internationally at the United Nations Framework Convention on Climate Change (UNFCCC) secretariat. The article uses 'information infrastructure' as a theoretical lens to conceptualize the reporting. The article uncovers elements of the information infrastructure relevant to international climate reporting and discusses the level of sophistication of the types of systems used.

The reports contain information about a country's emissions, and its government's pledges, measures, and achievements. On a global level, aggregated reports provide a global summary of progress towards the goal in the Paris Agreement which informs further decision-making in the UNFCCC process. The reporting provides a common, reliable source of verified information for global governance of climate change. Different IT artefacts are used throughout the reporting process to manage this information; to gather information and compile reports in the right format, to control information quality, to make calculations, to make scenario analyses, to submit reports, and to disseminate reports. Table J. summarizes the findings presented in the article on what IT artefacts are used for each report and how they are used, at national and global levels.

Report	IT artefact	Use	Level
GHG inventory	TPS (Technical Production System)	Collect, store and structure information in the right format	National
	Office programs	Compile reports	National
	Quality Controls	Verify that information is in accordance with the TACCC criteria (Transparency, Accuracy, Completeness, Comparability and Consistency)	National & international
	CRF Reporter	Submission portal at the UNFCCC secretariat where countries submit their GHG inventories	International
	Data warehouse	Storage of GHG inventories	International
	iVTR	Review platform for the review process, and communication between reviewer and country under review	International
	Control of outliers	Quality control of GHG inventories, that information is reasonable, identify outliers	International
	UNFCCC website	Disseminate reports Tools to visualize data	International
National Communication & Biennial Reports	Digital models	Analyze complex relationships, scenarios, and impact assessments	National
	Office programs	Compile report	National
	National Reports Submissions Portal (NRSP)	Submission portal at the UNFCCC secretariat where countries submit NCs and BRs	International
	Review platform	Review platform for the review process, and for communication between reviewer and country under review	International
Nationally Determined Contributions (NDC)	NDC Register	Storage of NDCs	International
All reports	UNFCCC website	Disseminate reports	International

Table J. IT artefacts used in the reporting process, for different reports, and at national and international levels.

An Information Infrastructure (II) consists of various elements, including technology, information, standards, organizations, and people, and is embedded in social structures (Hanseth & Monteiro, 1998). The elements of the climate reporting II are presented in Table K. This is also the installed base of the climate reporting information infrastructure.

Element of II	National level	International level
IT artefacts	Office programs TPS (Technical Production System) Digital models	*For annual GHG inventories:* Submission portal Data warehouse *For NCs and BRs:* Submission portal Records management system NDC register Review platforms UNFCCC website
Information	According to reporting requirements – GHG emissions – Climate action commitments (NDC) – Measures and projections Multiple sources of information input for the reporting	National reports Global synthesis reports
Standards	Reporting formats UNFCCC reporting guidelines IPCC methodology standard	CRF Reporter Reporting formats
Organizations	Environmental Protection Agency (EPA) Swedish environmental emission data (SMED) Public Agencies submitting data Ministry of the Environment Government & Parliament	UNFCCC Secretariat Conference of the Parties (COP) (the decision-making body of the climate convention) and CMA (Meeting of the Parties under the Paris Agreement)
People	Public Administration personnel Politicians	Personnel at the UNFCCC secretariat Government delegations at COP
Social structures	National and international governance frameworks – National legislation and	Governance framework at international level Climate Convention

	administrative arrangements – International negotiation of requirements and COP decisions – EU requirements	Paris Agreement COP and CMA processes and decisions

Table K. Elements of the climate reporting information infrastructure (Engvall & Flak, 2022c)

Although some examples are found of more advanced functions at the national level (such as digital models for scenario analysis and impact assessments), the article concludes that the information infrastructure is generally at a basic level. It is primarily comparable to a *transaction processing system*, with the aim to collect, verify, store, and share information. More advanced functions are called for, which resembles a *management information system*, with capabilities to process and link information and make comparisons with organizational goals, and a *decision support system*, which has more advanced functions to analyze and present information and support decision-making, according to the types outlined by Hendrick (1994). This is particularly requested at the global level, with new demands under the Paris Agreement for global synthetization and analysis of progress related to the goals in the Paris Agreement. However, some external initiatives at both national and international levels have been found which use the information for more analytical purposes, and which could also be considered as an extension of the information infrastructure.

This publication contributes to the overall *research question 2 on how information systems support global climate governance* by uncovering the tasks of digital technologies in the reporting process. The article conceptualizes the IS enabling climate reporting as an information infrastructure, which in the thesis is used as the theoretical basis to explain the relationship between information systems and global governance.

The main contributions from this publication are that it:

- Conceptualizes the information system enabling climate reporting as a global governance information infrastructure (GGII) and uncovers elements of the climate reporting information infrastructure.
- Describes the reporting process, identifies IT artefacts and their roles in the process, and discusses the level of sophistication of the use of digital technologies.

4.1.3 Exploring the impact of digital global governance through affordance theory: the case of climate reporting

Engvall, T. (2021). Exploring the impact of digital global governance through affordance theory: the case of climate reporting. *EGOV-CeDEM-ePart conference*, 7-9 September 2021, Granada, Spain

This paper responds to the RQ2: *How do information systems support global climate governance?*

The key contribution of this publication (Engvall, 2021) is an understanding of how digital technologies in the reporting II support governance. It does so through identifying and discussing affordances of IT artefacts in the reporting at the national level, using the case of Sweden. The IT artefacts are elements of the national sub-infrastructure of the global governance information infrastructure. The paper discusses how IT artefacts in the reporting at the national level support governance and the implementation of the Paris Agreement. The affordances indicate qualities of governance that the IT artefacts support.

Findings suggest that IT artefacts and information in the reporting have affordances that enable or support *monitoring, transparency, implementation of agreement, coordination & collaboration, analysis & visualization,* and *re-use of information*. The paper also reveals how the reporting serves both global governance purposes and national governance purposes. Affordances, descriptions of their support to governance, and the role of IT artefacts are summarized in Table L.

Affordance	Support to governance	Role of IT artefacts
Monitoring	The reporting enables monitoring of emissions.	IT artefacts are used to collect, aggregate, and preserve reports.
Transparency	Collection and dissemination of reports enable transparency of countries´ emissions and governments commitments and measures.	IT artefacts are used to disseminate verified reports, which serve as evidence of countries' emissions and governments' actions and commitments.
Implementation	International reporting requirements provide information for national policy processes and enable	IT artefacts can support analysis of implementation of commitments.

	assessment of implementation of commitments.	
Coordination & collaboration	Conducting reporting requires coordination of actors and information, which also increases cross-organizational collaboration.	IT artefacts enable coordination and collaboration across organizational units. IT artefacts are used to prepare information in various formats for the right reporting format.
Analysis & visualization	Information collected can be used to analyze patterns in emissions, policies, and measures and projections.	IT artefacts can be used to perform advanced analysis with complex relationships, and present this in comprehensible ways. They can show gaps and need for action.
Re-use of information	The information reported can potentially be used for various purposes by various stakeholders, supporting accountability, innovation, investment, and policy decisions.	Not yet known use of IT artefacts in leveraging reporting information for various purposes.

Table L. Affordances of IT artefacts in the reporting at national level

This paper contributes to research question 2 on how information systems support global climate governance through identifying and discussing affordances of IT artefacts in the reporting II related to global climate governance.

> The main contributions from this publication are that it:
> - Develops understanding of how digital technologies in the reporting II support governance through identifying and discussing affordances of the IT artefacts in the climate reporting II at the national level.
> - Identifies that digital technologies are used to support monitoring, transparency, assessment of global policy implementation, coordination and collaboration, analysis and visualization of reports, and innovation.

4.1.4 Affordances of e-reporting on a supranational level: the case of Reportnet

Engvall, T. & Flak, L.S. (2022a). Affordances of e-reporting on a supranational level: the case of Reportnet. *EGOV-CeDEM-ePart conference*, 6-8 September 2022, Linköping, Sweden

The paper responds to *RQ2: How do information systems support global climate governance?*

The paper is an empirical case study of the EU reporting platform Reportnet. The key contribution of this publication (Engvall & Flak, 2022a) is to develop an understanding of how digital technologies in the reporting II support governance in an EU supranational climate governance context through the identification of affordances of the digital reporting platform Reportnet. The identified affordances relate both to the process of reporting and qualities of governance, with a primary focus on policy implementation. Reportnet can be viewed as a supranational sub-infrastructure of the global climate reporting information infrastructure. The reporting to the EU serves two purposes: for the EU to compile its international reporting, and for the EU to assess EU member states´ compliance with EU climate regulations.

The paper reviews the literature on e-reporting which reveals affordances of digital technologies in reporting and situates reporting in the digital governance field. Automation, increased efficiency, quality controls, information sharing and abilities to make government performance transparent are some of the affordances highlighted in the literature. The paper also connects Reportnet and climate reporting to the EU's Digital Strategy, Strategy for data, and the EU climate policy, The Green Deal, with an emphasis on data-driven and evidence-based policy processes and decision-making. Findings of the paper on affordances of Reportnet in relation to governance are summarized in Table M.

Affordance	Support to governance	Role of IT artefact
Submission	Efficient & secure submission of reports which can be semi-automated. This facilitates timely reporting.	Reportnet enables various ways to submit reports, and they can be semi-automated. Furthermore, data is transferred directly to the database at the European Environment Agency, which makes it more secure.
Quality controls	Rigorous quality controls ensure information quality, and indicate errors immediately to the submitter. This strengthens the evidential quality of information used in policy processes.	Automated quality controls are set up in Reportnet for each data flow.
Compliance	Reportnet facilitates compliance with reporting requirements and assessment of compliance with climate legislation.	Reportnet has a clear process for reporting, which facilitates compliance with reporting regulations. Analysis tools in Reportnet facilitate assessments of compliance with climate regulations.
Monitoring	Information in Reportnet is used for monitoring and evaluation.	Reportnet collects and organizes EU member states' reports and has tools for analysis.
Transparency	The reporting process is transparent and traceable as all reports are available online, from member states' submissions to the aggregated EU report.	Reportnet facilitates a transparent and traceable reporting process and access to reports.
Communication & visualization	Reporting formats enable visualization of data. Database-website integration enables real-time visualization of data. This facilitates understanding of the information.	Data and information submitted to Reportnet is visualized on a website. Various tools are used to visualize data, and reporting formats in Reportnet enable structured management of data which can be visualized.

Table M. Affordances of Reportnet

The findings show that Reportnet has affordances both related to qualities of governance (such as transparency, compliance, monitoring, and communication and visualization), as well as related to the reporting process (such as administrative efficiency). The study suggests that a main area for improvement is in the re-use of information, particularly in policy processes. This includes both policy development, assessment of implementation, and evaluation of effectiveness of policy measures. The reports submitted to the EU are useful for both EU and national policy processes.

Compared to national reporting, EU reporting to the UNFCCC builds on an aggregation of national reports, but the primary data is collected at the national level by each country. Reporting to the EU follows the international standards for climate reporting. However, the EU offers another level of standardization supported by legal frameworks and robust quality control systems, which ensures the same level of quality of information reported among EU member states. The EU´s experiences of cross-national harmonization, digital integration, and information infrastructures, can be useful knowledge contributions to further development of a global information infrastructure for climate governance.

The paper contributes to research question 2 on how information systems support global climate governance, through focusing on governance at the supranational level in the context of global governance.

The main contributions from this publication are that it:

- Develops an understanding of how information systems at a supranational level support governance through identifying and discussing affordances of the EU reporting platform Reportnet, in the context of global climate reporting.
- The study identifies that Reportnet supports monitoring, transparency, assessment of EU member states' compliance with EU climate legislation, communication and visualization of reports, and efficient information management through semi-automated submissions and automated quality controls.

4.1.5 Sharing, cooperation, or collective action? A research agenda for online interaction in digital global governance

Engvall, T., Flak, L.S. & Sæbø, Ø. (2022). Sharing, Cooperation or Collective Action? A Research Agenda for Online Interaction in Digital Global Governance. *EGOV-CeDEM-ePart conference*, 6-8 September 2022, Linköping, Sweden

This publication responds to *RQ3: How can digital global climate governance be enhanced?*

This paper is a research note. The contribution of this publication (Engvall et al., 2022) is a research agenda for online interaction in digital global governance, exemplified by the Global Stocktake in global climate governance. The paper situates climate reporting within the context of online interaction in digital global governance and provides a foundation for research on different levels of interaction.

Climate reports contain information about countries´ emissions, measures, and commitments, as well as gaps and needs. National reports are then synthesized into global reports on progress towards the goal in the Paris Agreement. Both national reports and the global synthesis reports is an important foundation to inform various stakeholders´ decisions and actions, and to identify possibilities for collaboration.

The research agenda is structured according to three levels of online interaction (sharing, cooperation, and collective action) (Shirky, 2008), explained in Table N.

	Outcome	Level of interactions	Level of coordination/rules
Sharing	Sharing of information among a large number of individuals	Channels to distribute information	Providing access for everyone to share and use information
Cooperation	Information produced in collaboration	Interaction needed to support conversation, negotiation, and collective decisions resulting in an agreed upon outcome	Common agreed upon rules on how to navigate from individual ideas to a joint result
Collective Action	Collective decisions binding for all individual members	Interactions needed to agree and maintain a shared vision strong enough to bind members who may be displeased with some decisions	Rules to reduce the problem of the "tragedy of the commons"

Table N. Levels of online interaction (Engvall et al., 2022, p. 6), based on (Shirky, 2008)

Based on this framework, research questions related to each level were identified, using the example of the Global Stocktake in global climate governance. This is summarized in Table O.

Level of interaction	Potential outcome	Suggested Research Questions	Global Stocktake example
Sharing	Improved basis for political decision making	-How can technology facilitate collection of high-quality information from appropriate stakeholders? -How does technology influence the quality and flow of information? -How can technology be used to organize and disseminate information in comprehensible and inspiring ways to stakeholders?	Collect, organize and disseminate climate reports
Cooperation	Agreed upon knowledge status	-What is the role of technology in synthesizing and leveraging actionable information? -What are the relationships between regulations, digital solutions and consensus forming? -What organizational, cultural, and competence-related frameworks are needed to facilitate cooperation that bears results?	Synthesize national reports. Technical assessments leading to agreed upon status and synthesis reports.
Collective Action	Collective decisions binding for all individual members	-What are the roles of technology in decision making processes? -What is the relationship between technology and trust in the negotiation process, and how to mitigate decisions resulting in "tragedy of the commons"? -What are the relationships between technology and co-production? -What is the role of technology in processes of accountability and follow-up on decisions?	Declaration

Table O. Research agenda for online interaction in digital global governance (Engvall et al., 2022, p. 11)

The research agenda intends to explore how digital technologies and the information provided through climate reporting can be utilized to inspire and facilitate climate action by various stakeholders, while also consider the risks associated with online interaction, such as misinformation and sabotage from those who have counterproductive interests.

The paper contributes to research question 3 on how digital global climate governance can be enhanced. Related to the framework of sharing, cooperation, and collective action, the reporting II supports the information sharing level, and further initiatives can advance digital global climate governance towards cooperation and collective action levels. The research agenda provides key research questions to consider in future research.

> The main contributions from this publication are:
>
> - It contextualizes the role of reporting information, and thus the reporting II, in a broader context of stakeholder interaction in global governance.
> - A research agenda for interaction in digital global climate governance, with the intention to leverage climate action.

4.2 Summary of the contributions of the publications

Below is a summary of how the publications contribute to the research questions of this thesis:

Publication 1

- Defines 'digital governance'
- Develops in-depth understanding of the meaning of digital governance
- Develops understanding of the structural and normative transformations that digital governance is perceived to potentially bring about

Publication 2

- Conceptualizes the information system enabling climate reporting as a global governance information infrastructure (GGII) and uncovers elements of the climate reporting information infrastructure.
- Describes the reporting process, identifies IT artefacts and their roles in the process, and discusses the level of sophistication of the use of digital technologies.

Publication 3
- Develops understanding of how digital technologies in the reporting II support governance through identifying and discussing affordances of the IT artefacts in the climate reporting II at the national level.
- The study finds that digital technologies are used to support monitoring, transparency, to assess global policy implementation, coordination and collaboration, analysis and visualization of reports, and innovation.

Publication 4
- Develops an understanding of how information systems at a supranational level support governance through identifying and discussing affordances of the EU reporting platform Reportnet, in the context of global climate reporting.
- The study finds that Reportnet supports monitoring, transparency, assessment of EU member states' compliance with EU climate legislation, communication and visualization of reports, and efficient information management through semi-automated submissions and automated quality controls.

Publication 5
- Contextualizes the role of reporting information, and thus the reporting II, in the broader context of stakeholder interaction in global governance.

- Develops a research agenda for interaction in digital global climate governance, with the intention to leverage climate action.

5. Discussion

Scholars have argued that there is a need for a more robust scientific foundation for the digital governance field, and a central part of that is conceptual development (Charalabidis & Lachana, 2020a). In the literature review on digital governance as a scientific concept (Engvall & Flak, 2022b), it was revealed that both the digital and the governance aspects of digital governance have been treated superficially, and thus require more robust theorization. My contribution to this, from an information systems perspective, has been to investigate, conceptualize, and theorize the phenomenon of digital global governance from a sociotechnical perspective. A sociotechnical perspective means to address the interaction between digital technologies and the social context (Sarker et al., 2019), which in this case is global governance.

The global governance context is scarcely addressed in the digital governance literature. Since global governance has different attributes compared to national and local governance, it requires both conceptualization and empirical insights to develop knowledge of what digital governance means in a global governance context. This is crucial in order to adequately apply digital technologies in this setting and to respond to the challenges that global governance is facing. One of the critical global challenges we currently encounter is climate change, which has been the focal governance topic in this thesis.

A main challenge in global climate governance is weak implementation of international agreements (Rosenau, 2017; Weiss & Thakur, 2010). Some of the main reasons for this include the absence of a global authority with means to enforce decisions (Zürn, 2010), that the global governance system is disaggregated with multiple spheres of authority, many actors, and multiple governance levels to coordinate (Rosenau, 2017). Moreover, the UNFCCC process is very slow due to consensus decisions, and it does not sufficiently respond to the real-world problem of climate change (Klein et al., 2021). From an information systems perspective, we need to understand how information systems can support global governance so that it can better respond to societal challenges. Such understanding requires both theoretical and empirical insights.

The objective for this thesis was to develop an improved understanding of
1) What is digital global governance?

2) How do information systems support global climate governance?

3) How can digital global climate governance be enhanced?

This section discusses the findings from the five studies in relation to the conceptual framework developed in Chapter 2. Publication 1 provides an understanding of the meaning of digital governance. This has served as a foundation for the conceptualization of digital global governance, thus responding to research question 1. Publications 2, 3 and 4, which are based on case studies, provide empirical insights from cases of climate reporting. The empirical cases have investigated the use of digital technologies in climate reporting at the national level, supranational level, and the global level, and what role this socio-technical system (climate reporting) has in governance. The case studies thus reveal how information systems support global governance, which responds to research question 2.

The information system enabling the reporting is, in publication 2, recognized as an information infrastructure. This line of thought is further developed, leading to the novel conceptualization of a global governance information infrastructure (GGII), illustrated by the GGII model. The GGII model depicts the relationship between a global governance information infrastructure and global governance.

The 5th publication is a conceptual paper that outlines a research agenda to leverage digital technologies and reporting information to support different levels of online interaction (sharing, cooperation, and collective action). The research agenda raises potential research questions from a sociotechnical perspective, which is then the basis for a discussion in the thesis on the further development of the global governance information infrastructure (GGII) and digital global governance.

This chapter will be structured according to the following sub-sections:

5.1) What is digital global governance;

5.2) The information infrastructure for global climate governance;

5.3) Pathways for further enhancement of digital global climate governance through cultivation of the climate GGII.

5.1 Digital global governance

The research question 'What is digital global governance?' addresses two gaps in the digital governance literature. First, it contributes to a theorization of digital governance. Second, it addresses the global governance context, which has been scarcely investigated in the digital governance field.

The response to research question 1, 'What is digital global governance?' is based on literature studies. The literature review for publication 1 provided an in-depth understanding of the meaning of digital governance, which was the basis for articulating the definition of 'digital governance':

> "Digital governance is defined as digital technology ingrained in structures or processes of governance and their reciprocal relationships with governance objectives and normative values. Digital governance includes the utilization of digital capabilities and involves a transformation of structures, processes, or normative values" (Engvall & Flak, 2022b, p. 44).

This means that digital technologies are used in structures and processes of governance, and that it also implies either structural transformations, i.e., how governance is structured and conducted, or normative transformations, i.e., the objectives and values (Engvall & Flak, 2022b). Transformation is here understood in accordance with the Merriam Webster´s Dictionary definition of transformation as

> "an act, process, or instance of transforming or being transformed", and *transform* is further defined as "to change in composition or structure" or "to change in character or condition" (Merriam-Webster.com Dictionary, 2023b)

Additional literature reviews on governance and global governance in the thesis added to an understanding of global governance. In sum, governance implies the steering of society according to common goals through collective action (Ansell & Torfing, 2016), and implies an exercise of authority (Jreisat, 2004). It includes both formal and informal aspects, and rules and norms that create some order (Weiss & Thakur, 2010). Some scholars (such as (Rosenau, 1995)) have a process perspective on governance, while others have more of a system perspective where governance includes both structures, processes, and policy (Zürn, 2010). My view adheres to a system-oriented view that includes both structures, processes, objectives, and values. Global governance further implies the steering of society across national borders and is justified by transnational problems or common goods (Zürn, 2018a). Global governance has differences

compared to national governance, for example, that there is no overarching authority (Zürn, 2010). It further involves various heterogeneous actors (Rosenau, 2017), as well as a very multi-cultural and diverse socio-economic-political context. Due to the unique characteristics of global governance, it is important to state that it is global governance that is meant, otherwise the definition of digital global governance that I have proposed in this thesis is similar to the definition of digital governance. Thus, the definition is:

> Digital global governance is defined as digital technology ingrained in structures or processes of global governance and their reciprocal relationships with global governance objectives and normative values. Digital global governance includes the utilization of digital capabilities and involves a transformation of structures, processes, or normative values.

As digital global governance is so scarcely investigated, there is a lack of knowledge of what it means. Thus, this research has started the much needed development of gaining a broad understanding and offered a definition as a basis for further studies. However, digital global governance can materialize in various ways, and the understanding of digital global governance can be further specified as more research is conducted, for instance, in different governance areas.

In the following part, the case study of digital global governance will deepen the understanding of how digital global governance can manifest and how information systems can support global governance.

5.2 The information infrastructure for global climate governance

Very little of the digital governance research addresses global governance settings, which leaves us with scarce knowledge and limited understanding of the role of information systems in global governance, and of how digital governance can support and contribute to improvements in global governance. Due to the complexity of global governance and its unique characteristics compared to national or local governance, it requires special attention – both theoretically and empirically. The case studies in this thesis concerning international climate reporting contribute empirical insights from an example of digital global governance, and respond to research question 2, 'How do information systems support global climate governance?' Findings from these studies provide insights that will be discussed according to the following sub-sections:

a) The information infrastructure for international climate reporting
b) Applying the GGII model to the case of climate reporting
c) The climate GGII as the foundation for global climate governance

The case studies revealed that international climate reporting is supported by a global information infrastructure. The first part of this Section (5.2.1) establishes how international climate reporting is enabled by an information infrastructure, through a discussion of the case in relation to the characteristics of an information infrastructure. This articulates the nature of information infrastructures and reveals how it manifests in the case of international climate reporting, which provides an empirical and theoretical basis to respond to RQ2. The second part (5.2.2) applies the GGII model to the case of international climate reporting, illustrating the relationship between the information infrastructure for international climate reporting, and global climate governance. The third part (5.2.3) discusses how the climate reporting II contributes to governance. Together, these sections (5.2.1-5.2.3) discuss and theorize the empirical insights from the case studies through the lens of information infrastructures and the GGII model.

5.2.1 The information infrastructure for international climate reporting

This section responds to the request for a theorization of the role and characteristics of information systems (IS) in digital governance (Engvall & Flak, 2022b). Publication 2 (Engvall & Flak, 2022c) recognizes that there is an information infrastructure (II) that enables international climate reporting and identifies its elements. In this section, the case of climate reporting will be discussed in relation to the characteristics of an II and will thus deepen the understanding of the characteristics of IS in this case. An information infrastructure is a large sociotechnical network (Hanseth, 2010), that encompasses technological, social, and organizational elements, standards, and people, which creates, processes, preserves and disseminates data, information, and knowledge (Bowker et al., 2009). An II is open, shared, heterogeneous and continuously evolving (Hanseth & Lyytinen, 2010a; Hanseth & Monteiro, 1998), and co-evolves with organizational structures and work practices (Aanestad et al., 2017). IIs have an important role as an underlying foundation for the development of digital services in digital governance (Beconytė et al., 2022). Consequently, an II in a global governance setting would be an important foundation for the development of digital global governance, evolving with global governance structures and processes, providing information that is crucial for global governance. In the following, the case of climate reporting will be discussed in regard to the characteristics of an II.

Information infrastructures have a supporting or enabling function
This means that the II supports and enables various functions and activities (Hanseth & Monteiro, 1998). The information infrastructure (II) investigated in this thesis enables international climate reporting, including compiling and submitting standardized reports from countries to the UNFCCC, where the reports are shared globally. The reports support climate governance by providing relevant information, including reports on government commitments, measures, projections, and plans for action. How the II supports governance will be discussed in Section 5.2.2.

The climate reporting II is open and shared globally
That an II is shared means that it is open for all and cannot be divided into sections where some parts are only used by certain actors. The characteristic of openness means that there are no limits to users, technological components or operators, and the composition of the II and its use will change over time

(Hanseth & Monteiro, 1998). The framework for climate reporting to the UNFCCC enables reporting from all countries across the globe. The reports are also publicly available for anyone to use. Data can be downloaded and re-used by anyone, and there are no limits to the number of users of the information. Moreover, a national arrangement for reporting allows a variability in solutions, operators, and actors involved. However, there are rules concerning who is eligible to submit reports, which is important in a governance context so that government reports are not mixed with other types of information. Thus, the content that is open and shared is regulated.

Information infrastructures are sociotechnical networks

Information infrastructures encompass technologies, organizations, people and standards, and are embedded in social structures (Hanseth & Monteiro, 1998). IIs thus co-evolve with social structures and work practices (Aanestad et al., 2017). In this case, social structures are reflected in governance, at both global, national, and supranational levels. Because of the variability of political systems and sociocultural orientations in different countries, a global governance information infrastructure comprises a socio-cultural-political diversity. In the case of climate reporting, there are global decisions requiring countries to establish national arrangements for reporting, but each country decides how their infrastructure is designed.

At the global level, the UNFCCC secretariat is the organizational body that receives national reports and supports global coordination and governance. COP (Conference of the Parties) is the instance with decision-making authority in global climate governance and consists of government delegations. COP is the forum that decides on standards, formats, and procedures for reporting. At the national level, each country establishes organizational arrangements and procedures for reporting that meet the international requirements. In the case studies, various IT artefacts that are part of the II were identified, and they each contributed different functions to governance.

One aspect to consider is the role of information in the information infrastructure. Very few papers in the literature on information infrastructure address the role of information in an II. According to Hanseth & Monteiro (1998), the Gore report (which was the first outlet that mentioned information infrastructure) suggests that information itself is part of the II (Hanseth & Monteiro, 1998). In the article that analyzes the information infrastructure for climate reporting (Engvall &

Flak, 2022c), information was considered to be a part of the II. The continuously preserved information is suggested to be part of the installed base of the II because it is crucial to be able to compare information over time to evaluate the progress of climate change. Thus, new information must be related to the information that has previously been submitted. The II literature does not explicitly address the role of information in the II, thus I propose that the role of information in an information infrastructure be theorized further. Regarding the elements of the climate reporting II that were identified in the publication, one reflection after the article was published is that IT and consulting companies should be added to the II, as it was revealed in a later case study that IT companies also have an important role in developing digital solutions. In some countries, there are also consulting firms involved in the reporting. Furthermore, IIs are relational and one consequence of that is that they relate to practices (Star, 1999). In this case, this means that the II relates to the practice of reporting. A further extension of that premise is that the II relates to practices of use of information.

Global standardization

Information infrastructures are based on standards (Hanseth, 2010), which is also the mechanism for coordination of IIs (Tilson et al., 2010b). In the case of climate reporting, information is reported according to globally decided standards and formats. Reviews of reports verify the quality of reported information, and that it is in accordance with global standards and decisions. Standardization makes it possible to coordinate information at the global level; information from multiple countries is structured according to the same format, and it has a common level of quality. The information is thus comparable and can be aggregated at the global level, which enables us to evaluate global progress towards global goals. Because information infrastructures cover national, supranational, and global levels, standardization makes the reporting at different governance levels and between countries coherent and comparable. Standardization is what enables the global coherence of the information infrastructure. Moreover, the standards and quality controls ensure that the global collection of reports is a trustworthy source for climate governance.

Information infrastructures are ecologies of networks

Information infrastructures are interconnected systems, including multiple applications, tools, and components, that forms ecologies of networks (Hanseth

& Monteiro, 1998). Information infrastructures are also layered, connected to other information infrastructures, and may contain sub-infrastructures (Hanseth, 2010). The case studies indicate that various IT artefacts were used for different purposes, but all contributed to the whole of the information infrastructure. This includes IT artefacts to collect and structure information according to the right format, to make impact assessments and scenario analysis, to submit reports, to facilitate reviews of reports, and to share the information publicly. Collection of information and compilations of reports are carried out at the national level. Arrangements for reporting at the national level will be integrated with established national information infrastructures, but also be in accordance with international requirements. There are thus intersections between the global and national information infrastructures. Likewise, the EU has its own information infrastructure, but it is also interconnected with the global II. The II at the national or supranational levels that support international reporting are, in this thesis, viewed as sub-infrastructures of the global governance information infrastructure.

The installed base of the climate reporting II
Infrastructures always have an installed base of technologies, work practices, regulations, and organizational and social structures in place that must be considered in further development (Aanestad et al., 2017). Information infrastructures develop incrementally over time, through extension and improvement of the installed base. New components have to be interoperable with the installed base (Hanseth & Monteiro, 1998).

Global climate governance has a history of global agreements, starting with the Climate Convention, followed by the Kyoto Protocol, and currently the Paris Agreement. All agreements have had procedures for reporting, and they partly build on each other. For example, countries still report the 'National Communication' which is a report under the Climate Convention. Reporting under the Paris Agreement replaces the reporting under the Kyoto Protocol but will build on procedures developed under that agreement. One difference is that the Kyoto Protocol had different reporting requirements for developed and developing countries, but under the Paris Agreement (Paris Agreement, 2015) all countries should follow the same formats, although there are flexibilities for developing countries. This will enable a global aggregation of reports since they now follow the same standards. The Paris Agreement also has a different design

compared to the Kyoto Protocol. The Kyoto Protocol had decided targets for developed countries, while the Paris Agreement builds on voluntary commitments and measures. However, the reporting formats under the Paris Agreement have included tables for tracking progress, which makes proceedings of each country transparent (UNFCCC, 2018). Thus, the changed reporting requirements under the Paris Agreement, compared to those under the Kyoto Protocol, can be viewed as a cultivation of the installed base of the international climate reporting II. Since global and national levels are interconnected, the national level should also be considered in global standardization in order to avoid placing too costly requirements on countries. At the national level, countries have developed procedures and systems for reporting, which are part of the installed base of the national sub-infrastructures for reporting.

Generativity and innovation

While standardization enables interoperability and therefore coordination across boundaries an II must also enable local variability and adaptation to new needs to not become obsolete (Grisot & Vassilakopoulou, 2013). Standardization makes it possible to re-use solutions and enable coordination across boundaries, but it may constrain generativity through limiting innovations (Grisot & Vassilakopoulou, 2013). There must be a balance between standardization and flexibility. Too high of a level of flexibility will undermine the durability of the II, while a high level of standardization may become too rigid (Tilson et al., 2010b).

The climate reporting requirements set global standards which ensure that information can be coordinated at a global level. At the same time, the information can be re-used for various purposes at different governance levels. For example, in Sweden, the initiative called Panorama (The Climate Policy Council, 2023) illustrates the climate transition in Sweden. On a website, Panorama visualizes political goals, governance instruments and potentials for each governance instrument, i.e., how the goals will be met. Panorama uses various sources of information, including the information that is reported to the UNFCCC among others. According to respondents in Sweden, the national system for climate data builds on international requirements. In this way, international reporting requirements have also laid the foundation for information that is used at the national level. This information is further used in digital innovation to communicate information regarding the climate transition in Sweden. However, one impediment is that due to rigorous quality controls,

reports to the UNFCCC illustrate the situation two years before the year the reports are submitted. Therefore, respondents considered whether other, more recent statistics would be more useful for Panorama. Another example is an EU climate website (European Environment Agency, 2023) where the climate transition in the EU is communicated based on data that is reported. The website is integrated with the EU reporting platform Reportnet and is automatically updated based on the information in Reportnet. One non-governmental innovation at the global level, is the "NDC enhancement tracker", where countries' commitments in their NDCs (Nationally Determined Contributions), are analyzed and visualized on a website (World Resources Institute, 2023). The NDC tracker is an initiative driven by the World Resources Institute and is thus an example of how non-government actors can contribute to the information infrastructure. The core of the climate reporting II is the reporting from countries to the UNFCCC, but additional applications and innovations can be developed by other actors that contribute to the II.

Summary

This section has established that international climate reporting can be understood as being enabled by an information infrastructure. This gives us an understanding of the nature of IS in this case and provides a theoretical basis for analyzing how information systems support global climate governance. However, although 'information infrastructure' provides a theoretical lens to understand a type of large sociotechnical system, it does not articulate the particular characteristics of an II in the context of digital global governance. Therefore, I have proposed a conceptualization of 'global governance information infrastructure', illustrated by the GGII model to specify this. I further suggest that these are fruitful as an illustration of the relationship between information systems and global governance in the case of international climate reporting. The proposed definition of global governance information infrastructure is:

> A global governance information infrastructure is a globally shared, open, heterogeneous, and evolving sociotechnical system, built on an installed base encompassing standards, technology, organizations, and people. A global governance information infrastructure is ingrained in global governance structures and processes, with reciprocal relationships with global governance objectives and values. A global governance information infrastructure enables global exchange, management, and dissemination of information and the development of digital global governance services and functions.

In the case of climate reporting, the information infrastructure is shared globally, open, heterogeneous, and evolving. It is built on an installed base of standards, technology, organizations, and people. The II is further ingrained in global climate governance structures and processes, as the information provided is used in governance activities and the reporting requirements also means that countries have to do certain things. For instance, the requirement that a country has to submit a NDC means that it has to decide on some climate goals. The reporting requirements, which are global standards, are a central element of the global climate governance framework. There are reciprocal relationships with global governance values, such as transparency and climate objectives. The reporting II enables global information exchange, where reports are submitted from countries to the UNFCCC secretariat, and then publicly disseminated. Additional services can also be developed based on the information provided. The definition of GGII suggested in Chapter 2.5 is thus applicable to this case.

With the sparse understanding that we have in the digital governance field about the role of information systems in global governance, there is a need for conceptual tools to illustrate this relationship. The aim of the GGII model proposed in this thesis is to facilitate this understanding. In the next section, the GGII model will be applied to the case of climate reporting.

5.2.2 Applying the GGII model to the case of climate reporting

In this section, I will apply the GGII model to the case of climate reporting II, to verify the model and to deepen the understanding of the case. The GGII model, developed in Section 2.5, illustrates an information infrastructure embedded in and supporting global governance, see Figure F. The model specifies the application of an information infrastructure in a global governance setting, which is then illustrated by the case of climate reporting in Figure G.
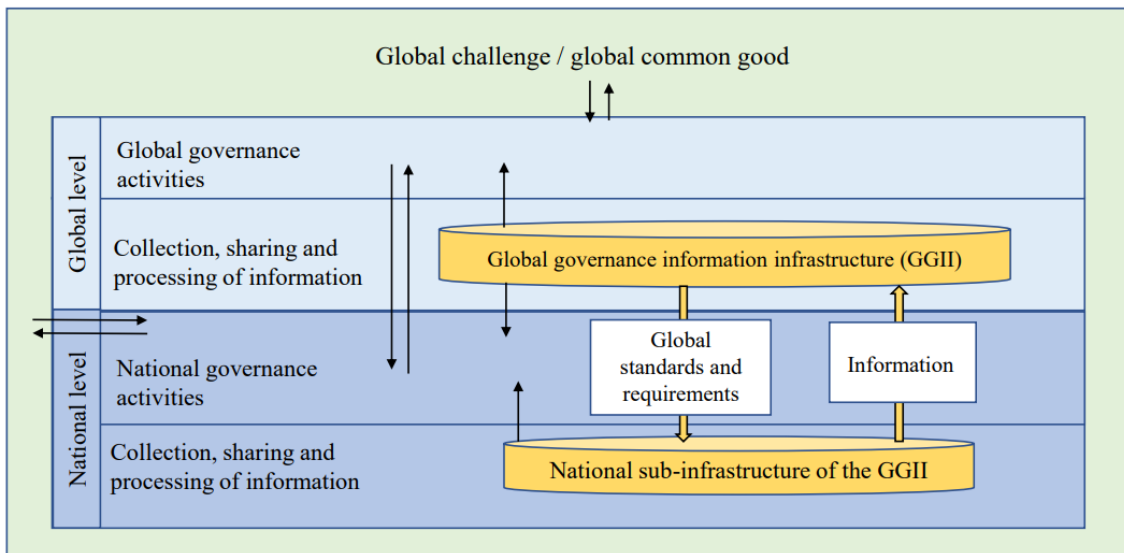
Figure F. The Global Governance Information Infrastructure model

Application of the GGII model to the case of climate reporting allowed the elements of the figure to be further specified in relation to climate reporting. This is outlined in Figure G. and will be explained thereafter.
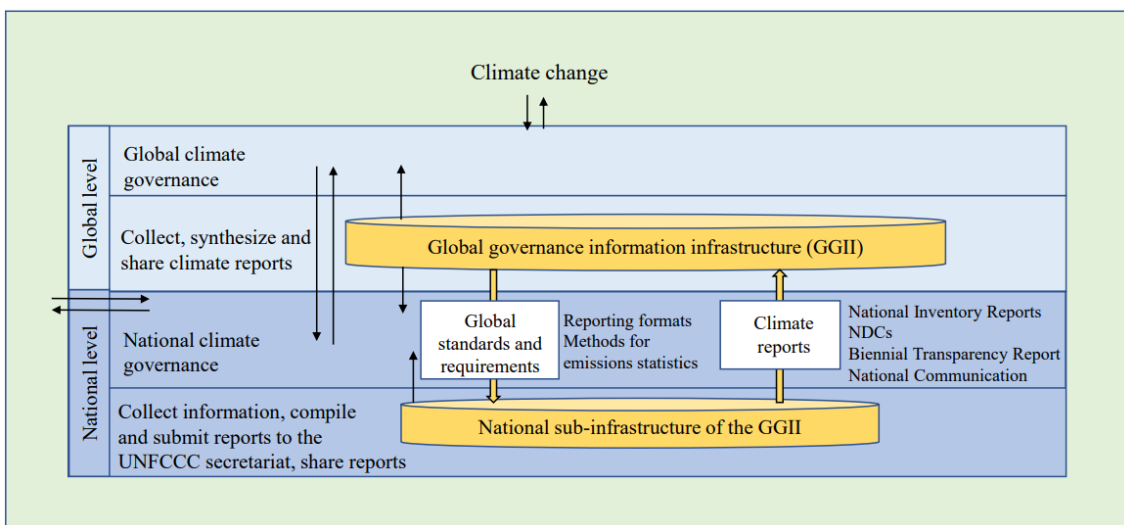
Figure G. The Global Governance Information Infrastructure model applied to the case of climate reporting

Global standards and requirements define what information is collected at the national level, and in what format it is reported. Reports are submitted to the UNFCCC secretariat where they become part of the globally aggregated information at the global level of the GGII. The GGII informs global governance activities, but also national governance activities. For example, the Global

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Stocktake aims to evaluate progress towards the goals in the Paris Agreement and to inform countries on the need for further measures (UNFCCC, 2022c). The global problem of climate change places demands on global governance, and the outcome of global climate governance aims to maintain a stable climate system. This is indicated in the figure by the arrows between the green field representing climate change, and global governance activities. However, climate change also poses demands directly at the national level, and national governance also contributes to solutions to the problem. This is indicated by the arrows between the green field of climate change, and national governance activities.
In the case of Sweden, the international reporting requirements have laid the foundation for the national system for climate information, i.e., the national sub-infrastructure of the GGII, which informs national governance activities. There is also an interaction between global governance and national governance in goal setting and measures.

Reports are shared and made publicly available via websites. In the case of Sweden, the national reports are accessible at the national level, which is likely the case for many countries. At the global level, reports from countries across the globe are available at the UNFCCC website.

The GGII model illustrates how the II for climate reporting are embedded in global governance and is thus an example of a global governance information infrastructure (GGII). The model shows that global standardization sets requirements for the national levels, and that information is submitted to the global level. It also shows that information in the II is used at both national and global governance levels. The GGII model can be used as a conceptual tool to facilitate understanding of this type of information systems in global governance. The next section will discuss how the information infrastructure contributes to governance.

5.2.3 The climate GGII as the foundation for global climate governance

Since little digital governance research has been conducted on the global governance context, we have little knowledge and understanding of how information systems can support and enable improvements in this area. Moreover, there is little research on information infrastructures in global governance. An II is important for the development of digital governance, as an underlying foundation for digital services and functions (Beconytė et al., 2022; Krishnan & Teo, 2012). A global governance information infrastructure is thus central to the development of digital global governance. Scholars further propose that IIs provide information to decision-makers and enable efficient information sharing and participation (Beconytė et al., 2022), which enables transparency, provides means for accountability (Meso et al., 2009), and facilitates stakeholder engagement. The ability of IIs to support information exchange across organizational boundaries and sectors (Hornnes et al., 2010), and interorganizational collaboration (Klievink & Janssen, 2014) are crucial to support global governance which requires both exchange of information and collaboration among governments, agencies, and other actors. The ability of IIs to stretch across geographical distances (Vaast & Walsham, 2009) is also necessary to support global governance, which encompasses the entire globe.

The reporting requirements are very central to the Paris Agreement (Paris Agreement, 2015), and the information infrastructure for climate reporting functions as a foundation for global climate governance by providing both the structure in the governance framework, as well as the information on which governance processes rest. This section will discuss more in depth how the II supports global climate governance.

Two of the case studies in this thesis have investigated how the climate reporting II supports climate governance through identifying action possibilities of IT artefacts in the reporting. Publication 3 investigated how IT artefacts in the information infrastructure for the reporting, at the national level support governance. Publication 4 investigated how the EU environmental reporting platform Reportnet, which is an essential part of the climate information infrastructure in the EU (at a supranational level), supports supranational governance. The findings are based on what the respondents addressed, which may reflect both differences and similarities in what is emphasized. This suggests that if something was addressed at one governance level but not the other, it does

not necessarily mean that it only occurs at that level. In summary, the case studies revealed that the reporting II enables the following:

Case National Level (Sweden)	Case Supranational Level (the EU)
Monitoring	Monitoring and evaluation of progress
Assess countries implementation of climate policies	Facilitate compliance and assessment of compliance
Transparency	Transparency
Analysis, visualization & communication	Analysis, visualization & communication
Coordination & collaboration	Efficient information management
Innovation	Information quality

Table P. Summary of how the II supports governance.

Some of the aspects above relate to each other and will, in the forthcoming discussion, be grouped according to the following governance related activities and objectives: monitoring and assessment of progress and policy implementation; transparency and communication of reports; coordination and collaboration; efficient and trustworthy information management; and innovation.

Monitoring and assessment of progress and policy implementation

An important function used to continuously improve governance is monitoring, which is underpinned by an II that collects, organizes, and analyzes information. Monitoring and assessment make it possible to follow up on progress and analyze the outcome in regard to goals (Hendrick, 1994). A central objective of the climate reporting II is to enable information collection for monitoring of emissions, policy implementation, and progress towards global goals. The reporting contains information on:
- Emissions statistics (National GHG inventories and inventory report)
- National commitments (NDCs)
- Measures and projections (National communications and Biennial Transparency Reports).

Reporting on GHG emissions (national inventories), makes it possible to monitor progress of emissions over time. Reporting of NDCs is where countries communicate their commitments and goals. In the National Communications and Biennial Transparency Reports, countries report on their climate work, including

measures they have undertaken, but also projections and scenarios. The reports make it possible to follow up on progress of emissions and implementation of commitments. At a global level, global emissions can be aggregated to a global number, and commitments, measures and projections can be synthesized to develop scenarios for global progress and inform further need for action. Functions to preserve information over time are thus an important feature of the II to enable monitoring and assessment of compliance. To follow progress over time, it is also crucial to be able to compare information to historical reports.

In the EU, reports are used to assess compliance with EU regulations and monitor progress towards EU climate goals, as well as being the basis for the EU´s reporting to the UNFCCC. Scholars also suggest that e-reporting can assist in identification of violations of compliance (Lewis, Neiberline, & Steinhoff, 2014). The reporting platform Reportnet supports analysis of EU member states´ compliance with regulations. However, the representative from the European Commission administration suggested that improvements could be made by developing tools that would better support analysis of both success cases and insufficient measures.

At the national level, in the case of Sweden, international reporting requirements have laid the foundation for the national system for climate data and climate policy information. In Sweden, national climate goals have been adopted along with legislation that requires the government to report to the Swedish Parliament on emissions and measures, and to follow progress towards national goals. In this way, the climate reporting II serves monitoring purposes at both national, supranational, and global levels.

A major problem in global governance is the weak implementation of global policies (Rosenau, 2017). There is no central authority with the means to enforce decisions (Zürn, 2010) and accountability is weak (Acharya, 2017). Government reporting supports accountability procedures (Filipovic, Martic, & Demirovic, 2018), for instance, related to achievement of governance goals and policy implementation. In the cases of climate reporting, the reports contain information of emissions and policy measures that can be used for accountability purposes. However, records on government actions are not enough for accountability but action by appropriate actors is also required (Hurley, 2005), along with organizational structures and procedures. The role of the II is here to provide the information that can be used as evidence in accountability procedures, which is

also central in democratic practices. How governments handle critical societal challenges is an important democratic issue and the development of trust between governments and citizens (Lee, 2004). This also relates to one of the major problems in global governance, in the implementation deficit and that it does not respond sufficiently to real-world problems (McKeon, 2017). Reporting provides information, but the step from information, knowledge and understanding to action must be bridged in order to have a real-world impact.

Transparency and communication of reports

Government reporting is a means for governments to communicate their performance on governance goals (Mullen, 2007). Government reporting can thus increase transparency and show results, which also contributes to building trust (Kloby, 2012). Through international climate reporting, enabled by an information infrastructure, governments communicate emissions, measures, and progress in their country, and at a global level, global progress can be assessed and communicated.

Research on information infrastructures also suggests that IIs can strengthen transparency by enabling the collection, organization, and dissemination of information (Meso et al., 2009), where information is shared across organizations (Jansen, 2012). In a global governance context, it is necessary to have an II that enables coordination and sharing of information from various organizations, both from national governments and international organizations, to enable transparency in global governance. Moreover, an II should be open (Hanseth & Monteiro, 1998). In a global climate governance context, this means that the information is accessible to the public across the globe. In the case of climate reporting, the reports are published on public websites (UNFCCC website, EU website, Swedish website).

Power inequalities in global governance, with the domination of strong states (Acharya, 2017), generates distrust (Klein et al., 2021). A risk is also that countries work for their self-interest rather than the global common good, which leads to the "tragedy of the commons" (Zürn, 2018a). Transparency can be a means to reveal such tendencies, as those of states avoiding responsibilities to the cost of others. Respondents suggested that transparency contributes to building trust because everyone can see what each country does. With common standards

in making an account of measures and emissions, it is transparent who does what. That can also be the basis for the discussion on responsibilities for different measures.

A common challenge related to reporting is to convert extensive volumes of data to comprehensible and actionable information that is useful to governance, for example, in supporting decision making and accountability (Lewis, Rominiecki, & Steinhoff, 2012). Digital technologies have an important role here in analyzing information and turning it into actionable knowledge (Johnston, 2010). The case studies in this thesis found that the reports contain vast amounts of valuable information, but the usability of the information can be improved through ways of communication. There are some initiatives already mentioned, such as Panorama, the EU climate website, and the NDC tracker, which are examples of ways in which digital technologies are used to communicate climate information that make the reports more transparent and actionable. Another example is the Climate action tracker, which tracks government climate action and compares it to the goals in the Paris Agreement. Climate action tracker is an independent scientific project that provides independent analysis to policymakers (Climate Analytics & New Climate Institute, 2022).

At a global level, the UNFCCC has some tools on their website to navigate statistics. However, further improvements can be made regarding communication, for example, tools may be tailored to what is relevant to different stakeholders (Siedschlag, 2011), to make the reports more comprehensible and usable. According to respondents, transparency is thought to encourage countries to take measures, and the reporting mechanism includes that there should be a continual increase of commitments and measures. In that way, the information infrastructure has a role which encourages actors to act. Against this backdrop, further research could investigate the role of digital technologies in increasing the effectiveness of such governance mechanisms, i.e., the relationship between digital technologies, transparency, and climate action. Knowledge and facts do not create an impact related to climate change by themselves, it needs to be acted on.

Coordination and collaboration

Information infrastructures coordinate and share information resources, which facilitate interorganizational collaboration (Klievink & Janssen, 2014), operational activities and coordination across organizations (Strader et al., 1998). In a global governance context, it is imperative to coordinate information resources to inform global governance. Climate change is also a challenge embedded in various societal processes (Bulkeley & Newell, 2015), and consequently requires coordination across sectors and policy areas. Standards set the structure for an II (Hanseth, 2010), and are thus an important mechanism for coordination of global governance information resources. In the case of climate reporting, there are globally agreed upon standards and guidelines that all countries should follow (UNFCCC, 2018). In that way, it is possible to coordinate and synthesize information at a global level and compare it over time across sectors and policy domains. Moreover, coordination of information facilitates coordination of actors, which can respond to the challenge of fragmentation in global governance, where it is difficult to have an overview due to the multiplicity of actors and sites of authority (Rosenau, 2017).

At the national level, climate reporting requires coordination of various organizations. For example, in the case of Sweden, multiple public agencies and the Ministry of the Environment and Energy are involved in the reporting. The respondents mentioned that the reporting had increased cooperation among agencies and promoted collaborative working among agencies, which was also beneficial for cooperation on other topics. This illustrates that the reporting both requires and triggers cooperation across organizational borders. The Swedish government has further assigned some government agencies to develop collaborative working procedures for climate impact assessments. Moreover, the Swedish Government Offices have a common information infrastructure supporting its work, which enables coordination and collaboration across governance sectors. Thereby, there may be opportunities to facilitate collaboration and integration of climate matters into various governance topics through sharing of climate information.

At the supranational level, within the EU, there is coordination among EU member states regarding reporting matters. The European Environment Agency coordinates the work concerning the reporting on behalf of the European Commission, and Reportnet has an important role in streamlining the reporting

from EU member states, thus facilitating EU coordination. Reportnet is central in the climate reporting II at the EU level, which can be viewed as a supranational sub-infrastructure of the global climate reporting II. Reportnet is an example of how a sub-infrastructure follows international standards but also has additional standardization through EU legislation, and features adapted to that context (in this case the EU) based on its needs for coordination. Reportnet has standardized reporting procedures and quality controls, which meet both international standards and EU needs. Reportnet is more digitally advanced (such as the quality controls) compared to the reporting platforms at the global level. This reflects how an II is both standardized and enables innovation and local adaptation (Grisot & Vassilakopoulou, 2013).

Platforms for review of the reports in the EU and UNFCCC facilitate collaboration among reviewers and those under review, through communication and document coordination. However, respondents said that there were some technical problems with the UNFCCC review platform which limited the possibilities for cooperation on the platform. Another related example was that respondents from the Swedish Climate Policy Council, which reviews the Swedish governments' policy from a climate perspective, has some collaboration with equivalent bodies in other countries. Even though the Climate Policy Council is not related to the international framework for reporting, it is a significant part of the Swedish climate policy framework, and use of the reports could be useful in their work.

Efficient and trustworthy information management

Information infrastructures enable efficient information exchange (Beconytė et al., 2022), within and across organizational boundaries (Jansen, 2012). Climate reporting requires an exchange of information across organizational borders; between agencies within a country and between national, supranational, and global levels. IT platforms have been developed to facilitate this. The UNFCCC has digital platforms to submit reports to. The digital reporting platform Reportnet facilitates reporting within the EU.

A common challenge found in reporting is the administrative burden, and digital technologies can facilitate the seamless exchange of information, facilitate information management, and also tailor reports to different users (Siedschlag,

2011). E-reporting is further suggested as a way to make reporting more efficient, for example, through the seamless exchange of information, automated controls, and through facilitation of information management (Siedschlag, 2011). In the EU, digital solutions have been used to reduce the administrative burden, streamline reporting, facilitate information exchange, semi-automate aggregation of information, and develop cost-effective solutions (Schleidt, 2013). Reportnet has different pathways for semi-automation and automated quality controls, which makes the submission process more efficient. The data goes straight into the EU´s database instead of through middle stages as it did previously, which makes it more secure.

For actors to trust reports, it is crucial to ensure the accuracy, completeness, and timeliness of information, which digital technologies have a central role to secure (Lewis et al., 2012). According to the reporting guidelines of the UNFCCC, all countries should have procedures for quality controls to ensure Transparency, Accuracy, Completeness, Comparability and Consistency (UNFCCC, 2018). In order for the EU to ensure this in their reports to the UNFCCC, they have to be certain that reports from EU member states follow these guidelines. Reportnet has rigorous and automated quality controls, and then expert reviews are conducted. There were some differences in how the respondents experienced the quality controls. Some thought that they provided instant feedback and were very good, while some thought that they were very cumbersome and had some errors.

Standardization is also contributing to efficient information management. Standardization of climate reports makes it possible to aggregate information at different governance levels. The same report is sent to both the EU and the UNFCCC, and the EU can compile its reports to the UNFCCC based on reports from EU member states. Standardization thus makes it possible to synthesize information at both supranational and global levels and to automize aggregation of some types of information.

The benefits of efficiency in reporting and managing reports were primarily highlighted in the EU case. However, a central aim of information infrastructures is to make information exchange efficient. The GGII for climate reporting, including standardized formats, timelines, quality controls and technologies facilitates making the information management efficient. As the respondents stated, reporting would not be possible without digital technologies, the reporting

platforms, or standards.

Innovation

An information infrastructure is shared, open, has an enabling function, and continuously evolves. This means that an II is a shared resource among a community, is open to various actors to develop services and functions for different purposes, supports various activities, and is also open for new and unanticipated use and innovation (Hanseth, 2010; Hanseth & Monteiro, 1998). An II should be open to various use areas and user groups (Aanestad & Hanseth, 2002). In the development of an II in a governance context, the installed base of the public sector must be considered, which includes various local architectures, sector-wise sub-infrastructures, routines, practices, social and cultural conventions, as well as a diversity of stakeholders, including governments, agencies, politicians, citizens, NGOs, and businesses. The needs of such stakeholders and the character of societal challenges will drive the development of the II in a governance context (Hornnes et al., 2010).

In the case of climate reporting, global standards establish reporting formats, what information to report and on what timelines, as well as methodologies for calculations of emissions (UNFCCC, 2018). This enables national adaptations, but also space for innovation, both related to the reporting and also to further re-use of the information. In the case of Sweden, digital models have been developed to make impact assessments. According to respondents, the assessments were included in the reporting even though it was not mandatory, and they have also been useful in informing national policymaking and decision-making on priorities concerning measures. Other examples of innovation where the reporting information is used are the previously mentioned examples of Panorama and the NDC Tracker. Panorama is a digital tool that visualizes the Swedish climate transition (The Climate Policy Council, 2023). The NDC tracker analyzes the NDCs (Nationally Determined Contributions) reported by countries to the UNFCCC. It is an open data platform, where users can analyze and compare countries' NDCs, access emissions data, follow up on commitments and map alternative low-carbon pathways (World Resources Institute, 2023).

The climate reporting II provides information that can be used for various purposes for various stakeholders, such as governments, investors, businesses,

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cities and municipalities, and Non-Governmental Organizations (NGOs). The case studies in this thesis suggest that digital technologies can be leveraged to improve communication with stakeholders to inspire informed action. Respondents in the studies, both in the EU administration and the Swedish administration, encouraged that stakeholders would use the reporting information, which is available online, to perform independent analysis. The EU further promotes data-driven innovation, both in the EU administration and processes, as well as the society and economy in general (European Commission, 2018, 2020). In addition, the UN advocates for the use of data to improve governance (United Nations, 2020). The question here is how digital technologies can be used to leverage the reporting information infrastructure to inspire actors to make informed decisions and actions that contribute to the Paris Agreement.

Information technologies create new possibilities for the analysis of information and its evolution into actionable knowledge, as well as provide new avenues for collective action where stakeholders can more actively participate in developing solutions to societal problems (Johnston, 2010). Digitalization enables new ways to coordinate collective intelligence, innovation, and creativity. Digital information spaces enable individual and cooperative activities and distributed collective practices (Akoumianakis & Alexandraki, 2012; Edwards et al., 2007). With the reach and interconnectedness of an II, there is a potential for rapid change of trajectories, new social and institutional orders, and a shift of perspectives from an organizational view to cross-organizational ecologies (Tilson et al., 2010b). Such transformations could support global governance and collaboration across national boundaries more in line with the characteristics of societal challenges that are not confined within a country, such as climate change.

An II also has the potential for fast growth in both scope and scale. As an II is open, innovations can occur on multiple sites and be disseminated across the II at a large scale as they are interoperable with the whole (Tilson et al., 2010b). IIs' role as infrastructure also makes them instrumental in transforming sectors (Tilson et al., 2010a) and creating structural change (Tilson et al., 2010a). In the context of climate governance, there is a need for rapid transitions, structural changes, and to re-think governance (Bulkeley & Newell, 2015). Innovation of the information infrastructure might support that.

Summary

In summary, the case studies revealed how the information infrastructure for climate reporting supports governance; by providing quality-controlled and verified information to governance activities and objectives, such as monitoring of progress and evaluation of policy implementation, supporting transparency and accountability, analysis and communication of progress, coordination and collaboration, innovation, and administrative efficiency. Even though this is not the sole solution, it responds to the problems in global governance of policy implementation deficit, weak coordination, trust challenges and power inequalities. The reporting provides facts that can function as a basis for evidence-based negotiations and policymaking. Table Q. summarizes how the GGII responds to some of the key problems in global governance.

Global Governance challenges	GGII contribution
Implementation deficit	• GGII provides information for assessing implementation of global policies and monitoring of progress towards global governance goals. • Reporting requirements require countries to set goals and to develop a plan for implementation. • The reporting of emissions and measures can be used for accountability purposes.
Weak coordination	• GGII coordinates information on a topic and thus supports coordination of actors and activities. • Reporting requires coordination and collaboration among actors, which promotes a collaborative approach.
Insufficient actions	• GGII is a common source for verified information, that can be the basis for collaboration and collective action. Trustworthy information supports evidence-based policymaking.
Power inequalities and trust challenges	• Transparency of emissions, commitments and measures contributes to building trust among actors, as it makes each Party´s measures transparent. This can be the basis for a further discussion regarding responsibilities for measures.

Table Q. How the GGII responds to key challenges in global governance

However, to what degree these features are actualized has not been that clear. Notably, there is an unutilized potential in the re-use of the reporting information. Thus, the case studies have identified areas where the II supports governance, but not to what degree, or what strategies and institutional arrangements are required to have a real-world impact. Additionally, these are the areas that are currently addressed, and there are unknown possibilities for further innovation left to discover. It is also important to acknowledge the limitations of the GGII. Although there is a focus on the potentials and possibilities with the GGII for global climate governance, it does not create real-world change per se. That requires people to act on the information. One risk is that there is too much focus on administrative practices and information management rather than actions with effects on climate change. Nevertheless, from an information systems (IS) perspective, the task in this thesis is to focus on how IS can support global governance. The IPCC has stated that effective governance of climate change requires strong action across jurisdictions, governance levels, actors, and policy areas (IPCC, 2021c). The information infrastructure provides the information resources that can support such coordination and inform actors across sectors, policy areas and governance levels.

Based on the research agenda in the fifth publication on three levels of online interaction (Engvall et al., 2022), insights from the case studies, and literature on information infrastructures, the next section will discuss possible pathways for enhancements of digital global climate governance through cultivation of the climate GGII.

5.3 Pathways for further enhancement of digital global climate governance through cultivation of the GGII

One of the main problems of global climate governance is the weak implementation of policies and insufficient measures related to the real-world problem of climate change (Rosenau, 2017). Thus, there is a need to increase action. The following section will discuss how the climate GGII can support that.

Governance is "the process of steering society and the economy through collective action and in accordance with common goals" (Ansell & Torfing, 2016, p. 4). This requires actors to come to agreements and take appropriate measures. Consequently, facilitating interaction is central in governance.

Global climate governance is characterized by a high level of stakeholder interaction (Obergassel et al., 2022), including government delegations, city leaders, NGOs, business leaders, investors, and others. Thus, interaction among various actors is a central element to consider in the further development of digital global governance. Digital governance research suggests that stakeholder interaction is an area where digital governance has a transformative potential, for example, in government – citizen interaction (G2C), government – business interaction (G2B), government – government interaction (G2G), and also broader digitally oriented societies involving interaction among multiple stakeholders (Engvall & Flak, 2022). Some initiatives have also been introduced in which digital technologies have been applied to support interaction in global climate governance. For instance, digital platforms have been used during COP meetings to facilitate stakeholder participation (UNFCCC, 2021a), and during the pandemic, some climate negotiations were conducted online, although with both positive and negative experiences (Klein et al., 2021). However, to be successful, it is important to understand the dynamics of interactions in the digital context as well as the conditions for developing digital services to support such interactions.

According to Krishnan & Teo (2012), an information infrastructure is imperative for the development of digital governance services and functions (Krishnan & Teo, 2012). In this thesis I suggest that the information infrastructure for climate reporting is 1) a global governance information infrastructure, and 2) an appropriate foundation for further development of digital global climate governance.

A common source of trusted information is crucial for constructive negotiations on a topic. The climate GGII provides a common source of verified information to guide actors in governance activities and is thus crucial for climate governance. The information can be used to monitor and follow up on progress, to inform further policymaking, to evaluate policy implementation and function as evidence in accountability procedures, as well as to inform negotiations, decision-making and prioritization for various stakeholders, such as governments, cities, investors, businesses, and NGOs. Digital technologies can be used to enhance such information services and functions. The fifth publication in this thesis is a conceptual paper that outlines a research agenda on three levels of online interaction (Engvall et al., 2022). The paper situates the climate reporting II in a broader context of climate governance and indicates research areas for different levels of online interaction. Based on insights from the empirical studies and the conceptual framework for online interaction, this section suggests areas for the development of digital global climate governance through cultivation of the climate GGII.

5.3.1 The climate GGII supporting three levels of online interaction

The fifth publication (Engvall et al., 2022) in this thesis uses a framework by Shirky (2008) with three levels of online interaction: information sharing, cooperation, and collective action, to develop a research agenda for stakeholder interaction in digital global climate governance, using the example of the Global Stocktake. In the Global Stocktake, information provided through the reporting is synthesized at a global level to take stock of the implementation of the Paris Agreement, evaluate progress towards its goals, and inform on further needs for measures. The Global Stocktake consists of three phases: information collection and preparation, technical assessment, and consideration of outputs, where further action and international cooperation are encouraged. The Global Stocktake should further be conducted in a transparent manner and involve non-government stakeholders, whose input will be transparently available online (UNFCCC, 2018). The Global Stocktake is thus an important process to mobilize more ambitious actions.

Information sharing implies that there are channels to distribute and access information. Cooperation implies some interaction in the form of conversation, negotiation, and decision-making that results in an agreed upon outcome, as well

as the coordination of a group of actors. Collective action involves interactions where the outcome is composed of decisions that are binding for all members, which is why there has to be a common vision that is strong enough to bind members to common decisions (Engvall et al., 2022; Shirky, 2008). The framework also illustrates that information sharing is the basis for cooperation and collective action. Information sharing is a foundation for transparency, building trust, and formulating common goals. To cooperate, it is vital to share information to identify common challenges and mutual interests, and having access to the same source of information facilitates the forming of a common understanding. Collective action is a central aspect of governance. It is explicated in the definition of governance by Ansell & Torfing (2016), where governance is defined as "the process of steering society and the economy through collective action and in accordance with common goals" (Ansell & Torfing, 2016, p. 4). To steer societies through collective action, it is important to establish a common understanding, formulate common goals and evaluate progress towards those goals. To achieve this, a common source of trusted information is vital, therefore, information sharing is a foundation for governance. In this context, the reporting II is key for information sharing, which further development towards cooperation and collective action can build on. Further enhancements of digital global governance could both improve information sharing functions, as well as support cooperation and collective action. In the following sections, the case of the climate GGII will be discussed in regard to the three levels of interaction: information sharing, cooperation, and collective action.

Information sharing

Information sharing implies that a vast number of actors can share and access information (Shirky, 2008). In a global climate governance context, the level of 'information sharing' includes collection, organization, quality control, and dissemination of information (Engvall et al., 2022). The climate GGII supports such activities. Through the reporting process, countries share information on their emissions, commitments, and measures, which is publicly shared at the UNFCCC website. The procedures for reporting are established, and the next issue to explore is how this information can be utilized. Organization of information resources, means for accessing targeted information and tools for analysis and learning are key areas for effective utilization of information.

Another aspect is how information feeds into relevant governance activities, as well as being utilized in a broader context of data-driven innovation.

Challenges at this level of interaction relate to organizing and making sense of a growing volume of information. According to the Paris Agreement (Paris Agreement, 2015), all countries must report to the UNFCCC according to the same format and frequency, which has increased the number of reports. Previously, developing countries reported according to other formats, and not as regularly and extensively. Every fifth year, information should be synthesized for the Global Stocktake (GST) to evaluate global progress towards the goals in the Paris Agreement and inform the need for further actions. Additionally, there may be a need to make synthetizations to inform COP meetings between the Global Stocktakes. In the paper on online interaction (Engvall et al., 2022), the research agenda suggests that key questions to investigate concerning the information sharing level are

- How can digital technologies be used to organize and disseminate information in comprehensible and inspiring ways to stakeholders?
- How can digital technologies organize information flows?
  This refers to how information flows can support governance activities and objectives of transparency and inclusion of stakeholders (UNFCCC, 2018).

In publication two (Engvall & Flak, 2022c), the level of sophistication of the reporting II is discussed in regard to three types of information systems: Transaction Processing System (TPS), Management Information System (MIS), and Decision Support System (DSS). A TPS has functions to collect, quality control, and store information. A MIS has the capability to link and compare information on progress towards goals, and a DSS has more advanced analytical functions to support planning and decision making (Hendrick, 1994). In the article (Engvall & Flak, 2022c) we suggest that the climate reporting II is primarily at the level of TPS. Although there are some notable examples with MIS functionality that uses the reporting information, such as Panorama (The Climate Policy Council, 2023) in Sweden, the EU climate website (European Environment Agency, 2023), the NDC tracker (World Resources Institute, 2023) and the Climate Action Tracker (Climate Analytics & New Climate Institute, 2022) at the global level, this type of functionality can be further explored. The

reporting information is potentially useful for various stakeholders and purposes, and utilization of the reporting information for innovation and mobilization of climate engagement among stakeholders in various sectors could be further enhanced. Researchers also suggest that to stimulate use of information and meaningful action in a broader context, governments should work proactively with potential users (Reggi & Dawes, 2022). Moreover, the reporting contains vast amounts of information that is a source for learning. Learning about good examples and best practice is a means to strengthen implementation, by raising awareness on possible solutions (Harrould-Kolieb, Van Asselt, Weikmans, & Vihma, 2023). Research questions for further investigation are thus

- How can the GGII facilitate data-driven innovation?
- How can the GGII be cultivated to support learning?
- How can the GGII be cultivated to leverage action by various stakeholders?

At the sharing level, the climate GGII provides information that can be synthesized for evaluation of progress and implementation towards the Paris Agreement and informs actors on further need for measures. However, deeper understanding of what is required for relevant actors to go from access to information to acting on the information is needed.

Cooperation

The next level of interaction after information sharing is cooperation. Cooperation requires more organization compared to information sharing and involves both interaction and coordination to enable interaction, achieve agreements, and set rules on how to navigate from individual ideas to joint results (Engvall et al., 2022; Shirky, 2008). Scholars suggest that information infrastructures can facilitate interorganizational collaboration, communication, coordination, decision-making, and innovation, based on information sharing among organizations (Strader et al., 1998). However, additional functions besides the sharing of information are required to support cooperation. In this section, I will discuss both how the GGII can support cooperation in the global UNFCCC processes, such as the Global Stocktake (GST), and also how the GGII can support cooperation among actors between the high-level UN meetings, in line

with the characteristics of climate governance that are voluntary, decentralized and involving many actors (Bulkeley & Newell, 2015; Jernnäs, 2023).

In the Global Stocktake, technical assessments include workshops and meetings with conversations on progress, based on synthesis reports of what countries report to the UNFCCC, such as the NDC synthesis report (UNFCCC secretariat, 2021). Moreover, views from external stakeholders are also collected to be considered in the process (UNFCCC, 2022c). The technical assessment includes coming to agreement on the state of progress towards the goals in the Paris Agreement. The output of the technical assessments are reports that synthesize an agreed position from the conversations and establishes the need for further measures. This requires cooperation. The GST is a new process, which raises questions about how it should be conducted as well, and what structures, rules, values, and technologies are required to facilitate a constructive outcome. The research agenda in the paper on online interaction (Engvall et al., 2022), suggests that, related to the GST process, key questions to investigate on the cooperation level are:

- What is the role of technology in synthesizing and leveraging actionable information?
- What are the relationships between regulations, digital solutions and consensus forming?
- What organizational, cultural, and competence-related frameworks are needed to facilitate cooperation that produces results? (Engvall et al., 2022)

What is the role of technology in processes of accountability and follow-up on decisions?

This relates to how the GGII can be cultivated, together with institutional structures and processes, to support conversations that reach outcomes that respond adequately to real-world needs.

The global climate governance process will focus onwards on implementation of commitments (Klein et al., 2021), which raises questions concerning how the GGII could be cultivated to strengthen climate action through cooperation. The Paris Agreement builds on voluntary actions (Jernnäs, 2023). An important question is therefore how the GGII could support cooperation between the high-level UN meetings to increase measures. Further research should investigate how

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the GGII could support cooperation to solve common problems. Based on the information provided by the climate GGII, common problems and need for contribution can be identified, which informs initiatives on international cooperation. Synthetization of information can also provide an overview of progress and gaps, which could facilitate coordination among actors, sectors, and governance levels.

Information infrastructures can share information across geographical distances and organizational boundaries and are thus central in inter-organizational learning (Vaast & Walsham, 2009). I suggest that learning also might be a step towards cooperation, by increasing the understanding of common challenges and recognizing mutual interests and goals.

In summary, an information infrastructure that supports cooperation needs functions for information sharing, as well as additional functionalities to enable interaction, conversation, negotiation, and decision-making. Further research is suggested to investigate what types of digital functions could be developed to support cooperation, both related to the UNFCCC processes, as well as to establish structures for a global collaborative environment that enables and supports climate action. The climate GGII can be viewed as a core in the development of a broader digital ecosystem that supports collaboration. Important to consider is that the cooperation level is more complex compared to the sharing level, including social, organizational, and technological aspects. All of those elements must be considered if the climate GGII is to be cultivated towards functions that support cooperation. Moreover, digital technologies can have "dark" sides and lead to destruction of values rather than constructive collaboration (Edelmann, 2022). Research also shows that technologies, such as social media, tend to increase tensions and polarizations (Kushwaha, Kar, Roy, & Ilavarasan, 2022). On the positive side, digital technologies can also be tools for communication that builds trust (Lerouge, Lema, & Arnaboldi, 2023). Digital divide and cyber security are other key challenges to consider in this context. A better understanding of such risks and development of response strategies are thus crucial to enable constructive cooperation.

Collective action

Collective action is the most advanced level of interaction, which includes common goals and decisions. Individual actions are linked to collective goals, and decisions are binding for members of a community (Engvall et al., 2022). There is thus a need to facilitate interaction to agree on decisions, as well as rules and procedures on compliance.

In global climate governance, decisions are made at annual COP meetings. The Paris Agreement has established a common temperature goal to limit global warming, and there are procedures for reporting (Paris Agreement, 2015). But countries themselves decide on goals and measures to contribute to the common goal (Jernnäs, 2023). Thus, it is a very bottom-up and voluntary process. Issues such as accountability are thereby soft, based on shame and blame and there are no penalties if countries fail to meet their commitments. In such a context, the question from an IS perspective is how digital technologies can contribute to inform decision-making, encourage climate action, and support accountability, and thereby strengthen the implementation of the Paris Agreement.

Information infrastructures have an important role in informing decision-making, and as a basis for participation (Beconytė et al., 2022). To support collective action in a global climate governance context, the GGII has a key role in providing verified information that informs and strengthens confidence in decision-making. Moreover, both the EU and the UN work towards data-driven and evidence-based governance. One can assume that fact-based, reliable, and trusted information facilitates the reaching of agreements, which is also more responsive to societal needs. Public access to reports further enables multiple actors to form positions and participate in climate governance.
Development of DSS (Decision Support System) functionalities, which includes more advanced functions for analysis and presentation of information to support planning and decision making, could in this context support processes of policy evaluation and further decision making in the Global Stocktake and COP meetings. COP continuously follows up on progress and needs for further measures. Every fifth year, a Global Stocktake will evaluate common progress and inform governments on needs for additional measures, which are intended to continuously increase (Paris Agreement, 2015). The Global Stocktake and COP meetings are thus important processes for further investigations into how the

GGII could support decisions and outcomes that respond appropriately to the climate challenge.

Although the Paris Agreement implies voluntary measures, the climate GGII lays the foundation for exercising accountability procedures. If countries further decide to strengthen global climate governance to regulated commitments, the reporting will provide the information that is necessary to follow up on compliance. The United Nations has also recently assigned the International Court of Justice to investigate whether pledges under the Paris Agreement could have legal implications and countries could be sentenced for not fulfilling their commitments (United Nations, 2023). If that is the case, the reports will function as legal evidence.

During the covid pandemic some of the climate negotiations were conducted online, which was evaluated in the research project "Building climate diplomacy back better: imagining the UNFCCC meetings of tomorrow" (Klein et al., 2021). The conclusion was that some activities in the UNFCCC processes are more appropriate than others for the digital format. What we need to look at is thus how digital technologies can support the climate governance processes and structures in appropriate ways, whether they are conducted in a physical, digital, or blended format. In the paper on online interaction in digital global governance (Engvall et al., 2022), the research agenda suggests that key questions to investigate on the level of collective action are:

- What are the roles of technology in decision making processes?
- What is the relationship between technology and trust in the negotiation process, how do digital technologies influence the quality of conversations and negotiations, and how to mitigate decisions resulting in the "tragedy of the commons"?
- What is the role of technology in processes of accountability and follow-up on decisions? (Engvall et al., 2022)

A heightened risk in the digital context is false information and sabotage. Thus, research is suggested on the role of information systems in relation to the quality of information, distribution of misinformation (unconsciously sharing misleading or inaccurate information), disinformation (intentionally shared false or misleading information), and fake news (intentionally packaged false information

as real news), which could sabotage productive outcomes of COP meetings (Engvall et al., 2022).

Summary and discussion

Researchers in the digital governance field suggest that digital technologies can transform structures and processes of governance and how stakeholders interact (Engvall & Flak, 2022b). Moreover, it is suggested that digital technologies can enable the transformation of information into actionable knowledge, support stakeholders in the active participation of the development of solutions to societal challenges, and provide avenues for collective action (Johnston, 2010). Global climate governance is currently in a phase where the rulebook under the Paris Agreement is established (UNFCCC, 2018), and there will be a greater focus on implementation of commitments and measures (Klein et al., 2021). Given that background, further research should investigate how digital global climate governance could be innovated to support climate action and effective implementation of the Paris Agreement. While considering the risks of introducing digital technologies in a context characterized by multiple interests and potential conflicts.

The research agenda for online interaction in digital global governance identifies key research questions related to different levels of online interaction: information sharing, cooperation, and collective action (Shirky, 2008), which are relevant to consider in further development of digital global climate governance. The information sharing level lays the foundation for transparency in global climate governance and provides information that can be leveraged by individual actors. In a broader context of policy implementation between the high-level UNFCCC meetings, the next level of interaction, cooperation, is the level that I suggest has the greatest potential to leverage climate action. Since the means for implementation, such as allocation of resources, are primarily within the authority of the states (and private actors), international cooperation is suggested to facilitate solutions and thus strengthen policy implementation (Zürn, 2010). Moreover, one of the problems in global climate governance is that the consensus-oriented procedures of the collective action level do not deliver sufficient outcome, since everyone has to agree on everything (Klein et al., 2021). Focusing on the cooperation level, which does not require all states to

agree, could thus be a promising next step for further cultivation of the GGII, to increase measures that contribute to the overall goals in the Paris Agreement. Additionally, the cooperation level allows non-state actors to actively contribute, including investors, businesses, and civil society. Further research is suggested to investigate how the climate GGII can be cultivated to support cooperation to strengthen implementation of the Paris Agreement.

This thesis recognizes that the topic of interaction among actors in global climate governance relates to climate diplomacy, and the subject of digital diplomacy. Diplomacy is the institutional framework for international negotiations and is about solving international problems in a peaceful way (Aggestam, 2021), conducted by states and other entities with standing in world politics (Westcott, 2008). Digital diplomacy includes the use of digital technologies for diplomatic tasks (Almuftah et al., 2016; Sotiriu, 2015). However, more research is needed to conceptually clarify the relationships between digital global governance and digital diplomacy, as well as the role of global governance information infrastructures in relation to digital diplomacy. This has not been included in the endeavor of this research project. Moreover, the ideas of digital diplomacy, including an emphasis on international collaboration rather than proclaiming national interests, and leverage of digital technologies (Gilboa, 2016; Sandre, 2015), is worth exploring related to the ideas in this thesis on supporting cooperation to strengthen the implementation of the Paris Agreement.

This section has discussed possible avenues for cultivating the climate GGII to support stakeholder interaction in digital global governance, through services and functions related to three levels of interaction, information sharing, cooperation, and collective action. The three levels of interaction also imply different levels of complexity and require different types of maturity. Some activities can be suitable for a digital format, while others are more suitable to have in-person. There may also be blended solutions, where the GGII supports both in-person and digital interaction. Suggested areas for research and innovation are summarized in Table R.

Level of interaction	Areas for enhancements
Information sharing Information is collected, organized, and shared among a large group of actors.	• How can the means for utilizing the reported information be improved, including organization of information resources, means for accessing targeted information, and tools for analysis and learning? • How can information flows be organized to support governance activities and effective participation? • How can MIS functionalities (Management Information System) for analysis and presentation of information related to governance objectives be enhanced? For instance, to illustrate global progress linked to climate governance goals and indications of areas that need further emphasis and global policy making. • Develop strategies and dialogues with stakeholders and explore how the GGII can be cultivated to promote data-driven innovation and mobilize action. What is required to close the gap between access to information and action?
Cooperation Cooperation involves both interaction, coordination, achieving agreements, and setting rules on how to navigate from individual ideas to joint results. Cooperation can include a selected number of actors.	• Investigate how the GGII can be cultivated to support cooperation in COP processes such as the technical assessment in the Global Stocktake, including - the role of technology in synthesizing and leveraging actionable information to facilitate conversations and reach agreements; - developing structures and processes to promote cooperation, including rules, organizational arrangements, technology, competences and values; • Investigate how the GGII can be cultivated as a foundation for a digital global governance ecosystem that supports and enables international collaboration among various actors and sectors.
Collective action Individual actions are linked to collective goals, and decisions are binding for members of a community.	• What decision support system (DSS) functionalities could be developed on the GGII, to support planning and decision-making in global climate governance? • How can the GGII be cultivated to support global collective action that responds sufficiently to real-world problems, from identifying a need to decision-making and ensuring implementation and compliance? • How can the GGII be cultivated to strengthen accountability? • What are the relationships between elements of the GGII and building and maintaining trust?

Table R. Summary of suggested areas for research and innovation of the climate GGII

The information infrastructure for climate reporting that has been studied in this thesis includes government reporting. However, as has been discussed in this thesis, global climate governance requires action by multiple actors, not just governments. A challenge of global governance is also that the number of actors and sites of authority creates fragmentation (Rosenau, 2017). A question is thus how the GGII can be cultivated to facilitate coordination.

5.3.2 Connecting different climate reporting information infrastructures to support coordination

To mobilize action across the world, COP has assigned two high level climate champions to coordinate the work of governments with voluntary actions by non-state actors, such as cities, regions, businesses, and investors (UNFCCC, 2022g). The campaigns Race to zero and Race to resilience include reporting on action plans and results by non-state actors (Climate Champions, 2023). Information infrastructures can grow through cultivation of the installed base, but also through connecting networks and infrastructures (Hanseth, 2010; Hanseth & Monteiro, 1998). Cultivation of the climate GGII could thus potentially include a connection with the reporting within the campaigns Race to zero and Race to resilience. The case studies in this thesis have only investigated government reporting, and not the reporting within the campaigns of the climate champions. Further research is suggested on cultivation of the GGII to support coordination between governments and activities within the frames of the climate champions. Following, I will raise some possible avenues for further cultivation of the GGII.

Hypothetically, the reporting in the campaigns Race to zero and Race to resilience may develop to an II for non-state actors, which could theoretically be connected to the GGII investigated in this thesis. This is exemplified in Figure H.
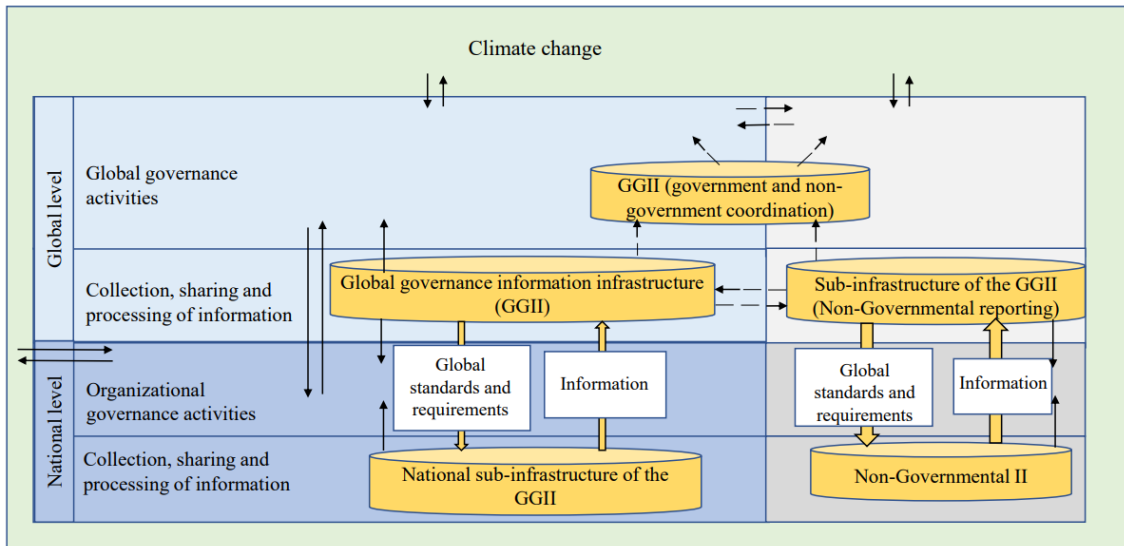
Figure H. Connecting government reporting II and non-governmental reporting II

This figure has the elements that the GGII model has, but additionally, there are other potential IIs, based on non-governmental reporting, such as reporting from companies and cities, that can be coordinated with information from government reporting. Connecting government and non-governmental information infrastructures could be a means for coordination among sectors and stakeholders, and between policymaking and non-state efforts. However, more research is required to investigate that relationship, and it is outside of the scope of this thesis.

Nevertheless, in explorations of further evolvement of the climate GGII, there are certain aspects to consider, such as the evolutionary characteristics of information infrastructures in general and governance of the GGII. Moreover, because information infrastructures evolve together with organizational structures and processes, it is important to deal with the innovation of a GGII concurrently with the evolvement of global governance structures and processes.

5.3.3 Cultivation of the installed base of the climate GGII to advance global climate governance

When considering how digital global climate governance could develop based on cultivation of the climate GGII, we should consider how IIs in general evolve, and how it can support collaboration to leverage climate action.

IIs grow through cultivation of the installed base, and by linking various networks and integrating individual applications (Hanseth & Monteiro, 1998). Standards ensure interoperability and compatibility (Bowker & Star, 1998), coordinate heterogeneous actors towards a common objective (Fomin, 2003), and enable re-use of solutions across domains and organizations and upscale of innovations. However, while standardization ensures stability of the infrastructure, it is also important to have flexibility to enable generativity and local adaptations to different needs and new possibilities (Grisot & Vassilakopoulou, 2013). It is especially important in a digital global governance context, characterized by extensive differences and conditions (Evans & Yen, 2006), such as digital divide (Ayanso et al., 2014), and different approaches to democracy (Lidén, 2018).

Since IIs are embedded in social structures and processes, they have a transformative potential (Tilson et al., 2010a). Through cultivation of the installed base of the climate GGII, there is a potential to reform structures and processes and develop new workings, functions, and services that support governance of climate change. If we are going to meet the goals in the Paris Agreement, the climate transition has to go much faster (IPCC, 2021a), which requires action on a broad scale by multiple actors. As was also expressed in the report on digital climate diplomacy, "We need to design a process people didn't know they needed." (Klein et al., 2021, p. 4).

Information infrastructures support a broad range of actors and activities, where different actors can develop and add components and no one is overall in charge of the II (Aanestad et al., 2007; Star, 1999). IIs further coevolve with organizational structures and work practices (Aanestad, 2017a). They are both shaping and being shaped by social structures and practices (Vaast & Walsham, 2009). Thus, development of the GGII is intertwined with the development of global governance structures and processes. In cultivation of a GGII, we therefore need to consider how it co-evolves with global governance, and what

the characteristics and main challenges of global governance are. To succeed, it is important that process innovation and innovation of the infrastructure are aligned (Bygstad, Hanseth, Siebenherz, & Øvrelid, 2017).

Global climate governance is characterized by voluntary actions, polycentric networks and partnerships (Jernnäs, 2023). Therefore, cultivation of the GGII needs to support collaboration among various networks and actors. Research on collaborative digital ecosystems may give some guidance in this area. Collaborative digital ecosystems are digital ecosystems that do not have one dominant actor, and where the aim is to solve problems that individual actors are not able to solve by themselves. Central in these ecosystems is an interplay between collaborative governance and collaborative architecture. A collaborative architecture is "a technical structure that is not designed top-down but evolves through adaptations and innovations (…) with components from several actors in interplay" (Bygstad et al., 2022, p. 3). Collaborative governance in this context refers to "decision rights distributed in the ecosystem structure" (Bygstad et al., 2022, p. 4), including platform resource governance, user service governance, and ecosystem governance (Bygstad et al., 2022). IT architecture and governance support each other, and architecture-governance configurations are key to shaping an environment that in some sense is self-organizing and facilitates stakeholder interaction to solve common problems. Since IIs are such large systems, the focus should not be on designing solutions centrally, but to facilitate transformation by various actors (Bygstad et al., 2022). Bygstad et al. (2022) further propose a combination of top-down and bottom-up governance, where the more stable elements are suggested to be governed top-down, and the more unstable elements are managed decentralized. I propose further research to explore whether collaborative digital ecosystem could be a way forward for digital global climate governance, to develop an infrastructure that supports and enables climate action through collaboration.

5.4 Summary

This section has discussed the findings in the publications in regard to the conceptual framework, to respond to the research questions for this thesis:

RQ1: What is digital global governance?

RQ2: How do information systems support global climate governance?

RQ3: How can digital global climate governance be enhanced?

Section 5.1 discussed what digital global governance is. The literature reviews and conceptualizations of digital governance and digital global governance form the basis for this discussion.

Section 5.2 responded to research question 2 concerning how information systems support global climate governance. First, the conceptual foundation for analyzing the case of international climate reporting was established through the lens and characteristics of information infrastructures. Then, the GGII model developed in Chapter 2 was applied to the case of climate reporting, which illustrated the relationship between the climate reporting II and global climate governance. This was followed by a discussion of how the climate reporting II supports governance.

Section 5.3 discussed pathways for further enhancements of digital global climate governance through cultivation of the climate GGII, where the role of climate reporting was contextualized in a broader context of stakeholder interaction in global climate governance. Based on three levels of interaction: information sharing, cooperation, and collective action, areas for further research and enhancements of the GGII were suggested. Moreover, issues related to cultivation of information infrastructures, and possibilities of collaborative digital ecosystems were discussed.

6. Conclusions and implications

6.1 Conclusions

The objective of this thesis was to deepen the understanding of digital global governance, how information systems support global climate governance and how digital global climate governance can be further developed. To that aim, the studies in this thesis have been comprised of literature studies and case studies of climate reporting. The thesis provides both conceptual and empirical results, as well as suggestions for enhancements of digital global climate governance.

6.1.1 Conceptual contributions

Conceptual contributions of the thesis include definitions of key concepts. 'Digital governance' is defined, and the novel concepts 'digital global governance' and 'global governance information infrastructure' are introduced and defined. A theoretical framework on global governance information infrastructure is developed based on an integration of digital governance, global governance, and information infrastructure literature. The GGII model (global governance information infrastructure model) proposed in the thesis illustrates the relationship between a global governance information infrastructure, global governance, and global challenge. The fifth publication (Engvall et al., 2022) introduces a conceptual framework for three levels of online interaction: information sharing, cooperation, and collective action (Shirky, 2008), which related to the case in the thesis, can be applied to guide climate governance from a paradigm of transparency to a paradigm of climate action.

'Digital governance' and 'Digital global governance'

The first publication of this thesis (Engvall & Flak, 2022b), which was based on an interpretive literature review on the meaning of the scientific concept of digital governance, suggests the following definition of digital governance:

> "Digital governance is defined as digital technologies ingrained in structures or processes of governance and their reciprocal relationships with governance objectives and normative values. Digital governance includes the utilization of digital capabilities and involves a transformation of structures, processes, or normative values" (Engvall & Flak, 2022b, p. 44).

Digital global governance is digital governance applied in global governance. Thus, in the thesis, an additional literature review draws on and synthesizes digital governance, governance, and global governance literature to deepen the understanding of digital global governance. Governance includes the steering of society and the economy in accordance with common goals, through collective action (Ansell & Torfing, 2016). Global governance implies an exercise of authority across national borders and is justified by transnational problems and global common goods (Zürn, 2018a). Global governance includes both formal and informal steering mechanisms (Finkelstein, 1995; Rosenau, 2004), and encompasses structures, processes, and policies (Zürn, 2010). In global governance there is no central, sovereign authority such as a government. It is characterized by governance with governments or without governments, rather than by governments (Zürn, 2010). Moreover, multiple governance levels are often involved (Enderlein et al., 2010), as well as various actors, resulting in multiple spheres of authority (Dingwerth & Pattberg, 2006). Key challenges in global governance relates to policy implementation deficiencies (Rosenau, 2017), inadequate response to real-world challenges (McKeon, 2017; Rosenau, 2004), challenges of coordination (Bulkeley & Newell, 2015; Rosenau, 2000), and power inequalities (Acharya, 2017; Zürn, 2018b). Understanding of digital global governance requires an understanding of global governance structures, processes, objectives, and characteristics, as well as the challenges it aims to improve.

'Digital global governance' is defined in Section 2.3 in this thesis as:

> Digital global governance is defined as digital technology ingrained in structures or processes of global governance and their reciprocal relationships with global governance objectives and normative values. Digital global governance includes the utilization of digital capabilities and involves a transformation of structures, processes, or normative values.

The definitions of digital governance and digital global governance are identical, except that 'global' is added to digital governance in 'digital global governance', to explicitly articulate the global governance setting.

Global governance information infrastructure

'Global governance information infrastructure' has, in the thesis, been introduced as a concept to describe an information infrastructure that is ingrained in global governance structures and processes and is also a foundation for digital global governance. In Section 2.4 in this thesis, the following definition is proposed:

> A global governance information infrastructure is a globally shared, open, heterogeneous, and evolving sociotechnical system, built on an installed base encompassing standards, technology, organizations, and people. A global governance information infrastructure is ingrained in global governance structures and processes, with reciprocal relationships with global governance objectives and values. A global governance information infrastructure enables global exchange, management, and dissemination of information and the development of digital global governance services and functions.

The GGII model illustrates how the II is embedded in global governance, and also relates to the global challenge/global common good in question. The information provided through, and information services developed on, the II thus aim to support global governance activities and objectives to ensure the global common good.
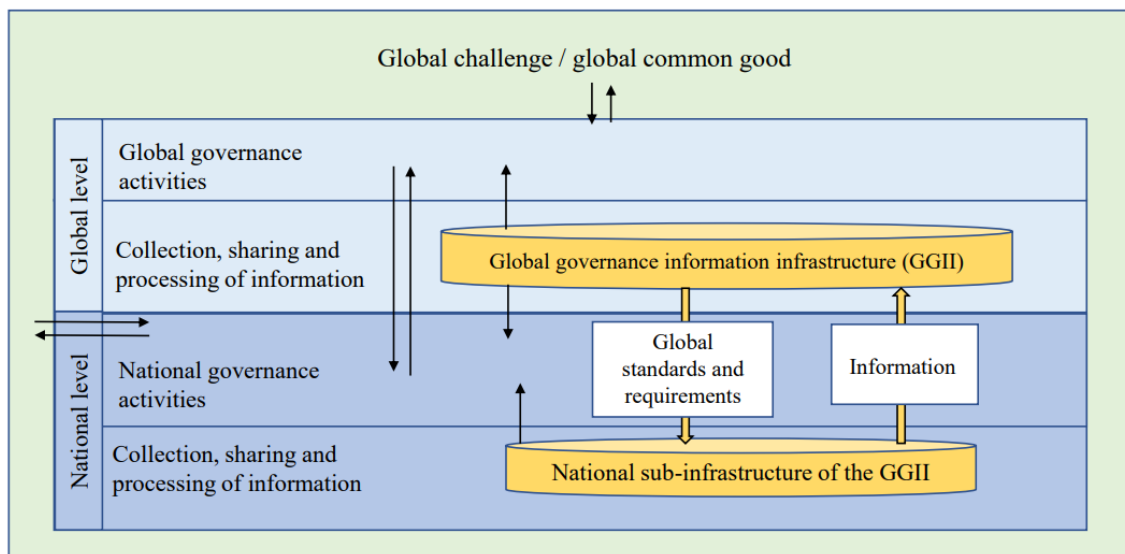
Figure I. The Global Governance Information Infrastructure model

The GGII model has been applied to the empirical case of climate reporting, to deepen the understanding of the role of information systems in global climate governance. A conclusion is that the model facilitates an understanding and thus contributes meaning. The model should be further tested on other cases of global governance as well.

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6.1.2 Empirical contributions

Empirically, the thesis provides insights on a case of digital global governance, i.e., UNFCCC climate reporting. This is a valuable empirical contribution to the digital governance field, which has little research on the global governance setting. It is further a valuable contribution to the information systems field through the insights on the role of information systems in global climate governance.

The thesis establishes that the information infrastructure underlying the climate reporting is a foundation for global climate governance. It provides verified information on GHG emissions, countries´ commitments and measures, which is used to monitor progress, follow up on implementation of the Paris Agreement, and inform further decision making. The information infrastructure further enables transparency, which is a central objective of global climate governance to build confidence and mutual trust among Parties. The reporting requirements are framed in what is called the 'Enhanced Transparency Framework', which is the backbone of the Paris Agreement (Paris Agreement, 2015). The thesis reveals how the information infrastructure (II) for climate reporting, as an example of a global governance information infrastructure, materializes in practice.

Case study 1 investigates the reporting process from the national to global levels, and uncovers the elements of the II, including IT artefacts, information, standards, actors, and regulatory frameworks. One conclusion is that the reporting II provides basic functionalities to collect, quality control and disseminate information but there is a large potential for further utilization of the information. Even though some initiatives can be found on more advanced use of digital technologies, advancements towards an MIS (management information system) and DSS (decision support system), particularly at the global level, are suggested. Such development should be guided by user needs among various stakeholders to promote the advancement of the GGII with an emphasis on mobilizing action.

Case study 2 investigates how digital technologies in the climate reporting II at the national level (Sweden) supports governance. Case study 3 investigates how the digital platform for EU climate reporting, Reportnet, supports governance at a supranational level. The findings are summarized in Table S. The information

systems at national and supranational levels are arrangements that can be viewed as sub-infrastructures of the climate GGII.

Case 2 National Level (Sweden)	Case 3 Supranational Level (the EU)
Monitoring	Monitoring and evaluation of progress
Assess countries implementation of climate policies	Facilitate compliance and assessment of compliance
Transparency	Transparency
Analysis, visualization & communication	Analysis, visualization & communication
Coordination & collaboration	Efficient information management
Innovation	Information quality

Table S. Summary of how the II supports governance.

In summary, the information infrastructure (II) for climate reporting supports governance objectives and activities such as monitoring and evaluation of progress; compliance and accountability; transparency; analysis and communication of reports (containing information on countries´ GHG emissions, commitments, measures, and projections); coordination and collaboration; and innovation, which can be applied at multiple governance levels. Moreover, the II supports administrative efficiency for tasks such as submission procedures, and trustworthiness of information through quality controls and review.

The GGII further responds to some challenges of global governance, such as the implementation deficit, weak coordination, insufficient actions, and power inequalities and trust challenges, which are summarized in Table T.

Global Governance challenges	GGII contribution
Implementation deficit	• GGII provides information for assessing implementation of global policies and monitoring of progress towards global governance goals. • Reporting requirements require countries to set goals and to develop a plan for implementation. • The reporting of emissions and measures can be used for accountability purposes.
Weak coordination	• GGII coordinates information on a topic and thus supports coordination of actors and activities. • Reporting requires coordination and collaboration among actors, which promotes a collaborative approach.

Insufficient actions	• GGII is a common source for verified information, that can be the basis for collaboration and collective action. Trustworthy information supports evidence-based policymaking.
Power inequalities and trust challenges	• Transparency of emissions, commitments and measures contributes to building trust among actors, as it makes each Party´s measures transparent. This can be the basis for a further discussion regarding responsibilities for measures.

Table T. How the GGII responds to key challenges in global governance

6.1.3 Enhancements of digital global climate governance through cultivation of the GGII

One of the major problems in global climate governance are challenges with policy implementation and insufficient measures and actions related to real-world needs (Rosenau, 2017). The fifth publication in this thesis (Engvall et al., 2022), which is a conceptual paper, situates climate reporting in the context of digitally supported interaction in global climate governance. The paper suggests a research agenda for online interaction in global climate governance based on three levels of interaction: information sharing, cooperation, and collective action. The research agenda is exemplified by the Global Stocktake, which is the process to evaluate progress towards the goals in the Paris Agreement and inform of the needs for further action.

In the thesis, further enhancement of digital global climate governance through cultivation of the climate GGII, related to the levels of information sharing, cooperation, and collective action, is discussed, both related to the UNFCCC processes such as the Global Stocktake, but also in a broader context of policy implementation between high-level UN meetings. The climate GGII primarily corresponds to the level of shared information, which is an important foundation, but further use of digital technologies to support cooperation and collective action is suggested to be explored in a way that is appropriate, considering the delicate global political situation and risks of misinformation, sabotage and cybersecurity threats, as well as digital divide (Antwi-Boateng & Mazrouei, 2021; Engvall et al., 2022). Following, the main issues to further investigate and develop are discussed.

At the information sharing level, I propose that means for utilizing the reported information can be improved, including means for organizing, accessing, and analyzing information, to support understanding, learning, and informing governance activities. Moreover, strategies and dialogues with stakeholders should be developed to promote data-driven innovation and mobilize action. More research is required to close the gap between access to information and action.

At the cooperation level, I propose that further research should investigate how the GGII could be cultivated to support cooperation in the UNFCCC processes, such as the Global Stocktake. This includes, for instance, means for synthesizing information in a way that facilitates conversations that achieve adequate agreements. From a socio-technical view, research is also suggested on how structures, processes, rules, technology, competences, and values could coevolve to support cooperation. In a broader global climate governance context, I further propose to investigate how the GGII can be cultivated as foundation for a digital global climate governance ecosystem that supports and enables international collaboration among various actors and sectors, in a way that builds and maintains trust and ensures legitimacy and accountability.

At the collective action level, further decision support system (DSS) functionalities could be developed on the GGII, to support planning and decision-making in global climate governance. Issues to investigate are further how the GGII could be cultivated to support global collective action that responds better to real-world problems, from identifying a need, to decision-making and ensuring implementation and compliance and accountability. Moreover, research is suggested to improve the understanding of the relationships between elements of the GGII and building and maintaining trust.

At all levels of interaction, it is imperative to address the risks of misinformation, disinformation, cyber security, and digital divide, and what is required to build and maintain trust. The strategy of developing digital global climate governance through cultivation of the GGII provides a theoretical foundation for further innovation, which includes both social, technological, and organizational elements and consider the co-evolving of system development and organizational structures and work practices (Aanestad et al., 2017). I further propose to explore the possibilities to cultivate the GGII to support a collaborative digital ecosystem that facilitates problem solving through collaboration (Bygstad et al., 2022). To

solve the climate crisis, extensive measures must be taken by many different actors. We thus need an infrastructure that supports that.

To summarize, the thesis makes the following contributions related to the research questions:

1) What is digital global governance?
Based on literature studies, this thesis has proposed a definition of digital global governance, and further discussed its meaning based on the understanding of digital governance and global governance. Through empirical investigations of a case of digital global governance (the UNFCCC climate reporting), the understanding of how digital global governance can materialize is further deepened.

2) How do information systems support global climate governance?
Case studies of climate reporting have revealed how an information infrastructure (which is a type of information systems) is a foundation for global climate governance, and how it supports governance activities at different levels of governance. The characteristics and role of information systems related to climate governance have been investigated from a sociotechnical view, through the lens of information infrastructures. Although this is not the *only* way that information systems support global climate governance, it is a case that illustrates the central foundation of the global climate governance framework.

3) How can digital global climate governance be enhanced?
Guidance for further enhancements of digital global climate governance is suggested based on cultivation of the installed base of the climate GGII, thus indicating how information systems could further support global climate governance.

6.2 Implications for research

This thesis has addressed the weak theoretical foundations and understanding of the role and implications of information systems in global governance by proposing novel definitions of digital governance, digital global governance, and global governance information infrastructures. Moreover, the thesis makes a theoretical contribution to the knowledge foundation of digital global governance, by integrating previously separate theoretical elements (such as

global governance, digital governance, and information infrastructures; and digital governance and online communities) to develop conceptualizations and understanding of the phenomenon of digital global governance; generalizing knowledge to higher level constructs such as the GGII model; and suggesting new propositions by theorizing the relationship between digital governance, information infrastructures and global governance. The knowledge developed in the thesis primarily falls into the category of understanding, describing, analyzing, and conceptualizing a phenomenon (Gregor, 2006). The theoretical basis developed in the thesis is then used to discuss further enhancements of digital global climate governance through cultivation of the GGII.

Furthermore, I have shown how 'information infrastructures' (II) is a valuable conceptual foundation for digital global governance. Information infrastructures provide a holistic perspective and hence contribute with an overview – something that is a challenge in global governance due to its scattered nature. Moreover, information infrastructures, which are characterized by large and complex networks of systems where nobody has the overall control, align well with the characteristics of global governance, which comprises multiple actors, governance levels, and sites of governance (Bulkeley & Newell, 2015), and there is no overarching authority (Weiss & Thakur, 2010). The approach to II design, by cultivation of the installed base (Aanestad et al., 2017; Hanseth & Lyytinen, 2008), can guide further development of digital global climate governance. Information infrastructure, as a phenomenon and as a theoretical approach, is thus an adequate foundation for the understanding and development of digital global climate governance. The use of 'information infrastructures' (II) in a global governance context, including the conceptualization of 'global governance information infrastructures' is both a theoretical and empirical contribution to II theory. The GGII model is a theoretical contribution that specifies the meaning of II in a global governance context.

In this thesis, I have argued that there is a need for more research on digital global governance. Research on the global governance setting, which has unique conditions and challenges, has been scarce in the digital governance field. This has left us with an insufficient understanding of how digital governance can be appropriately applied to support global governance objectives. Digital technologies are increasingly employed in global governance structures and processes, and I encourage the digital governance field to extend its research

agenda to offer a greater contribution to the global governance domain. To provide clear theoretical guidance on the utilization of digital technologies in response to global governance challenges. The case studies in this thesis contribute empirical insights that provide greater understanding of aims, characteristics, and challenges in the global governance realm, which digital governance seeks to respond to. My intention is also that the conceptualizations of 'digital global governance' and 'global governance information infrastructure' will ignite further research on digital global governance.

6.2.1 Future research

Further research is suggested along the following pathways to validate and further develop the theoretical and empirical foundation for digital global governance:

- Validation of the conceptualizations presented in this thesis, such as digital governance, digital global governance, and global governance information infrastructure.
- Validation of the GGII model in different global governance settings.
- Theorization of digital diplomacy in relation to the conceptualizations of digital global governance and global governance information infrastructure.
- Theorization of the role and characteristics of information in a global governance information infrastructure.
- Investigations concerning further cultivation of the climate GGII, related to the levels of information sharing, cooperation, and collective action, considering different stakeholder needs.
- Investigations of how a global collaborative digital ecosystem can be cultivated, based on the climate GGII.
- Investigations into what is required to close the gap between information access and action, and to facilitate the transition from a paradigm of transparency to a paradigm of climate action.
- Investigations of how the climate GGII can facilitate rapid transformation towards the goals in the Paris Agreement, including what regulatory, institutional, technological, cultural, and competence-related aspects are

required, considering risks of misinformation and disinformation, tensions, and conflicts, as well as cyber security and digital divide.

- Investigations of how monitoring and governance of the climate GGII could be organized, to strengthen positive and mitigate negative cycles of reinforcement.
- Empirical investigations of digital global governance efforts to enrich the empirical insights concerning the global governance setting in the digital governance field.
- Further theorization to build a knowledge foundation for digital global governance that effectively responds to global challenges.

6.3 Implications for practice

The thesis provides conceptual and empirical insights about international climate reporting related to climate governance, which can provide new and deeper understanding of the complex relationships between information infrastructure and global governance. Specifically, the thesis provides insights into the relationships between the information infrastructure and certain governance activities. This insight can be used actively in the further cultivation of the information infrastructure to increase the chance of faster and more accurate digital global climate governance. It is relevant to those working strategically with digital governance in public administration at national, supranational, and global (such as the UNFCCC secretariat and the UN Secretary General´s office) levels, policymakers, CIOs, and those who work with reporting activities, in collaboration with relevant stakeholders.

The overview of the reporting process, identification of key IT artefacts in the process and their use, along with identification of other elements of the information infrastructure (II), provide a common understanding for people in different roles, and can be useful in the cultivation of the II and process innovation.

Findings from the case studies reveal some common as well as specific challenges for each governance level. For example, making large volumes of information comprehensible and inspiring for stakeholders to act upon is a challenge at all levels, but with different breadth and depth. The global level

handles larger volumes of information, has delicate diplomatic conditions, as well as multicultural aspects to consider to a greater extent. All case studies suggest that an area for improvement is the utilization of digital technologies to make better use of the reporting information to support action among various stakeholders, as well as cooperation and collective action.

The thesis provides concrete examples of questions for further investigation and development, structured according to three levels of interaction: information sharing, cooperation, and collective action. This provides guidance for further development and issues to be considered at each level of interaction, which can support a transition from transparency to climate action. A suggested next step is to explore how the climate GGII can be cultivated to support international collaboration to deliver on the goals in the Paris Agreement.

6.4 Final remarks

My final remark in this thesis is this: We have the future in our hands, and as climate change is caused by human activities, we also have the power to enact change. It is a matter of choice and action, but such change requires the governance of multiple actors throughout society. In the field of information systems, the key question for us to ask is how digital technologies can be leveraged to support this necessary evolution.

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8. Appendixes

Appendix A Research publications

#	Research Publications
1	Engvall, T., & Flak, L.S. (2022). Digital governance as a scientific concept. In Y. Charalabidis, L. S. Flak, & G. Viale Pereira (Eds.), *Scientific Foundations of Digital Governance and Transformation. Concepts, Approaches and Challenges* (pp. 25-50): Springer.
2	Engvall, T.S., & Flak, L.S. (2022). The state of information infrastructure for global climate governance. *Transforming Government: People, Process and Policy, 16*(4), 436-448.
3	Engvall, T. (2021). Exploring the Impact of Digital Global Governance through Affordance Theory: the Case of Climate Reporting. *EGOV-CeDEM-ePart 2021*, September 7-9, Granada, Spain.
4	Engvall, T., & Flak, L.S. (2022). Affordances of e-reporting on a supranational level: the case of Reportnet. *EGOV-CeDEM-ePart 2022*, September 6-8, Linköping, Sweden.
5	Engvall, T., Flak, L.S., & Sæbø, Ø. (2022). Sharing, Cooperation or Collective Action? A Research Agenda for Online Interaction in Digital Global Governance. *EGOV-CeDEM-ePart 2022*, September 6-8, Linköping, Sweden.

Digital Governance as a Scientific Concept

Tove Engvall and Leif Skiftenes Flak

Abstract

The term eGovernance has been used for almost 2 decades and suggests a relationship between some electronic—or digital—aspects and governance in a traditional form. Several scholars have pointed out that eGovernance has been defined and used in a number of ways in the academic discourse. This is problematic as it may hinder the development of cumulative knowledge and robust theoretical constructs. To investigate how eGovernance has been used and understood, we reviewed the eGovernance and digital governance literature to identify the theoretical foundations and to understand variations in the use of the term. Our overall objective was to contribute to a consolidation of the understanding and use of the term. This chapter suggests that there is considerable variation in how eGovernance is understood and applied in the literature. Recently, some argued that eGovernance has evolved into the term "digital governance". Although there seem to be more theoretical contributions related to the concept of eGovernance and the digital aspect of digital governance has been slightly more elaborated, we found no clear conceptual distinctions between the two concepts and used digital governance for our conceptualization. To provide clarity, we posit that governance and digital are basic elements of digital governance. Further, we found that digital governance is typically either studied with emphasis on the use of ICT in governance or on structural or normative transformational outcomes of digital governance. As a novel contribution, we suggest a definition of digital governance.

Keywords: eGovernance, Digital governance, Concept analysis

1. Introduction

Development of concepts is a central part of the development of a scientific discipline. Concepts enable generalization and transfer of understanding. It can clarify phenomena and create order. Development of concepts and theory are intertwined. The better the concepts are, the better theories can be developed (Khazanchi, 1996). "In essence, conceptual development provides a means of crisply defining and elaborating ideas regarding certain phenomena" (Khazanchi, 1996, p. 1).

It is fundamental that concepts are clear and understandable, and there should be a strong underlying logic and rationale behind a concept and theory. A common problem though is that concepts are often interpreted in inconsistent and ambiguous ways (Conboy, 2009). There is rarely a clear agreement on their meaning, and the IS field has even more challenges due to its continuously changing environment and technologies (Khazanchi, 1996). The management information systems (MIS) field has for instance been criticized for its lack of a

formal and consistent development, and a methodology for construct development in MIS is suggested by Lewis et al. (2005). They argue that in construct development, level of analysis and philosophical aspects with different levels of abstraction ought to be addressed (Lewis et al., 2005). Characteristics of qualities of a concept are, for instance, clarity, parsimony, possible applications of the concept, theoretical glue and whether it is cumulative (building on research in the field) (Conboy, 2009).

Concepts and theories can be native or imported. A native theory for the IS field is a theory that is developed specifically for IS phenomena, while an imported theory is borrowed from another discipline (Straub, 2012). Concepts have an important role in different ways. Wand and Weber (1988) have for instance modelled information systems based on definitions on central concepts. It is used to formalize aspects of information systems, to develop requirements for information systems, formalize the representation (of the real world) and perceived system and develop a theoretical foundation for decomposition (Wand & Weber, 1988). Information systems (IS) theories have also been categorized according to five types that provide analysis and description, explanation, prediction, explanation and prediction or prescription (design and action) (Gregor, 2006).

A scientific foundation for the digital governance field has recently been requested (Charalabidis & Lachana, 2020a, 2020b), and conceptual development is an important element of such a foundation. The digital governance concept can be seen as an evolvement of the eGovernance (electronic governance) concept (Misuraca & Viscusi, 2014). Bannister and Connolly (2012) noted a decade ago that eGovernance had so far been used with considerable elasticity in the literature and that this is unfortunate as the consequence is that there is no agreed upon definition of the term. They especially emphasized the blurred lines between eGovernance and eGovernment and suggested that the two terms were often used haphazardly in the literature.

Over the years, a number of competing or overlapping terms have been suggested and used. In addition to the already mentioned digital governance, eGovernance and eGovernment, terms such as open government (Misuraca, 2006), joined-up government (Mundkur & Venkatesh, 2009), smart governance (Alotaibi, 2019) and digital era governance (Dunleavy, 2006) have emerged in the literature. While some of these may offer nuances or distinctions adding to the existing understanding of eGovernance, our fascination for developing new terms may also inhibit us from a deep necessary understanding of the basic terms and concepts in our field of study. Nevertheless, to be certain to include both early and recent developments, we decided to study both eGovernance and digital governance.

In light of the above, we wanted to investigate if Bannister and Connolly's concerns from 2012 are valid today or if there has been a clear conceptual consolidation of the field of eGovernance and digital governance. We were specifically interested in how the literature uses the eGovernance concept, but also how governance and technology are understood, and how this has evolved into the term of digital governance.

1.1 Method

This chapter is based on a literature review. A literature review enables us to build on and extend existing knowledge, discover what is already known and stimulate further research

(Levy & Ellis, 2006). The digital governance field is a relatively young field and also an interdisciplinary field that draws on multiple theories, why literature reviews may seem to be a challenging task. Nevertheless, it is important for theory development to accumulate knowledge and for the distinctness of a field. Literature reviews can also be used to describe and analyse concepts (Webster & Watson, 2002).

This chapter is based on an inductive and interpretative study of the concepts eGovernance and digital governance. The aim of an interpretative study of concepts is to describe and interpret meanings of concepts and their definition, as it is formulated in written texts, and to formulate new definitions where it is needed (Nuopponen, 2010). The quality of an interpretative study of concepts, such as rigour and plausibility, relates to the interpretative ability of the researcher (Takala & Lämsä, 2004). The interpretation of concepts will be affected by research approach. Four types of interpretative studies of concepts have been identified: heuristic, theory oriented, descriptive and critical. This study is descriptive, as it intends to develop understanding of the meaning of the concept of eGovernance, and partly critical, in a way that it has analysed assumptions and values embedded in the definition or description of the concept (Takala & Lämsä, 2004).

Two sources have been used for this literature review; the Digital Government Reference Library—DGRL (Scholl, 2020) and Google Scholar.1 The DGRL is a database containing more than 14 000 publications in the field of digital governance and digital government. It is maintained by the University of Washington and is publicly accessible (Scholl, 2020). Google Scholar was chosen because it is a database that has a good coverage of scientific publications. Search terms that were used in the DGRL bibliography were "eGovernance" and "e-Governance", with the selection in title journals, and in title journals and books, and 145 articles were downloaded. Search in Google Scholar was made with the search terms "eGovernance theory" (with 21 articles selected) and "eGovernance definition" (with 13 articles selected) to focus the search on theory and conceptual definitions (a search on eGovernance in Google Scholar gave 23 800 hits which was too broad). Articles that were journal or conference publications and that were related to definitions of eGovernance were included. The articles were read briefly, and certain parameters were put into a concept matrix in an excel sheet. Next, a selection was made where articles that had a definition of eGovernance were included. A new matrix was developed. The definitions of eGovernance were then analysed, and themes were identified. The main categories drawn from this as an understanding of eGovernance were "ICT in governance/government services" and "outcomes of eGovernance". The analysis is presented in text and tables. Finally, this was concluded with a discussion on contributions and limitations of existing concepts and understanding of eGovernance. After this, a search was made in both databases on digital governance, where 20 articles were selected from the DGRL database, and 14 articles were selected from Google Scholar. In our sample, we observed that there has been more theoretical development around the concept of eGovernance than the more recent digital governance.

2. Results

We reviewed a subset of the literature to understand its meanings. Our analysis suggests that for eGovernance, "governance" and the notion of "e" are fundamental concepts that in combination can lead to transformation of government structures, governance processes, relationships and effects. The result section is organized as follows. First, we outline different views on eGovernance. Then we explore how the literature has used governance and e as foundational constructs. Third, we outline the transformational aspects of eGovernance and discuss outcomes of eGovernance efforts. Finally, we discuss our results in light of the more recent term digital governance.

2.1 eGovernance

We identified a number of definitions of eGovernance in the literature we studied. There seems to be considerable agreement that eGovernance can affect, or for the most part, improve, governance by utilizing some form of digital technologies. However, when investigating how eGovernance has been described more closely, we identified distinct variations in what different scholars emphasize. Examples of definitions of eGovernance are presented in Table 1.

Example Definition	Emphasis	Reference
"eGovernance means the utilization of internet and World Wide Web (www) for transfer of information and delivery of services from government to citizens"	Use of ICT in governance/government services	Din et al. (2017, p. 3)
"eGovernance may be defined as the delivery of government services and information to the public by using electronic means"		Barthwal (2003, p. 288)
"eGovernance or electronic governance may be defined as the delivery of government services and information to the public using electronic means, including the dissemination of information to the public and other agencies. There are three aspects to e-governance: - automating the routine government functions - web-enabling the government functions so that the citizens will have a direct access - improving the government processes so that openness, accountability, effectiveness and efficiency may be achieved. In general, it may be defined as 'giving citizens the choice of when and where to access government information and services"		Akotam, Kontoh, & Ansah (2013, p. 136)
"eGovernance refers to new processes of coordination which apply the advancements of information and communications technology (ICT) to governance"	Functions of governance	Pathak, Belwal, Naz, Smith, & Al-Zoubi (2010, p. 2)
"E-governance is the application of electronic means to improve the interaction between government and citizens; and to increase the administrative effectiveness and efficiency in the internal government operations. Further, it is the application of information technology to the Government processes to bring Simple, Moral, Accountable, Responsive, and Transparent (SMART) governance"	Improvements and achievement of objectives	Ramadoss & Palanisamy (2004, p. 1)

"The UNESCO definition (…) is: 'E-governance is the public sector's use of information and communication technologies with the aim of improving information and service delivery, encouraging citizen participation in the decision-making process and making government more accountable, transparent and effective. E-governance involves new styles of leadership, new ways of debating and deciding policy and investment, new ways of accessing education, new ways of listening to citizens and new ways of organizing and delivering information and services. E-governance is generally considered as a wider concept than e-government, since it can bring about a change in the way citizens relate to governments and to each other. E-governance can bring forth new concepts of citizenship, both in terms of citizen needs and responsibilities. Its objective is to engage, enable and empower the citizen'"		Palvia & Sharma (2007, p. 3)
"eGovernance is a broader term (than eGovernment) that includes transformation on at least four levels. First, it involves the transformation of the business of government (e-government). Second, it involves a transformation in the operational definitions of the principles upon which governance is founded, shifting towards increased participation, openness, transparency, and communication (…). Third, it involves a transformation in the interactions between government and its (internal and external) clients (…). Finally, it involves a transformation of society itself, through the emergence of so-called "e-societies", made up of networks of relationships like citizen-to-citizen connections, as well as relations among non-government organizations (NGOs), built and sustained using electronic means"	Transformation at different levels	Pablo & Pan (2002, pp. 289-290)

Table 1: Example definitions of eGovernance

Our analysis of the different definitions of eGovernance suggests that eGovernance can be viewed in two distinct but interrelated ways:

• Use of ICT in governance/government services;
• Outcomes of eGovernance as transformations (e.g. service improvement, stakeholder involvement and participation).

These aspects are illustrated in the literature in different ways, and a synthesized understanding is depicted in Table 2.

eGovernance understanding	Description	Example references
Use of ICT in governance/government services	ICT (or electronic means) are used in governance processes, and in provision of government information and services, utilizing the Internet and WWW. ICT enables automation and supports internal operation and external interactions.	Din et al., (2017); Barthwal, (2003); Bah & Mansour, (2018); Pathak et al. (2010); Khanra & Joseph (2019).
Outcomes of eGovernance as transformations	eGovernance may transform both structural and normative aspects of governance, including governance	Ramadoss & Palanisamy, (2004); Pablo & Pan (2002); Palvia & Sharma (2007);

	processes and structures, relationships between stakeholders, values, and means and methods to achieve governance objectives. Common objectives are to improve efficiency, effectiveness, participation, transparency, accountability, responsiveness, good governance, democracy and economic development.	Chen & Hsieh (2009); Akotam et al. (2013); Kalsi & Kiran (2015).

Table 2. Understandings of eGovernance

The core characteristics of eGovernance are the use of ICT or electronic means in governance processes, including government services and interaction with stakeholders (Bah & Mansour, 2018; Barthwal, 2003). Services and interactions can be performed online via the Internet (Al Athmay, 2015; Din et al., 2017) and be automated (Ray & Mukherjee, 2007) to different extent.

It is common to include aims and outcomes in definitions and descriptions of eGovernance. ICT is viewed as a means to achieve certain objectives (van der Meer & van Winden, 2003), such as improved service delivery and interaction with stakeholders (Palvia & Sharma, 2007; Ramadoss & Palanisamy, 2004; Saxena, 2005), improved transparency, accountability, efficiency and effectiveness (Akotam et al., 2013; Ray & Mukherjee, 2007), as well as increased participation of stakeholders (Misuraca, 2006; Nyirenda & Cropf, 2009), enhanced democracy (Bubou et al., 2018; Saxena, 2005) and good governance (Lal & Haleem, 2002; Misuraca, 2006; Saxena, 2005). Technologies support interactions in a networked, online context (Meijer & Bekkers, 2015) and facilitate transformation and innovation at multiple levels throughout societies. New forms of leadership, coordination, communication and collaboration may emerge.

The concepts of eGovernance and eGovernment tend to be conflated and used interchangeably. For instance, eGovernment has been defined as "the use of ICT and its application by government for the provision of information and public services to the people" (Meyerhoff Nielsen, 2016, p. 109), while others describe eGovernance with the same meaning (e.g. Barthwal, 2003; Din et al., 2017). eGovernance is sometimes interpreted as an incorporation of technology in the traditional governance concept (Larsson & Grönlund, 2016), while others emphasize that in order to be considered to be eGovernance, it has to involve a transformation (Bannister & Connolly, 2012). When eGovernance is distinguished from eGovernment, eGovernance is seen as a broader concept that involve multiple actors, not just the operation of governments. eGovernance is also different from traditional public governance (Bannister & Connolly, 2012). It includes new forms of organization and leadership, communication and decision-making (Palvia & Sharma, 2007; Rubasundram & Rasiah, 2019). Sometimes eGovernment has a structural perspective, while eGovernance is more focused on processes (Bubou et al., 2018). eGovernance has a broader scope than eGovernment and includes different actors and relationships throughout society. eGovernance involves an active use of ICT to achieve certain outcomes that can facilitate transformation at multiple levels throughout societies and also how multiple actors relate to each other and take a more active role (Misuraca, 2006).

2.2 Basic Elements of eGovernance

eGovernance consists of two basic elements: "governance" and "e". This part of the chapter addresses how these elements are understood in the literature.

2.2.1 Governance

In the literature, governance is typically seen as a process, including steering, decision-making and policy-making. It tends to have an emphasis on relationships and how things are conducted (see Table 3 for an overview).

Governance understanding	Description	References
Steering	• Steering • Authority to steer, control, influence or lead	Misuraca (2006) Lal & Haleem (2002)
Governance as a process	• Governance is about processes • Processes and institutions that guide and restrain activities of a group • "The process through which institutions, businesses and citizens groups articulate their interests, exercise their rights and obligations and mediate their differences".	Misuraca (2006) Palvia & Sharma (2007) Lal & Haleem (2002, pp. 99)
Managing policies and procedures	• Governance can be conducted in different sectors and manages policies and procedures.	Palvia & Sharma (2007)
Decision making and implementation	• The process by which decisions are made and implemented • "The process whereby a society makes important decisions, determines whom they involve, and how they render account". • Governance refers to decision making processes in networks of public and private actors	Akotam et al. (2013); Lal & Haleem (2002) Kalsi & Kiran (2015, p. 171) Larsson & Grönlund (2016)
Governance relates to "how"	• Governance refers to how governments and stakeholders interact, how public functions are carried out, public resources are managed and regulation are conducted	Kalsi & Kiran (2015)
Relationships	• Governance is concerned with the broader relationships between citizens and public institutions. • Governance include multiple stakeholders	Misuraca (2006) Lal & Haleem (2002)

Table 3: Understandings of governance

Governance is seen as a steering process (Misuraca, 2006), the authority to steer, control, influence or lead (Lal & Haleem, 2002).

> "The word governance has its origin in the Greek language and it refers to steering (…). As an act of steering a people's development, Governance is about processes not about ends. While the study of "Government" is primarily concerned with understanding the institutional means through which public management is realized, "Governance" is concerned with the broader relationships between citizens and those institutions". (Misuraca, 2006, p. 210)

Governance includes processes of making and implementing decisions (Finger & Pécoud, 2003; Lal & Haleem, 2002; Singla & Aggarwal, 2014), who is involved and how account is rendered (Kalsi & Kiran, 2015). Governance includes processes in which groups articulate their interests, exercise their rights and obligations and mediate their differences. It includes

> "authority to steer, control, influence or lead in the management of a country's politics, economy and administration; the making and implementation of decisions (…); encom☐passing the state, but transcending the state by including private sector and civil society groups. Thus governance also implies a certain set of mechanisms, processes, and structures that guide political and socio-economic relationships and the articulation of interests; an enabling environment for social and economic development" (Lal & Haleem, 2002, p. 99).

In the Handbook on Theories of Governance, governance is defined as

> "the process of steering society and the economy through collective action and in accordance with common goals" (Ansell & Torfing, 2016, p. 4).

Processes and institutions (both formal and informal) guide and restrain activities of a group and can be conducted in multiple sectors and include multiple stakeholders. Government is a subset of governance and has the authority to create formal obligations (Palvia & Sharma, 2007). Government can be seen as "an actor in the process of governance" (Bannister & Connolly, 2012, p. 8). Central activities of a government are regulation, service delivery and policy-making (Zwahr & Finger, 2004). Governance concerns the state's ability to serve citizens and other actors, as well as the manner in which public functions are carried out, public resources are managed and public regulatory powers are exercised, including interactions between government and social organizations and how they relate to citizens (Kalsi & Kiran, 2015).

Descriptions of eGovernance also include new processes of coordination (Pathak et al., 2010), planning, formulating and implementing decisions and operations related to governance challenges (Bubou et al., 2018), which point towards that governance implies processes of coordination, planning, formulating and implementing decisions and operations.

To sum up, governance can be seen as processes for steering in order to respond to common challenges. This includes decision-making, implementation and coordination that includes multiple actors. From an IS perspective, it would be beneficial with a structured outline of governance functions, in order to identify how information systems and digitalization can contribute to achieve governance objectives, as well as to further theorize the role of the "e" element.

2.2.2 Notion of "e"

Our analysis of the eGovernance literature illustrates that the notion of e, referring to something digital, is generally superficially dealt with. Apparently, the most common reference to e is information and communication technologies, ICTS or ICT solutions. However, some also refer to the utilization of Internet and the World Wide Web, advanced forms of ICT, new technologies, electronic means, Internet-based technologies and computer networks. An outline of how the literature deals with e is shown in Table 4.

Notion of "e"	Description	References
Information and communication technologies ICTs (Information and Communication Technologies), especially the internet ICT solutions	Electronic Governance is the application of Information and Communication Technologies (ICTs) for delivering government services through integration of various stand-alone systems between Government-to-Citizens (G2C), Government-to-Business (G2B), and Government-to-Government (G2G) services	Chen & Hsieh (2009) Singla & Aggarwal (2014) Bah & Mansour (2018) Finger & Pécoud (2003) Larsson & Grönlund (2016) Molinari, (2011)
Utilization of Internet and World Wide Web	Similar to the above, but with emphasis on the Internet	Din et al. (2017) Garcia-Sanchez, Rodriguez-Dominguez, & Frias-Aceituno (2013)
Advanced forms of ICT	No further description on what is understood with advanced forms of ICT	Haque, (2002)
New technologies	No further description on what is understood with new technologies	Meijer (2015)
Electronic means	...to improve the interaction between government and citizens; and to increase the administrative effectiveness and efficiency in the internal government operations.	Ramadoss & Palanisamy (2004) Marche & McNiven (2003)
Internet-based technologies	direct online connection with the common people, entrepreneurs and other stakeholders	Khanra & Joseph (2019)
Computer networks	to permit expanded public involvement in policy deliberations, an area sometimes described as "E-governance" to distinguish it from service initiatives	Carlitz & Gunn (2002)

Table 4: Notion of e

The literature seems to rely on an assumption that *e* represents ICT and ICT networks as necessary enablers for positive changes to governance. In definitions of eGovernance, many authors in some way imply the use of ICT or electronic means in governance and government services. Some authors also refer to eGovernance as a process where ICT is used to automate procedures and interactions (Akotam et al., 2013; Gberevbie et al., 2016; Ray & Mukherjee, 2007), while others refer to the utilization of Internet for providing services (Akotam et al., 2013; Din et al., 2017; Garcia-Sanchez et al., 2013; Khanra & Joseph, 2019; Potnis, 2010; Singla & Aggarwal, 2014), or the use of technologies to support government relations and interactions (Bannister & Connolly, 2012; Carlitz & Gunn, 2002; Meijer, 2015; Meijer & Bekkers, 2015).

Some argue that *e* refers to the use of new or advanced technologies (Haque, 2002). While this may be true in several cases, one can easily point to eGovernance efforts utilizing mature technologies such as ERP systems or simple technologies such as apps, social media or discussion forums.

The representations of *e* in Table 3 can all be seen as coarse categories that offer basic understanding beyond indicating that ICT and ICT networks are integrated components of eGovernance. While the literature provides a variety of examples of ICTs used for eGovernance, we found few attempts to classify, categorize or theorize e. A notable exception is Bannister and Connolly's reflection that technology is not value free but rather ingrained with specific values that are likely to affect the outcomes of its use. We also found examples of categorizations. For example, Ramadoss and Palanisamy (2004) suggest a layered architecture perspective on technology.

In summary, our analysis left us with the clear impression that e is superficially understood in the eGovernance literature. This offers ample opportunity for future research to further define the digital aspect that can be used in further theory development.

2.3 Outcomes of eGovernance

This section addresses how eGovernance can be understood in terms of intended outcomes and as transformation—structurally and normatively. A central underlying assumption in the eGovernance literature seems to be that the combination of digital technologies and governance enables innovation or transformations in various areas, e.g. relationships, processes and structures, in order to achieve some desired outcomes or effects. eGovernance should also be understood in a context of technological development in a co-evolution with institutional development as well as societal changes and how collective problems are managed (Rossel & Finger, 2007).

2.3.1 Outcomes as Structural and Normative Transformations

Outcomes related to eGovernance can be categorized in terms of being structural or normative.

> Structural governance is defined to be the 'how' of government. It encompasses things such as processes, structures, lines of authority, laws, regulations, stakeholders, forms of communication and responsibilities – the mechanisms by which power is exercised, decisions made, policy is created or changed and its

implementation achieved. Normative governance is the set of value-related features of structural governance including transparency, accountability, integrity, honesty, impartiality, efficiency and so on that governance is desired to enable, to possess or to deliver. Structural governance may be designed to support or achieve normative aims, but in itself it is about how something is done, not about whether or not the way it is done is efficient (or honest or fair). In summary, normative governance qualifies structural governance and structural governance may be, but does not have to be, designed to deliver or support norms. (Bannister & Connolly, 2012, p. 7)

We consider this a valuable, high-level distinction and discuss eGovernance outcomes in our sample in light of these two categories. Much of the literature is concerned with the transformational effects of eGovernance, and we therefore refer to outcomes as structural and normative transformations.

Structural Transformations

The literature offers a number of examples of outcomes as structural transformations. These are summarized in Table 5.

Structural transformations	Description	Example References
Service delivery	ICT changes processes for service delivery	Zwahr & Finger (2004); Al Athmay (2015); Banerjee, Ma, & Shroff (2015); Chen & Hsieh (2009); Finger & Pécoud (2003); Palvia & Sharma (2007)
Regulation	ICT changes processes for regulation; Electronic rulemaking	Zwahr et al. (2005); Zwahr & Finger (2004); Barthwal (2003); Finger & Pécoud (2003); Misuraca (2006)
Policymaking	ICT changes processes for policy making	Zwahr et al. (2005); Zwahr & Finger (2004); Haque (2002); Dawes et al. (2016); Finger & Pécoud (2003); Misuraca (2006); Rubasundram & Rasiah (2019)
Governance mechanisms	New governance mechanisms may be developed; New governance structures	Zwahr et al. (2005); Dawes (2016); Lal & Haleem (2002)
Relationships, interaction & participation	ICT changes governments relationships and interactions with stakeholders; Increased participation of stakeholders in governance processes; Electronically facilitated network interactions, e-societies	Haque (2002); Wong, Fearon, & Philip (2007); Pablo & Pan (2002); Nyirenda & Cropf (2009); Finger & Pécoud (2003); Gberevbie et al. (2016); Ray & Mukherjee (2007); Bannister & Connolly (2012); Saxena (2005)
Coordination	ICT enables new forms of coordination	Misuraca (2006); Pathak et al. (2010); Myeong, Kwon, & Seo, (2014)
Decision making	ICT enables new processes for planning, formulating and implementing decisions	Larsson & Grönlund (2016); Akotam et al. (2013); Kalsi & Kiran (2015); Marche & McNiven (2003)

Table 5: Structural transformations of eGovernance

ICT is used to enable transformation of governance processes and relationships to citizens, businesses and different governmental bodies (Khanra & Joseph, 2019; Wong et al., 2007). It provides means to facilitate stakeholder interaction (Haque, 2002; Molinari, 2011) and is assumed to involve an increased participation, openness and transformation in communication and interactions (Al Athmay, 2015; Calista & Melitski, 2007; Carlitz & Gunn, 2002; Pablo & Pan, 2002; Ramadoss & Palanisamy, 2004). It includes transformation in multiple relations, classified as

> "government-to-citizen (G2C), government-to-business (G2B), government to its internal employee clients (G2E), government to other government institutional clients (G2G), and citizen-to-citizen (C2C). (…) Finally, it involves a transformation of society itself, through the emergence of so-called "e-societies", made up of networks of relationships like citizen-to-citizen connections, as well as relations among non-government organizations (NGOs), built and sustained using electronic means" (Pablo & Pan, 2002, p. 289-290).

eGovernance changes processes for managing and sharing information and knowledge (Al Athmay, 2015; Meijer & Bekkers, 2015; Ray & Mukherjee, 2007) and ways to deliver services (Haque, 2002; Zwahr & Finger, 2004). New governance mechanisms to manage social interactions may also develop, instead of being primarily governmental (Zwahr et al., 2005). Technologies are used to support networked interactions between government organizations and stakeholders (Bannister & Connolly, 2012; Meijer, 2015). Central is the exchange of information between government and citizens and is a form of interface between them (Singla & Aggarwal, 2014). Technologies have an impact on the role of the state and its core functions service delivery, policy-making and regulation. It is according to Zwahr and Finger (2004) even one of the key drivers of state transformation, while others (Bannister & Connolly, 2012) mean that technology enables transformation but there is little evidence that it is the driving factor.

ICT is used to facilitate processes for decision-making and implementation, as a medium for communication and collaboration and enables active participation and citizen involvement (Misuraca, 2006). It may include electronic consultation, controllership and engagement (Bubou et al., 2018).

eGovernance is also related to innovation and improvement and is often intended to bring something new. eGovernance is argued to enable new styles of leadership and decision-making, new ways of conducting and transacting business, new ways of communicating and debating and new ways of organizing and disseminating information (Gberevbie et al., 2016; Lal & Haleem, 2002; Palvia & Sharma, 2007). eGovernance has even been referred to as "an innovation management process in the public sector" (Potnis, 2010, p. 41), and a main rationale for eGovernance is to trigger innovation (Haque, 2002). It brings a new understanding of governance, which requires of all actors to participate actively (Misuraca, 2006). eGovernance will raise new practical and theoretical problems, which also motivates it to be a distinct field of study (Bannister & Connolly, 2012).

To sum up, structural outcomes of eGovernance may involve transformations in structures and processes for service delivery, policy-making, regulation, decision-making and interaction between stakeholders. Technologies may also enable development of new mechanisms, means and methods for governance, which will raise new issues for problematization.

Normative Transformations

Our analysis suggests that the eGovernance literature has a strong emphasis on outcomes in the form of normative transformations, i.e. improvements in different areas. Table 6 summarizes these.

Normative transformations	Description	Example References
Efficiency	eGovernance is argued to be more efficient; including cost efficiency and time efficiency	Akotam et al. (2013); Haque (2002); Calista & Melitski (2007); Din et al. (2017); Gberevbie et al. (2016); Kalsi & Kiran (2015); Khanra & Joseph (2019); Ray & Mukherjee (2007)
Transparency	Information and communication technologies (ICTs) are seen by many as effective and convenient means to promote openness and transparency and to reduce corruption.	Akotam et al. (2013); Barthwal (2003); Din et al. (2017); Haque (2002); Kalsi & Kiran (2015); Khanra & Joseph (2019); Nyirenda & Cropf (2009); Ray & Mukherjee (2007)
Accountability	eGovernance is expected to enable increased accountability	Akotam et al. (2013); Al Athmay (2015); Barthwal (2003); Choudhari, Banwet, & Gupta (2011); Gberevbie et al. (2016); Haque (2002); Misuraca (2006); Nyirenda & Cropf (2009);
Participation	eGovernance enables increased participation of stakeholders in governance processes and increased civic engagement	Saxena (2005); Calista & Melitski (2007); Carlitz & Gunn (2002); Saxena (2005); Al Athmay (2015); Choudari et al. (2011); Kalsi & Kiran (2015); Lal & Haleem (2002)
Effectiveness	eGovernance is assumed to improve effectiveness, in for instance information and service delivery.	Al Athmay (2015); Bubou et al. (2018); Dawes (2016); Gberevbie (2016); Khanra & Joseph (2019); Pablo & Pan (2002)
Responsiveness	eGovernance is expected to improve responsiveness	Barthwal (2003); Choudari et al. (2019); Gberevbie et al. (2016); Khanra & Joseph (2019); Lal & Haleem (2002)
Democracy	eGovernance intends to enhance democracy	Al Athmay (2015); Calista & Melitski (2007); Chen & Hsieh (2009); Gberevbie et al. (2016); Misuraca (2006); Saxena (2005)
Good governance	eGovernance intends to enhance good governance	Barthwal (2003); Lal & Haleem (2002); Misuraca (2006); Kalsi & Kiran (2015)
SMART governance	eGovernance aims to achieve Simple, Moral, Accountable, Responsive & Transparent (SMART) governance	Alotaibi (2019); Singla & Aggarwal (2014); Ramadoss & Palanisamy (2004)
Economic development	eGovernance is expected to improve economic development	Banerjee et al. (2015); Din et al. (2017); Marche & McNiven (2003); Misuraca (2006); Nyirenda & Cropf (2009)

Table 6: Normative transformations of eGovernance

Some definitions and descriptions of eGovernance include expected outcomes, effects or aims in terms of normative aspects, such as efficiency, transparency and accountability (Akotam et al., 2013; Din et al., 2017; Haque, 2002). Aim is to improve the quality of services and governance and to encourage and empower citizen participation in decision-making. This may change the notion of citizenship and understandings of needs and responsibilities (Palvia & Sharma, 2007). Central objectives with eGovernance are to achieve good governance (Barthwal, 2003; Misuraca, 2006; Saxena, 2005), advance democracy (Bubou et al., 2018; Gberevbie et al., 2016; Haque, 2002; Pathak et al., 2010), strengthen civil society (Haque, 2002), and support economic development (Banerjee et al., 2015; Misuraca, 2006; Saxena, 2005). Some authors mean that eGovernance is an attempt to achieve SMART governance (simple, moral, accountable, responsive and transparent) (Ramadoss & Palanisamy, 2004; Singla & Aggarwal, 2014).

A question is whether ICT affects normative values, and Bannister and Connolly (2012) argue that it does—technology enables certain norms. Norms may also change in themselves, and transparency is suggested to be an example of that. The argument is that transparency and provision of information are a way to transfer governance to a community by information rather than regulation. In a network society, accountability is also something that is challenged, since there are no clear nodes to make accountable as there is in hierarchical systems. New technologies, such as AI and further automation, will pose new challenges to governance, and an aspect of eGovernance will also be to address these challenges (Bannister & Connolly, 2012). eGovernance also has potential to improve access to information (Al Athmay, 2015; Barthwal, 2003; Calista & Melitski, 2007; Haque, 2002; Saxena, 2005), reduce corruption (Al Athmay, 2015; Din et al., 2017; Gberevbie et al., 2016; Haque, 2002), facilitate collaboration (Chen & Hsieh, 2009; Lal & Haleem, 2002; Pablo & Pan, 2002; Potnis, 2010), have seamless integration of information and services (Chen & Hsieh, 2009; Saxena, 2005) and decentralize power (Al Athmay, 2015; Calista & Melitski, 2007; Misuraca, 2006).

To summarize, eGovernance is often associated with normative values such as efficiency, transparency, accountability, participation, effectiveness, responsiveness, as well as enhanced democracy and good governance. Even though technologies may facilitate this, it is important to problematize this notion and to be aware of risks related to digitalization.

2.4 From eGovernance to Digital Governance

"Digital governance" is by some scholars (Misuraca & Viscusi, 2014) considered to be an evolvement of the concept of eGovernance. It has also been considered to have developed through four stages: organization-oriented eGovernment, citizen-oriented eGovernment, organization-oriented eGovernance and citizen-oriented eGovernance (Kang & Wang, 2018). If eGovernment has a focus on using technologies to improve public services, eGovernance embraces transformations of the relationship between governments and citizens and other stakeholders, and digital governance is a further development of this, accentuating the impact of technologies and how it transforms governance (Barbosa, 2017). A distinction is made between digital government and digital governance, where digital government refers to structural elements while digital governance is about functionality (Charalabidis & Lachana, 2020b). While for instance Charalabidis and Lachana emphasize that digital governance

brings increased efficiency, others argue that it also goes beyond efficiency and includes enhanced democracy and equity (Kitsing, 2019). Nevertheless, digital governance involves an advanced use of ICT (Kang & Wang, 2018) and the use of new technologies for advanced data analysis (Chandler, 2019).

> "'Digital governance' is based on information and communication technology and big data. As a governance model, it optimizes managerial decisions and policies through integration of complex data analysis, data modeling, data optimization and data visualization in government operations and public management processes (…) Digital governance emphasizes strength☐ening governmental managerial capacity and enhancing the legitimacy, transparency and responsiveness of good governance. All of this is done so as to better solve social problems and serve all citizens" (Kang & Wang, 2018, pp. 92–93).

Similar to eGovernance, for digital governance it is also argued that ICT has a "potential to enhance service quality, openness, transparency and ultimately quality of life and sustainable growth" (Charalabidis & Lachana, 2020b, p. 383). It is assumed that digital governance will bring increased efficiency as well as engagement between citizens and governments. It is not clear though to what extent ICTs empower actors in actuality (Vij & Gil-García, 2017). Digital technologies are applied to develop innovative solutions to social, political and economic challenges (Bertot et al., 2016). Some authors also argue that digital governance is a means to achieve sustainable development goals (Barbosa, 2017; Janowski, 2016), but that there is a gap between aspiration and capacity (Janowski, 2016).

Digital governance relates to the use of Internet, which enables new ways for stakeholders to organize themselves and participate in various contexts (Luna-Reyes, 2017). With the application of network technologies, governance is developing into a more network-oriented form (Barbosa, 2017; Kitsing, 2019). It is also argued that digital governance may trigger a shift from new public management to digital era Governance. It is based on digital processes, citizen-oriented holism and reintegration of government organization (Dunleavy, 2006; Kitsing, 2019; Misuraca & Viscusi, 2014). Digital governance brings the possibilities to bridge fragmentation and silos and enable collaboration. However, digital technologies are not enough, development of public sector governance is to a high degree dependent on formal and informal institutions, including laws and regulations, and norms, values and habits. Network-oriented governance is distinguished as a mode of coordination, compared to hierarchical or market-based principles. Network-oriented governance builds on reciprocal relationships, mutual trust and common values and interests (Kitsing, 2019). With digital governance, values may be generated in new ways, such as through public–private partnerships. There is however a need to do more research that evaluates value outcomes from digitalization initiatives (Luna et al., 2015).

Digital governance addresses problems in terms of effects rather than causation. The complexity of today's interactions and processes makes it difficult to investigate causes of phenomena, and interventions and digitalization usually have unintended side effects. Therefore, the focus in digital governance is rather to minimize negative unintended consequences and focus on responsiveness, rather than figuring out root causes of things. The attention is on correlation and interlinkages and development of new means for sensing and responding continuously to emergent effects (Chandler, 2019).

As Almeida et al. (2020) point out, digitalization generates various dilemmas, which challenge how collective actions are conducted. Institutions have to develop resilience and adaptability in order to manage contemporary and future challenges. Governance in the

digital world is not just about regulation, but is more complex. It involves multiple actors and vast cultural, political, economic and social differences. Governance mechanisms and models have to be developed that lead to public goods and promote good behaviour. There are various risks associated with the digital environment, such as misinformation, biased algorithmic decision-making, social media manipulation, monopoly situations for large tech companies, cyber attacks, how surveillance is applied and violations of privacy. Critical issues are protection of human rights, accountability, fairness, compliance and allocation of social benefits. The digital context is not territorial, and decisions made in a company may have effects in multiple countries elsewhere. Digitalization also tends to bring turbulence and fast transformations, which may bring social crises. In this context, institutions have an important role for societal resilience. Some argue that the solution to these challenges, is not more control by the state nor privatization, but polycentric governance mechanisms that promotes civic engagement and involvement of actors. Key to governance in the digital context is decentralized processes and collaborative decision-making that involves multiple stakeholders and transparency and accountability of both stakeholders and algorithms (Almeida et al., 2020). One of the changes that digitalization and informatization brings to governance, is some shift from legality towards transparency. Formal legislation tends to lag behind technological development, and there is an increasing horizontalization of relations, which partially changes power dynamics. In this context, transparency and accountability are key, with information rights as an important aspect (Bovens & Loos, 2002).

2.4.1 Definition of Digital Governance

In light of the above, there is a need for a definition of digital governance. Based on the literature on eGovernance and digital governance this definition should reflect both the use of digital technologies in processes and structures of governance, its relation to governance objectives and values, the capabilities digital technologies bring, as well as its transformative potential. Based on that, we suggest the following definition of digital governance:

> Digital governance is defined as digital technology ingrained in structures or processes of governance and their reciprocal relationships with governance objectives and normative values. Digital governance includes the utilization of digital capabilities and involves a transformation of structures, processes or normative values.

3. Discussion

Considering digital governance as an evolvement of eGovernance, it was important to first develop a deeper understanding of the concept of eGovernance. There has been a development from a focus on digitalization of government services, to embracing a wider perspective that includes interaction among multiple stakeholders in eGovernance. In the literature reviewed, digital governance has many aspects in common with the notion of eGovernance, but was found slightly more elaborate regarding the digital aspect. It has an emphasis on new technologies and network organization (Barbosa, 2017) that is less visible in the eGovernance literature. This relates to the concept of digital era governance, which is a different mode of governance compared to hierarchical and new public management approaches (Kitsing, 2019) which also resonates with the new possibilities that digital

technologies enable for participation and engagement of stakeholders. Digital technologies changes the conditions for governance and how power and influence are distributed, and also has an emphasis on values such as transparency, trust, mutual interest and participation. However, digitalization also brings new challenges and requires new mechanisms of governance to protect human rights and establish a societal infrastructure of fairness and accountability. Nevertheless, governance is going through a transformation, where information and digital technologies to manage, utilize and leverage on information are central mechanisms (Kang & Wang, 2018). Therefore, it is crucial to further expand the theoretical foundation for the role of both information and information systems in governance in the digital age.

According to Dawes (2009), research in digital governance has focused primarily on advancing the practice concerning online services and improved management. Due to complex and dynamic challenges that reality presents, there is a need for a holistic approach that accounts for questions of what an appriopriate digital governance infrastructure would look like, as well as basic questions regarding governance and democracy in the digital era. This has to consider institutional reforms, social trends, human elements, new technologies, information management, multiple actors, interactions and various complexities. Legitimacy, trust, power relationships and balancing of different objectives are questions that are highlighted as important to address (Dawes, 2009).

A scientific foundation for research in digital governance has been requested (Charalabidis & Lachana, 2020a, 2020b), including the following major parts; identification and description of problems and solutions in digital governance; a coherent conceptual development; methods and tools to develop scenarios, impact assessment and simulation along with training curriculum and strenghtening of the scientific foundation of digital governance (Charalabidis & Lachana, 2020a, 2020b). Related to this, this article is a contribution to the conceptual foundation of the field of digital governance.

As Kazanchi (1996) pointed out, conceptual development provides a means to define and create understanding of a phenomena. This chapter contributes to an understanding of the meaning of the concept of digital governance. Related to some of the qualities of concepts that was highlighted in the introduction, such as clarity, possible application of the concept, theoretical glue and cumulativeness (Conboy, 2009), improvements can be made. There are sometimes conflicting explanations of the concept of eGovernance, and different concepts are used quite interchangeably, so clarity of concepts can be enhanced. This tends to create some confusion and influences the theoretical robustness. Certain patterns of meanings of eGovernance and digital governance have been recognized, and our sample indicates that digital governance builds on the notion of eGovernance, which makes the cumulative aspect stronger.

A final dimension of quality of concepts is the level of abstraction that is addressed (Lewis et al., 2005). We found that eGovernance and digital governance primarily tend to be addressed at a practical level, and a more theoretical and also philosophical contribution would be beneficial and provide a deeper theoretical foundation.

4. Conclusion

This study has explored the use and understanding of the concepts eGovernance and digital governance and suggested a definition of digital governance. The literature contained a number of different views and perspectives and neither of the concepts were found to have agreed upon definitions or well-defined constructs. The concept digital governance has inherited meanings from the concept of eGovernance. While we found more theoretical contributions related to eGovernance, the digital aspect of digital governance was found to have been slightly more elaborated. In light of this, we found no clear conceptual distinction between the two concepts and therefore suggest that the scientific community from now on joins forces in developing the concept digital governance further, thus ensuring to encompass existing understandings of both terms. As a starting point, our analysis offers elaborate perspectives on existing use and understanding of the two basic elements of digital governance— namely "governance" and "digital" (where the digital aspect corresponds to the notion of "e" in the concept of eGovernance). Further theorization and conceptualization of the digital aspect in digital governance would be a valuable contribution to theory development.

The literature revealed different views on eGovernance which can be structured in two distinct but interrelated perspectives: (1) how ICT is used in governance and (2) outcomes of eGovernance as structural or normative transformations. It seems to be common to include normative values in descriptions of eGovernance, and a structured outline of (existing and possible) structural elements of governance in which information systems can play an important role would be beneficial for further development of the digital governance field.

4.1 Future Research

We suggest that the digital governance domain would benefit from increased theorization related to its basic concepts. Our analysis can hopefully be seen as an initial contribution to this work by offering clarity on what the basic building blocks are and how they have been understood and used by the community so far. Future steps may include developing more definitions on concepts, constructs and relationships that can later be further theorized and tested.

The literature tends to describe digital governance in positive terms. However, there are risks and concerns that invite critical reflection and problematization. Many times, such initiatives fall short on expectations or fail (Choudari et al., 2011; Haque, 2002; Kalsi & Kiran, 2015; Nyirenda & Cropf, 2009). Digital divide (Din et al., 2017; Haque, 2002; Khanra & Joseph, 2019; Marche & McNiven, 2003), issues of security, identity and privacy (Akotam et al., 2013; Alotaibi, 2019; Dawes et al., 2016), trust (Dawes et al., 2016), fake information (Alotaibi, 2019; Calista & Melitski, 2007), technological dependencies (Dawes et al., 2016) and information overload (Calista & Melitski, 2007) have been highlighted in the literature as concerns. Another risk that has been raised is that digital governance tends to be driven from a technocratic viewpoint, and a stronger governance angle ought to be taken (Saxena, 2005).

Even if the literature on digital governance seems to address challenges of governance in the digital environment a bit more than the eGovernance literature, there is more work to be done to develop a theoretical foundation for governance in the digital era. A further understanding of what changes digital governance brings and what this means is also suggested, whether it is improvement of current practices or whether governance per se transforms. A thorough understanding of the conceptual foundation of digital governance provides a basis for studying relationships between digital governance and societal challenges—both how digital governance can be applied to address societal challenges, as well as considering the risks that it may bring.

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The State of information infrastructure for global climate governance

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Abstract

Purpose

The world is facing global challenges that require international collaboration. This study describes and analyses how digital technologies are applied in global governance to respond to such critical challenges.

Design/methodology/approach

The authors apply an interpretive case study of climate reporting to the United Nations Framework Convention on Climate Change (UNFCCC) as a case of digitalization in global governance. It includes interviews with officials in the Swedish public administration and the UNFCCC secretariat to cover national and international levels. The authors describe the reporting process and analyze the role of information systems through the lens of information infrastructures.

Findings

'Information infrastructure' is a valuable instrument to understand digitalization in global governance as a complex interplay between information systems, information, standards, organizations, people, and social structures. The level of sophistication is, however, basic with a large potential for improvement — for instance in analytical and communicative services to support evidence-based decision making and assessment of progress.

Research limitations/implications

The data collection is limited to one governance process: reporting. Future studies should complement the findings by broadening the scope to other processes. The authors propose that digital global governance is dependent on an effective information infrastructure and that the five design principles by Hanseth and Lyytinen (2016) offer guidance when developing this.

Practical implications

The results indicate a large unutilized potential of digital technologies to improve progress assessment, communicate more effectively with stakeholders and identify new ways of visualizing data to support decision making in global climate policy.

Social implications

Use of digital technologies, as suggested in the article, could strengthen the implementation capability of climate goals, which is of urgent need.

Originality/value

While most research in digital governance considers the national or municipal, this study provides empirical insight and theorization of digital technologies in a global governance setting.

Keywords

Digital governance, information infrastructure, global challenges, global governance, climate governance

Paper type research paper

1. Introduction

As societal challenges have increasingly become global, the need for global governance increases (Finkelstein, 1995). Global governance involves global structures, procedures, and common goals (Rosenau, 2005) with no central authority that can exercise a legitimate use of force (Zürn, 2010). Moreover, apart from governments multiple actors have key roles in achieving the common goals (Rosenau, 2005).

A critical global challenge is climate change. According to the Intergovernmental Panel on Climate Change (IPCC), urgent and ambitious action at all scales is necessary to meet the temperature goal (1.5-2°C) of the Paris Agreement (IPCC, 2021). Since the Climate Convention was adopted in 1992, regular Conference of the Parties (COP) summits have brought together world leaders and an increasing number of stakeholders. COP is the supreme decision-making body of the Climate Convention where decisions and agreements are made regarding global climate governance (UNFCCC, 2022a). COP26 was held in Glasgow (UNFCCC, 2021a) in November 2021.

In the international climate agreements, reporting on emissions and measures has been an important component. The aim of the reporting is to make it possible to monitor greenhouse gas emissions; follow individual and collective progress; and inform decision-making (UNFCCC, 2020a). With the Paris Agreement, the reporting procedures have been further developed into an Enhanced Transparency Framework (UNFCCC, 2018). Collection of information and monitoring as a basis for evaluation of progress towards governance goals gives information systems a key role in governance (Hendrick, 1994). Furthermore, digital governance is argued to strengthen institutions and governance (Janowski, 2016) to implement the sustainable development goals (SDGs). To respond to global challenges, it is imperative to explore how digital technologies can support global governance. In general, there is a need to better understand the digital infrastructure in governance (Dawes, 2009) and particularly the global dimension of digital governance (Geiselhart, 2007).

Given the above, we found the international climate reporting to the UNFCCC to be a suitable case to increase our knowledge of digital global governance. When studying climate reporting, implementations both at national and international levels are relevant. This article analyzes Sweden's climate reporting to the UNFCCC using information infrastructures as an interpretive lens. The article offers insights into hitherto unexplored areas of digitalization in global governance. The research question guiding the research was:

> *RQ1.* 'How are digital technologies used in climate reporting, and to what level of sophistication?'

2. Conceptual Foundation

2.1 Global governance

In the *Handbook on Theories of Governance*, governance is defined as

> 'The process of steering society and the economy through collective action and in accordance with common goals' (Ansell and Torfing, 2016, p. 4).

Governance is backed by shared goals but does not have to derive from legal and formally prescribed rules (even though it can) and has both formal and informal mechanisms to

achieve the goals (Rosenau, Czempiel, & Smith, 1992). Global governance is justified by transnational problems or global common goods (Zürn, 2018), and has been defined as:

> 'Global governance is governing, without sovereign authority, relationships that transcend national frontiers' (Finkelstein, 1995, p. 369).

It means that there is no central authority such as a government that can wield a legitimate use of force (Zürn, 2010). Global governance as a concept emerged in response to the development of an increasing global interdependence and the development of international and transnational organizations, structures, and processes. Furthermore, the transformation from a state-centric to a multi-centric world with various spheres of authority and vast number of actors playing an important role in global development, is reflected in the concept of 'global governance' (Rosenau, 2005). In the case of climate governance, to mobilize climate action, two high-level champions have been assigned to connect the work of voluntary initiatives by cities, regions, investors, businesses, and other organizations with the work of governments (UNFCCC, 2022b).

2.2 Information Infrastructure
'Information Infrastructure' in this article will be used as an analytical lens to examine climate reporting and, the way information systems support climate governance.

Information Infrastructure (II) is a form of information system (IS) with a set of distinct characteristics. IIs are large and complex socio-technical networks (Hanseth and Lyytinen, 2016). An II is intertwined with organizational structures and work practices and co-evolves with them (Aanestad *et al.*, 2017).
An infrastructure is a common foundation on which different activities are developed (Hanseth, 2010). An II is a shared resource for a community (or multiple communities) for developing and using information services (Hanseth and Lyytinen, 2004). An II involves interrelated social, organizational, and technical components, including hardware, software, services, and personnel with expertise (Bowker *et al.* 2009). IIs are characterized by six aspects;
(1) They have an enabling or supporting function to a range of activities;
(2) They are shared by a community and cannot be split into parts that are used independently by different groups;
(3) They are open to be used by an unlimited number of users and use areas, which may also change over time;
(4) They are socio-technical networks that encompass hardware & software, organizations, people, information, and standards and are embedded in social structures;
(5) They are interconnected and interdependent networks that integrate various components;
(6) They are continuously evolving by extending and improving the installed base, which new elements have to adapt to (Hanseth and Monteiro, 1998).

This description by Hanseth and Monteiro (1998), elucidates an II as a socio-technical system and not just as technology per se, which is also the perspective we have in this article.

An II involves many interconnected elements. Development of new components must adapt to and be interoperable with what already exists in the installed base (Hanseth and Monteiro, 1998). The *installed base* includes 'existing practices, conventions, tools, and systems (…) the organizational, institutional, regulatory, sociotechnical arrangements that are already in

place' (Aanestad *et al*., 2017, pp. 28-29). This indicates the complexity of IIs.
An important aspect of IIs are standards that enable interaction, interoperability, and compatibility of components into a larger system. However, as user needs change over time, there must also be a level of flexibility, which is often achieved by modularization (Hanseth and Monteiro, 1998). Due to their complexity, the development and design of IIs are complex; the challenges of attracting large user groups and adapting to increasing heterogeneity need to be considered (Hanseth and Lyytinen, 2016).

IIs are embedded in, and coevolve with, other infrastructures (Aanestad *et al.,* 2017). To emphasize the specific characteristics of the public sector, Hornnes et al (2010) articulated the concept of government information infrastructure (GII), including technical, organizational, and legal structures (Hornnes, Jansen, & Langeland, 2010). A GII is thus also part of a governance infrastructure (Johnston, 2010, p. 122).

3. Method

This paper is based on an interpretive case study of climate reporting to the UNFCCC. The aim of interpretive research is to develop an understanding and make sense of a social phenomenon. An interpretivist view is that knowledge about a phenomenon is gained through understanding the meanings individuals and groups assign to it (Klein and Myers, 1999). Case studies are appropriate in research about information systems embedded in a certain context, since the method embraces real-world dynamics (Shanks and Bekmamedova, 2013). As empirical material, semi structured interviews was carried out with professionals in the Swedish public administration, the UNFCCC, and international experts. Semi-structured interviews enabled us to capture the respondents' views (Williamson, 2013). The study adopted a process perspective to understand and describe the climate reporting process, from the national to international level, and analyzed the use of digital technologies in this process. In research with a process perspective, the focus is on entities and actors involved in events in a process (Burton-Jones*et al*., 2015). Interviews were constructed to describe the reporting process, and to identify and understand the characteristics of reporting information and the IT artefacts used. Respondents were purposefully selected based on their experience of reporting. Twenty interviews were conducted via Zoom or telephone that lasted for 45-60 minutes each. Interviews with two of the respondents were not recorded, respecting their wish. However, extensive notes were taken in each case. The other interviews were recorded and transcribed. Each interview guide was prepared with questions relevant to the role of the respondent, their expertise, and the role of the public body they work at. The respondents (see Table 1) were asked about their role related to the reporting, the reporting process, what should be reported, what IT artefacts are used, challenges they experience, the meaning of reporting and IT artefacts, organizational arrangements, and follow up questions based on their answers.

Organizational body	Role of respondent	Code
The Swedish Environmental Protection Agency (EPA)	Project Manager	R1
EPA	Climate advisor	R2
EPA	Senior Advisor at the climate department	R3
SMED (Swedish Environmental Emission Data)	Project Manager for Sweden's calculations of greenhouse gas emissions	R4
EPA	Climate negotiator	R5
EPA	Climate negotiator and legal expert	R6

Government Offices Sweden, Ministry of the Environment	Ministry Secretary at the Ministry of the Environment	R7
EPA	Climate analyst	R8
EPA	Climate analyst	R9
Panorama	Project Manager	R10
Swedish Climate Policy Council	Senior Analyst	R11
Ministry of the Environment, Sweden	Policy Analyst	R12
UNFCCC secretariat	Data and information expert	R13
UNFCCC secretariat	GHG national inventory submissions	R14
UNFCCC secretariat	Global stocktake expert	R15
UNFCCC secretariat	Global stocktake expert	R16
UNFCCC secretariat	Coordinates technical analysis of reports	R17
Expert reviewer for the UNFCCC	Expert reviewer	R18
Anonymous	International expert	R19
UNFCCC secretariat	Expert on National Communications for developing countries	R20

Table 1. List of respondents

4.   Findings

The findings section outlines the processes and ISs used for climate reporting to the UNFCCC. Our analysis had two focal points: the international level represented by the UNFCCC, and the national level represented by Sweden.

4.1 United Nations climate governance framework

Climate change has been discussed internationally within the United Nations since the 1980s, resulting in a series of agreements. The current agreement, the Paris Agreement (2015), was adopted in 2015. Central to the climate agreements is reporting (UNFCCC, 2021). All agreements have had reporting requirements, but with the Paris Agreement, this has been further developed into the Enhanced Transparency Framework (ETF), to strengthen the tracking of progress and transparency. Every fifth year a global stocktake will evaluate global progress. Specifications regarding reporting are negotiated and decided at UNFCCC COP meetings, which are annual meetings under the UNFCCC umbrella (UN, 2015).

4.2 Swedish framework for climate policy and climate reporting

Sweden has developed a climate reporting system based on international requirements, and the Swedish *Climate reporting regulation* (The Swedish Parliament, 2014). Sweden is a member of the European Union (EU) and has signed the Paris Agreement. Further, it has adopted a national climate policy framework in 2017, which includes a Climate Act, climate goals and a Climate policy council. In Sweden, the reporting system serves both national, EU and UNFCCC reporting requirements. The overall responsibility for the national system for international climate reporting is held by the Ministry of the Environment. The Swedish Environmental Protection Agency (EPA) is responsible for coordinating and maintaining the national reporting system and produces the required reports. SMED (Swedish Environmental Emission Data), a constellation of four agencies, gathers data and makes calculations of GHG (greenhouse gas) emissions (Government Offices of Sweden, 2019).

4.3 Reporting to the United Nations Framework Convention on Climate Change
Countries report climate data, plans and actions to the UNFCCC. There have been different reporting requirements for Annex I (developed) and non-Annex I (developing) countries. However, under the Paris Agreement all countries will report according to the same obligations, although there will be certain flexibilities for non-Annex I countries. This article will primarily focus on reporting from Annex I countries (to which Sweden belongs).

The reporting to the UNFCCC consists of different processes, and consequently different reports on different formats. The reporting includes the following three main processes:

- Statistics of CO2 emissions
    - Reported annually in the National Inventory Report (NIR) and Common Reporting Format (CRF) tables (greenhouse gas emission inventory)

- Description of the climate actions in a country
    - Reported in the National Communication (NC) (under the Climate Convention) every four years and Biennial Report (which will be replaced by Biennial Transparency Report from 2024) every two years

- Commitments on national efforts
    - Nationally Determined Contribution (NDC) (under the Paris Agreement), reported every five years

4.3.1 Statistics of C02 emissions
All Annex I countries annually report a national inventory of statistics of emissions and uptakes of greenhouse gases. In Sweden, various government agencies have statistical responsibilities and provide data for the reporting (R1). SMED collects the data and makes the calculations (Government Offices of Sweden, M.o.t.E, 2019). This way, statistics are produced independent of politics (R7). As was explained by the respondent from SMED (R4):

> 'Emissions for different sectors are calculated, and figures are entered into a common database called Technical Production System (TPS). UNFCCC reporting guidelines and IPCC methodology guidelines should be followed as a standard and deviations must be explained. An important requirement is to have a Quality Assurance and Quality Control system' (R4).

National Inventories are reported in the CRF, to the CRF Reporter at the UNFCCC secretariat. The reporting consists of standardized CRF tables and a NIR that describes the procedure applied (R4). As a respondent at the secretariat explained:

> 'The CRF reporter is an online reporting tool where each Annex I country has its own account. The CRF reporter generates a reporting template with excel tables that is populated with data by the reporter, and aggregations and conversions are made by the software. Then the report is submitted through the submission module in the CRF reporter' (R13).

When reports are submitted, the UNFCCC secretariat makes an initial assessment (partly automated and partly manual) on whether the report is complete, consistent, timely, and in the correct format. The software notifies the reporting country after the automated check, but will not refuse any reports (R13). An assessment report is then created, involving an automated statistical analysis of outliers, using implied emission factors (i.e., if there are deviations from what is normal to a sector or emission source) (R14). An expert review team (ERT) verifies whether the submitted reports are in accordance with reporting requirements and guidelines and provides recommendations. The review ensures that countries have

reported their emissions correctly (R18). A digital platform called iVTR is used to communicate questions and answers in the review process (R8; R13). An analysis of outliers and comparisons with previous years are conducted (R13; R18). There can sometimes be a re-submission of data (R19). The respondent said that the guideline for the review process becomes increasingly more comprehensive, and suggested that:

> 'In general, the review process should be more efficient if you utilize digitalization better, to make information that is key for the review process more searchable; now it can be quite cumbersome to look at all these heavy documents' (R18)

The reports are stored in a data warehouse, which is connected to the CRF Reporter, and the final version is published on the website (R13). On the website there is an online tool to make queries on the emission data, called GHG interface (R13).

With the changes under the Paris Agreement, the CRF format will be replaced by CRT (Common Reporting Tables), and the reporting tool will be developed based on the reporting format (R13). A new storage of inventories might be needed (R14) and there will also be a need to develop functionality to generate reports on the data, and interfaces to visualize the information (R13). Furthermore, the most appropriate tools for reviews are being explored and will be implemented, subject to the availability of financial resources (R17). The reporting process of GHG emissions is illustrated in Figure 1 below .
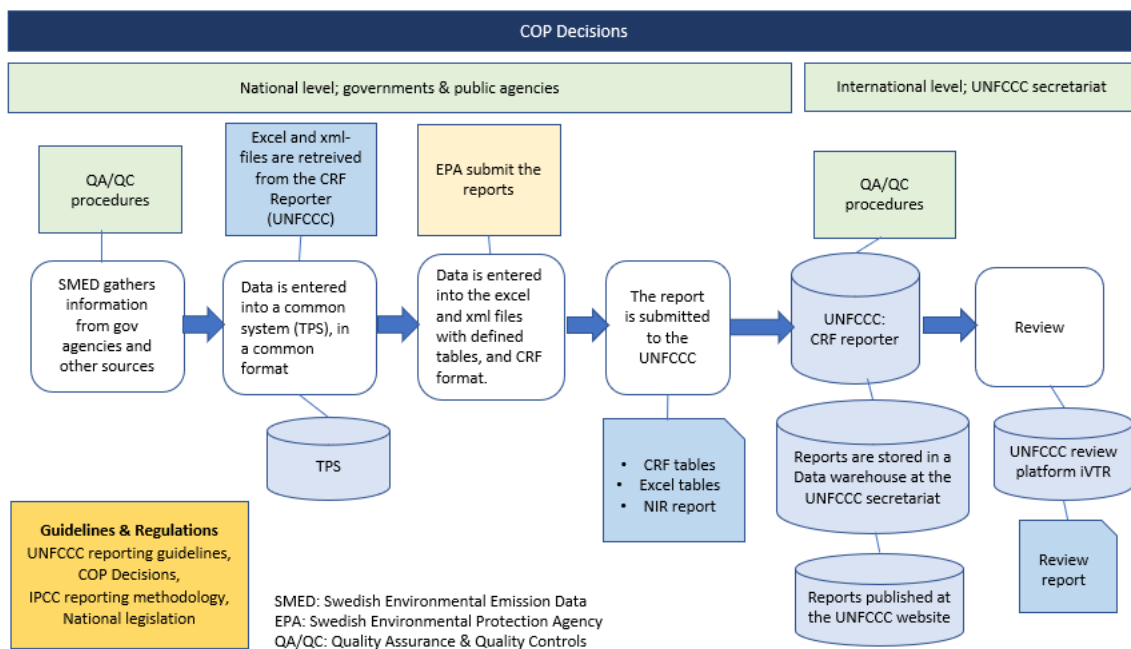
Figure 1: Overview of the GHG inventory reporting process

4.3.2 Reporting of climate actions

The NC report describes a country's climate work, and is a pdf text report submitted every fourth year by all countries (R5). Annex I countries report a Biennial Report (BR) every second year, which follows up on policies, measures, and projections (R3). If possible, they should also include effects of policies and measures, and for this work digital technologies are crucial.

> 'In the work with scenarios and impact assessments in Sweden, advanced digital models have been developed, which comprises a variety of complex relationships that cannot be calculated manually' (R9).

This illustrates that digital technologies have a significant role in managing the complexity of interrelated aspects of climate policy.

To compile the report, the EPA gathers information from SMED and various agencies and sends a draft report to the Ministry of the Environment. The report is processed in the governments offices and then returned to the EPA, which finalizes and submits it to the UNFCCC (R8).

> 'The National Communications (NC) and Biennial Reports (BR) are submitted in the National Reports Submissions Portal (NRSP), which has a link to a records management system where the reports are preserved at the UNFCCC secretariat. They are also published on the UNFCCC website' (R13).

The secretariat verifies that it is the right type of report, but no quality checks are conducted (R19). The NC and BR are reviewed by international expert review teams; there can also be multilateral assessments. A digital platform is used in the review to communicate questions and answers. One of the respondents (R8) had experienced technical problems with the review platform. BRs will be replaced by the Biennial Transparency Report (BTR), starting December 2024. All countries will then report in the same format, but the level of extent of the reports may differ (R17).

4.3.3 National commitments

Countries should report their commitments on what they will contribute to the Paris Agreement goal in the NDC. NDCs should be in the Information for Clarity, Transparency and Understanding (ICTU) format, and are submitted to a common NDC register at the UNFCCC (R6). The EU submits a common NDC (R2), and the Effort Sharing Regulation specifies how much emission each EU member state should reduce (European Union, 2018). There is no review or assessment of the NDC, but countries report on their implementation. Commitments in the NDC should increase every fifth year. However, it is not yet clear how this will be assessed (R19).

There is a table called 'Track in progress' to follow up on commitments and progress of each country (R13). As one of the respondents said

> 'In the table "track in progress", the country has its targets and a set of indicators. Then they have a balance in the "structured summary", and they can see if the data from the inventory translated into indicators is meeting their commitments in their NDC' (R14).

The track in progress will be reported in Excel in the Common Tabular Format (CTF). Individual countries' progress will be considered during a "facilitative multilateral consideration of progress" (R13).

4.3.4 Synthetization of global progress

Based on reported information, the UNFCCC secretariat is mandated to develop synthesis reports, which provide a view on global commitments (UNFCCC, 2021b), and is an input to the global stocktake (R16). The first global stocktake starts in June 2022 and continues throughout 2023 (R15). The new demands on global synthetization of information, along with increased volumes of reports will place new challenges on information management and analysis at the international level (R14). One of the respondents emphasized that smart ways to manage huge volumes of reports and to make them usable must be developed:

> 'Imagine as of 2024 we will receive biennial transparency reports every 2 years from almost 200 countries. These reports can be excessive and they come as a pdf. That will be a huge amount of information to read. They should be summarized and synthesized, and there should be a discussion on how to do this. If

something could be standardized or put into tables, for example. If digitalization should be used to support this, it must first be decided what information people want to get out of it. Nevertheless, it is important to find what is relevant in the reports in an easier way' (R19).

Respondents have further emphasized the need for improved means to make sense of and illustrate progress towards the goal in the Paris Agreement (R5; R19), as well as to improve the website, as the content grows (R20). One of the respondents at the UNFCCC (R14) also said that their systems were not adjusted to analyze the global status because they lacked that mandate. Currently, they must add all countries' emissions manually. On the question on what the respondent would like to address in further digitalization, the response was:

'It would be helpful to see the contribution of different Parties and the trends on emissions, then the contributions of the gases, the contribution of the sectors, and then the same for the categories and then for each category. For example, what is the trend in agriculture in countries in a particular region of the world. It would also be good to see some indicators of the efficiency, like implied emission factors.' (R14).

The reporting structures to gather information at a global scale are in place, but there are growing challenges in managing large volumes of information, as well as making the information comprehensible. There are, however, some external initiatives that use the reporting information to make analyses. For example, the *Climate Action Tracker* makes independent scientific analyses and measures government climate action towards the goal in the Paris Agreement (Climateactiontracker, 2022), and *Climate Watch*, which visualizes countries' emissions, compares NDCs, and provides analyses on how countries can improve their efforts (Climatewatch, 2022).

4.3.5 Information infrastructure for global climate reporting
Our objective was to map global climate reporting as an instantiation of an information infrastructure, to achieve an increased understanding of the role of information systems in governing global problems. In Table 2 below is an overview of the key elements of the II and how these manifested in our case.

Element of II	National level	International level
Information systems	Office programs TPS (Technical Production System) Digital models	For annual GHG inventories: CRF Reporter Data warehouse For NC & BR: National Reports Submission Portal (NRSP) Records management system NDC Register Review platform UNFCCC (iVTR) UNFCCC website
Information	Reporting requirements; - GHG emissions - Climate action commitments - Climate action Multiple sources of information input for the reporting	Reports from countries Synthesis reports based on country reports
Standards	Reporting formats UNFCCC reporting guidelines IPCC methodology standard	CRF Reporter Reporting formats
Organizations	Environmental Protection Agency SMED Public agencies submitting data	UNFCCC secretariat COP & CMA meetings

	Ministry of the Environment Government & Parliament	
People	Public administration personnel Politicians	Personnel at the UNFCCC secretariat Government delegations
Social structures	National & international governance frameworks - National legislation & administrative arrangements - International negotiation of requirements and COP decisions - EU requirements	Governance framework at international level Climate Convention Paris Agreement COP & CMA processes and decisions

Table 2. Information infrastructure elements in global climate reporting

5. Discussion: climate reporting as an information infrastructure

In this section, we position our findings against key characteristics of IIs outlined by Hanseth & Monteiro (1998), and discuss the sophistication level of the II of climate reporting according to Hendrick's (1994) typology.

As illustrated in Table 2, the reporting II encompasses information systems, information, standards, organizations, people, and social structures. The reporting can thus be viewed as a socio-technical structure. The interviews revealed that standard reporting formats and reporting guidelines have been decided at a global level, which enables global coordination. Modalities, procedures, and guidelines (MPGs) for the reporting and review under the Paris Agreement have been decided in the rule book under the Paris Agreement (UNFCCC, 2018). Systems and software have been developed at the UNFCCC secretariat to facilitate and manage reporting. Procedures have been developed and there are requirements on countries to develop institutional arrangements for the reporting (UNFCCC, 2018). The elements of the II for climate governance are interconnected and interdependent. Digital technologies are embedded in reporting activities, which are then embedded in governance processes and structures, and involve various actors.

The II serves governance functions and activities for various stakeholders. In a global governance context, various stakeholders have different roles. As one respondent (R5) said, NGOs (Non-Government Organizations) are important to put pressure on governments. Private investors can be instrumental in enabling the climate transition. Involving businesses is key to leverage the climate transition in the for-profit sector. The UNFCCC climate champions work to engage stakeholders to mobilize climate action (UNFCCC, 2022b). The information provided through the reporting is accessible to everyone via the UNFCCC website, and emissions and efforts can be aggregated to the global level. This information is potentially useful to all these stakeholders. As countries' emissions, measures, commitments, and needs are reported, the information can be used for monitoring and to inform decision-making in the UNFCCC process, support accountability, identify sectors that need attention, investment needs and business possibilities, and facilitate collaboration.

An II evolves incrementally through extension and improvement of the installed base (Hanseth & Monteiro, 1998). This means that the II for climate governance can be developed through innovation on existing II, where additional modules can be added to support governance towards the global climate goals.

5.1 Sophistication level of the II

Hendrick's (1994) three levels of types of information systems offers a way to analyze the sophistication of an information infrastructure. The first level is a *Transaction Processing System (TPS)* to collect, store and maintain quality control of information. The next level is a *Management Information System (MIS),* including capabilities to process, manipulate and link information, and to make comparisons with organizational goals. The most advanced level is a *Decision Support System (DSS),* which has more sophisticated data analysis and presentation capabilities to support planning and decision making. These types of systems build on each other. First, information is collected, validated and organized, after which more advanced analysis and presentations can be done (Hendrick, 1994). Our findings indicate that the information infrastructure of global climate reporting is evolving but currently at a rather basic level, where digital technologies are primarily used to gather, store, and maintain quality control of the information. This resembles a TPS. While plans for developing more sophisticated systems and functionality can be found both at the national and UN levels, several of our respondents pointed to a need for functionality at the MIS and DSS levels. With increased requirements for global synthetization and stocktaking of the global progress, there will be a need for further digital support to make comparative analyses at the global level, link that with the goals in the Paris Agreement, and to visualize information that clearly illustrate progress and gaps.

Additional functionality for data-driven decision making could be developed, based on the verified reporting information. The interviews indicate an increasing need of analytical capability, e.g., impact assessments at the national level as well as visualisations for improved decision support at the global level. The UNFCCC secretariat works on a very strict mandate from the COP, where extensive negotiations substantially slow down the speed of digital innovations. The development of the II needs to consider its inherent dynamic complexity, with increasing socio-technical heterogeneity of components and interactions, as the number of users and applications increase. Hanseth and Lyytinen (2016)'s 5 design principles for IIs (designing for usefulness, drawing upon the installed base, stimulating an expanding user base, making each application and IT capability simple, and modularising the II to enable continuous adaptability) offers concrete guidance to this end.

6.   Conclusions

This study fills a knowledge gap by offering insights into the previously unexplored area of digitalization in global governance. Our analysis showed that information infrastructure offers considerable value as an instrument to open up and understand the black box of digitalization in global governance as a complex interplay between the information systems, information, standards, organizations, people and social structures.

Given the urgency of the global climate crisis and the obvious potential in digital technologies to contribute towards addressing the problem, we expected to find extensive and advanced applications of digital technologies in our case. However, our analysis of the sophistication level of the information infrastructure currently supporting climate reporting revealed a relatively basic use with much potential for improvement — for instance related to improving analytical capabilities and communicative services for various stakeholders, to support evidence based and data driven decision making, and more effective assessments of

progress towards established goals.

5.1 Implications

The UNFCCC and others should consider our results as a call to arms to quickly assess how they can speed up the implementation of digital technologies to increase their analytical capabilities to improve progress assessment, communicate more effectively with stakeholders and identify new ways of visualizing data to support decision making. The 5 design principles for IIs by Hanseth and Lyytinen (2016) offer useful guidance for practice.

Our investigation has only just started to reveal the complexities of digitalization in global governance. More research is needed on how global IIs can be enhanced to support effective implementation of global governance goals, considering the roles and needs of various actors. There is certainly a need for descriptive studies of different cases that can later be compared and synthesized. Moreover, we encourage colleagues to explore *why* digital technologies are not used more sophistically to address the imminent climate crisis. Finally, research on *how*, and under what circumstances, digital technologies can improve the global response to societal problems is suggested.

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Exploring the Impact of Digital Global Governance through Affordance Theory: the Case of Climate Reporting

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Abstract:
The world is facing global challenges, which has led to international policy development such as the Paris Agreement (the United Nations climate agreement). An important element of the Paris Agreement is reporting. As digital technologies are used in reporting, this can be considered a case of digital global governance. Surprisingly, the global dimension of digital governance has received little attention from the academic community. Thus, theoretical and empirical understanding of digital global governance and how it responds to global challenges is needed. To address this, climate reporting to the United Nations, with Sweden as a case, has been studied. Reporting was chosen because of the significant role of embedded IT artefacts. Empirical data was analyzed with the lens of affordance theory. Findings suggest that IT artefacts and information in the reporting have affordances that enables monitoring, transparency, implementation of agreement, coordination & collaboration, analysis & visualization, and re-use of information.

Keywords: Digital global governance, IT artefact, affordances, climate reporting

1. Introduction

Some of the more pressing challenges of today, such as climate change, are challenges of global character. Global challenges further drive the need for global governance. Regarding climate change, climate agreements have been adopted within the United Nations Framework Convention on Climate Change (UNFCCC), with the Paris Agreement as the most recent one. A central element in this is that countries should report on emissions, commitments, measures, scenarios and some more. The intention is to enable monitoring of emissions and tracking of progress, transparency of Parties´ commitments and actions, and to inform further decision making and actions towards the common goal set in the Paris Agreement (United Nations, 2015). International climate reporting is a process in global governance, in which information and information technologies (IT) are embedded and have a significant role. By that, international reporting is also considered to be an element of digital global governance. As a conceptualization of IT used in the reporting process, the concept of IT artefact is used. IT artefact is understood as the application of IT to support a certain task in a certain context (Benbasat & Zmud, 2003). A characteristic of governance is to work towards common goals.

A task for IS research can thereby be to analyze what IT artefacts in a digital governance setting contribute to working towards governance goals. A key aspect of an IT artefact is also that it aims to communicate information (Goldkuhl, 2013a), and it is important to consider the role of information in a particular social context. It is the IT artefact together with the information that create value. Digital governance is often argued to enable good governance (Kalsi & Kiran, 2015) and facilitate implementation of sustainable development (Janowski, 2016). However, there is a need of empirical evidence of what IT artefacts in digital governance initiatives actually enable. Additionally, little research in the digital governance field addresses global governance of global challenges. Global governance has conditions different from governance at national level, and there is a need for theoretical understanding of digital global governance. Regarding reporting, there is also little empirical evidence on what impact it has at national level, which is important because the actual implementation of international agreements is primarily carried out at national level. To explore what IT artefacts and information in the reporting contribute related to governance, the concept of affordances is applied. Affordances can be explained as action possibilities applied to achieve a certain goal, and arise in the interaction between IT and user (Volkoff & Strong, 2013). Affordance theory has shown to be promising in studying IT and organizational change (Volkoff & Strong, 2017), as well as sustainability transformation in organizations (Seidel et al., 2013). In light of the above, the aim of this paper is to explore what the affordances of the IT artefacts and information in the reporting to the UNFCCC are, in relation to governance. The focus of this paper is to understand how this materializes at national level. To pursue this matter, a case study has been carried out, with Sweden as a case.

1.1 Theoretical Foundation

Digital governance can be seen as an evolution of the concept of eGovernance (Misuraca & Viscusi, 2014). eGovernance involves the use of ICT in governance, and changes or creates new governance structures and processes or normative ideas and values (Bannister & Connolly, 2012). eGovernance has an emphasis on what could be enabled by using ICTs, and some of the outcomes that are often addressed are greater efficiency, transparency and accountability (Kalsi & Kiran, 2015; Bannister & Connolly, 2012; Jreisat, 2004), participation, democracy and good governance (Misuraca, 2006; Saxena, 2005), effectiveness, and SMART governance (Al Athmay, 2015). Digital governance is often related to the concept of Digital Era Governance (DEG). Digital Era Governance implies a reintegration of government services, needs-based holism and use of digitalization in processes and services (Misuraca & Viscusi, 2014; Vij & Gil-Garcia, 2017). Big data, data analysis, data modeling and data visualization is used to optimize decision making (Kang & Wang, 2018). The eGovernance and digital governance literature has a focus on the national level, and little research has been found that addresses global governance. Common themes of studies with an international perspective, are comparisons of eGovernment development in different countries (Evans & Yen, 2006; Welch et al., 2005), and digital divide (Rose, 2005; Zhao et al., 2014).

In order to understand digital governance from an information systems (IS) perspective, it is important to understand the role of the IT artefacts. IT artefact has been conceptualized in different ways. Orlikowski & Iacono (2001) describe it as

> *"Bundles of material and cultural properties packaged in some socially recognizable form such as hard-ware and/or software"(Orlikowski & Iacono, 2001, p. 121)*

Benbasat & Zmud also emphasize that it intends to support a task and that it is embedded in a context, suggesting that an IT artefact is

> *"the application of IT to enable or support some task(s) embedded within a structure(s) that itself is embedded within a context(s). Here, the hardware/software design of the IT artifact encapsulates the structures, routines, norms, and values implicit in the rich contexts within which the artifact is embedded" (Benbasat & Zmud, 2003, p. 186).*

Important to consider is that an IT artefact has a purpose and is intended to contribute to a goal in a certain context (Goldkuhl, 2013b). An IT artefact is a means for informing, which also makes it an information artefact. One of the most important traits of an IT artefact is that it contains information (Goldkuhl, 2013a). Because its purpose is to communicate information between people, it is also part of social activities (Goldkuhl, 2013b). In an eGovernment setting, it is crucial to consider the characteristics of public policy, including regulations, strategies and public norms and values (Goldkuhl, 2016). Different aspects of IT artefacts have been emphasized by IS scholars, both information processing and computational capabilities, contextual and interactional aspects, economic values (Orlikowski & Iacono, 2001), and functional affordances and symbolic expressions (Markus & Silver, 2008). To examine how IT artefacts and the information it manages contribute to a certain goal, affordance theory is an appropriate lens to use. In this paper, the affordances are derived from both what the IT artefacts and the information they manage enable. IT artefacts are in this article understood to be the IT systems, platforms and applications used in the reporting process.

In the IS literature, affordances address the relation between information systems and human actors (Thapa & Sein, 2018) and how technologies are used to support actors´ goals (Conole & Dyke, 2004). Affordances can be understood as action possibilities to achieve a certain outcome, and arise in the relation between an actor and an IT artefact (Volkoff & Strong, 2013). IT artefacts have both action possibilities (affordances), but also limitations (constraints) (Hatakka et al., 2016). An IT artefact has affordance potentials that can be actualized in its use, and this is influenced by structural, social, cultural, technical and economic factors. Different contexts may provide different affordances. In order for affordances to actualize, there must be both actors with action capability, as well as facilitating conditions (Thapa & Sein, 2018). It is important to consider how information systems relate to the organizational context, and how this trigger activities (Seidel et al., 2013). Affordance theory applied to an organizational context ought to include IT artefacts, individual actions, and effects of organizational structures on change processes (Strong et al., 2014), as well as consideration of collective goals, potential for coordinated action, and organizational affordances (Volkoff & Strong, 2013). Affordance theory is an appropriate lens to analyze the role of IT artefacts in digital governance because it emphasizes goal-orientation, which put emphasis on the use of IT artefacts to achieve governance goals.

1.2 Method

The paper is based on an interpretative case study. A case study is suitable to study the use of information systems in a particular context (Shanks & Bekmamedova, 2013). Interpretative studies seek to create deeper understanding of a phenomena, and how meaning is created by participants in a social setting (Williamson, 2013). Sweden was considered an appropriate case because there is a regulatory framework for climate and ambitions in both climate policy and digitalization. Semi-structured interviews have been carried out with officials in the Swedish public administration. Respondents were chosen based on their roles related to the reporting and Swedish climate policy at relevant agencies. Semi structured interviews were conducted via zoom or telephone, each lasting for 45-60 minutes. The interviews were recorded except two, because the respondents did not want to be recorded. In that case, notes were taken. In total, 13 people were interviewed, and the respondents are labeled R1, R2 and so forth. Seven officials from The Swedish Environmental Protection Agency (R1, R2, R3, R4, R5, R6, R11), two from the Ministry of Environment (R7, R13), one from Government Offices (R8), two from Climate Policy Council (R9, R10), and one from Panorama were interviewed (R12). Interviews were transcribed and coded in Nvivo 12 in two rounds. In a first reading, codes were identified. The coded material was reviewed and themes were recognized. The material was then coded a second time according to these themes. It was during the coding and analysis of the coded material that affordance theory was recognized to be an appropriate theoretical lens, as affordances emerged inductively from the data.

2. Results

Reporting to the United Nations Framework Convention on Climate Change (UNFCCC) started with the Climate Convention, was more specified with the Kyoto Protocol, and has been further enhanced with the Paris Agreement. Reports on greenhouse gas emissions, commitments, actions and means for implementation should be reported, and are reviewed by international experts to ensure quality of the reports. With the Paris Agreement there should be a clear tracking of progress of countries´ implementation of their nationally determined contributions (NDC) and every fifth year, there will be a global stocktake with a global assessment of progress towards the goal (UNFCCC, 2021). Sweden has an ordinance on climate reporting that regulates how the reporting is coordinated and which public agencies that should provide information (Climate Reporting Regulation, 2014). In 2018, the Swedish climate policy framework was established. Included in the framework is a Climate Act, climate goals, and climate policy council. Every year, the Swedish Government has to provide an annual climate report in the Budget Bill to the parliament. Every fourth year, the Government has to make a climate policy action plan. The climate policy council makes an annual assessment of how the overall Government policy is aligned with the climate goals, and give recommendations to the Government (The Swedish Climate Policy Framework, 2018). Based on the interviews, affordances of the IT artefacts and information in the reporting have been identified, which is presented below.

2.1 Monitoring

The climate reporting provides data of emissions in all countries, which enables monitoring of the situation. Every fifth year, a global stocktake will assess common progress towards the goal in the Paris Agreement, and what additional measures are needed (R2). According to one of the respondents, the international reporting has also laid the foundation for the national climate policy development

> *"The basic statistics are very important. We can never calculate the effect of a policy instrument if we do not have statistics. Had we not been aware of how much emissions we have today, and estimates of what the development looks like in the future, then politicians would never have dared to take these ambitious goals" (R4).*

Standardization of what information that should be provided, and IT systems that manages this information enable monitoring. Countries submit CRF (Common Reporting Format) tables with figures of emissions for different sectors to the CRF Reporter platform, which calculates emissions per sector. In Sweden a system called TPS (Technical Production System) has been developed specifically to prepare emission reports to the UNFCCC in the right format (R1). Regular reporting makes it possible to assess progress over time. Standardization makes it possible to make a global assessment.

2.2 Transparency

Transparency is a central part of the Paris Agreement. One respondent (R5) meant that transparency is important to trust that countries estimate their emissions in a good way, so there can be a reliable calculation. As was also expressed by another respondent

> *"Transparency of emission reduction, scenarios and effects of measures is important to assess, verify and build trust among parties, that countries actually do what they say they will do" (R3).*

Specific tables for tracking progress will show the progress in a country and enables to see that commitments are continually increased. Transparency enables for NGOs and other stakeholders to make their analysis and take action (R5). In order to have transparency, you need trustworthy information and IT artefacts to manage, disseminate, access and present information over time. Commitments in form of NDCs (Nationally Determined Contributions) are preserved in the NDC registry, so there can be comparisons with what is actually achieved. The NDCs are also important in the global evaluation of actions that are taken. One of the respondents (R6) emphasized that it will be very important what comes out of the global stocktake and how it is presented.

> *"It will be very important to get very clear information about how we are doing, that it will be comparable to forthcoming global stocktakes, and that decision makers and the broad public understand what it says. It can work as a driving force or a form of ambition mechanism (R6).*

Transparency of information on emissions, commitments of emission reduction, and measures enable an open democratic debate. It is crucial though to consider issues of how information is presented and how this affects interpretation, in order for this affordance to actualize. The value of transparency relates to the capability of the IT artefact to present information in meaningful ways.

For instance, it has been suggested that the statistics could be presented in more comprehensible ways, that it is now not so easy to fully understand (R9). It was also pointed out that some countries just do the absolute minimum, and want to have high flexibility in how information is reported (R5).

2.3 Implementation of International Agreement

The Paris Agreement requires countries to submit certain reports at certain points in time, but as one of the respondents (R7) expressed

> *"the Paris Agreement is a very voluntary agreement. It has a common ambition and reporting system, and a mechanism for improvements, but there are no sharp requirements or sanctions. It provides a common orientation to reduce emissions, take measures, climate finance and some more" (R7).*

Countries make voluntary commitments in their NDC and report on measures and scenarios in the Biennial Transparency Report. The NDC should be tightened every fifth year. One of the respondents (R5) emphasized that follow-up of the NDCs will be important to see whether countries implement their commitments. However, there is no official assessment or sanction possibility of insufficient actions taken. Expert reviews control whether the reports follow the reporting guidelines but does not assess achievements. One of the respondents (R13) meant that the expert review does not influence national policy, but EU on the other hand has legal authority to enforce laws and regulations. The EU reports a common NDC to the UNFCCC. EU has adopted climate goals and legislation for reporting procedures (Regulation (EU) 2018/1999 of the European Parliament and of the Council on the Governance of the Energy Union and Climate Action, 2018), as well as how responsibilities of emission reduction are shared between member countries (Regulation (EU) 2018/842 of the European Parliament and of the Council on binding annual greenhouse gas emission reductions by Member States from 2021 to 2030 contributing to climate action to meet commitments under the Paris Agreement and amending Regulation (EU) No 525/2013, 2018). Member countries report in a certain digital platform called Reportnet, which is also structured to facilitate compliance with regulation (EEA, 2021). In this way, EUs reporting platform is an IT artefact that not only gather information, but also facilitates compliance of regulation which intends to implement political goals.

In Sweden, the government should provide a climate report to the Swedish parliament every year, which includes key decisions and actions carried out. Even though the Swedish Climate Policy Framework is a Swedish initiative, it relates to the international level. According to a respondent at the Ministry of Environment

> *"It is the goals that influence how much action that is taken. It sets a sharp level of ambition. This in turn derives from the fact that we have made certain commitments in the Paris Agreement. Then, the climate policy action plan and the climate report ensure that the Government fulfills its task. This means that the issue comes up and has a clearer and sharper preparation process, both in the budget process and in policy development for each term of office" (R13)*

Reporting makes it possible to assess implementation of political climate goals at different levels (national, European and international). Legislation also gives the reports greater weight and a function as legal evidence. IT artefacts enable the reporting and management of evidential information.

2.4 Coordination & Collaboration

Development of the reports as well as the review requires coordination and collaboration. As one of the respondents (R4) expressed

> *"I would say that thanks to that we have had these reports, we have built up our national system that builds a lot on that we work together agencies between. In Sweden, it is stated in a regulation what responsibility agencies have, and the reporting in general is very controlled. Now comes a new regulation that we should share even more with each other, in order to facilitate collaboration around impact assessments" (R4).*

Coordination of information may also trigger coordinated working across organizational boundaries. This may facilitate to put the matter in question (climate change) at the center. At Government level, the climate policy council gave recommendations to improve coordination to have a coherent climate policy across policy areas, and a forum for dialogue for all ministers and their State Secretaries have been established (R13). According to the respondent from the Government Offices (R8), the Government Offices has a technical environment that facilitates collaboration and sharing of information. There is a common IT platform, a collaboration platform where for instance the budget is developed and cross-departmental working groups can collaborate, and an intranet where information can be shared with all embassies and other government bodies. Between government departments and agencies there are legal aspects to consider for sharing information (R8). Coordination of information and work processes are interrelated, and the IT systems and platforms are important tools to enable this. Both national and international requirements on coordination affects work at national level. Gathering of information at international level enables global coordination. A submission portal, website with access to reports, and a digital platform for conducting reviews of reports are examples of how IT artefacts are used for global coordination.

2.5 Analysis and Visualization

There are different initiatives where IT artefacts are used to support analysis and visualization of the climate policy work, where also reporting information is used. Panorama is a digital tool that visualizes the climate work in Sweden (R12). The climate policy council has developed a method and digital tool for making impact assessments of policy instruments (R9). Digital models have been developed for scenarios that should be reported to the UNFCCC (R4).

Panorama is a Swedish initiative, related to the Swedish climate policy framework. The idea with Panorama was to be a support for decision making, but many citizens also use it. The idea is to show what areas need measures, as well as what is going well. Panorama visualizes emissions, goals, measures and policy instruments, and potentials for different measures (R12). The climate statistics is one of the sources in Panorama. One of the respondents at the Ministry of Environment (R7) thought that

> *"Panorama can support decision makers and provide confidence for the climate work. You can show statistics, follow up on what is being done, and see if the ambition and measures are enough. But it*

can have more purposes, to inspire citizen engagement, provide support for more policy instruments because you see a gap. In that way, reporting can be more proactive and generate more values" (R7).

Digital technologies provide possibilities to present information in new ways, which enables new means for interpretation of complex societal challenges, which may also empower actors to take action.

2.6   Re-use of Information

The Swedish climate reporting to the UN is based on national statistics of emissions, which is also the basis in development of policies and scenarios. According to one of the respondents (R4), the international reporting requirements has also laid the foundation for the Swedish system

"The basic work has been done thanks to the international. Thanks to the fact that we have had that system and those methods, we have also been able to look at what happens if we take a little more action. By being able to show it very concretely, politicians dare to make these ambitious decisions. I would say that we could not have been where we are today without this basic data and scenario work. It has also been valuable to have a common picture of our policy instruments, to have this map. This is something we developed because of the international reporting" (R4).

An affordance of the reporting is that the information can be used for more purposes. Accessible information may also create action possibilities for multiple stakeholders. As example, Panorama uses the UN reports as one of their sources (R12), and NGOs can make independent analysis and put pressure on countries to take action (R5). Further re-use of information may have affordances that we don`t yet know.

3. Discussion

The Paris Agreement does not have sharp obligations of what measures countries should take or any sanction possibilities. This is decided at national (or EU) level. What it has is a common ambition and reporting obligations. Embedded within the reporting, is the use of IT artefacts that manage information of value to governance. The IT artefacts are used to carry out reporting activities, which together with the information provide affordances to governance. The information serves as evidence of emissions, commitments and actions. IT artefacts enable access to, management, preservation, presentation and dissemination of the information. In order to analyze affordances related to governance it is therefore crucial to consider both information and IT artefacts.

Affordances are action possibilities that arise in the interaction between IT and users, intended to achieve a certain outcome (Volkoff & Strong, 2013). In this case, this relates to how it contributes to governance. The affordances of the IT artefacts and information in the reporting process that were identified were: monitoring, transparency, implementation of agreement, coordination & collaboration, analysis & visualization, and re-use of information.

IT artefacts should not be treated in isolation, but involved in social activities and embedded in a social context (Orlikowski & Iacono, 2001). The context is also crucial to consider regarding affordances and what the IT artefacts are intended to contribute to (Thapa & Sein, 2018). The social

context may also change due to implementation of IT artefacts. In the case of Sweden, laws regulate how reporting should be conducted, and this has also increased cross-organizational collaboration. Affordances may vary between countries due to contextual conditions, such as regulations, working practices, social norms and political will. Affordances of IT artefacts can as well have different level of impact. An example is that IT artefacts enable transparency, but how the information is presented will impact how it is interpreted, which will influence how it is acted on. There is also a potential for re-use of the information which for instance enables new ways to make visualization and analysis, which may influence actors´ understanding, decision-making capability and responsiveness to societal challenges. However, in order for global governance to be effective and appropriate responses are made globally, shared affordances (Leonardi, 2013) have to be actualized. Even though the reporting may be a mechanism for governance towards the climate goals, it is going too slow. Due to the urgency of the climate crisis, current ambitions are not enough to meet the climate goals. The questions for us to ask is how digital technologies can be utilized to facilitate more effective actions?

Below is a summary of affordances of the reporting and possible outcomes;

Table 1: Affordances of the IT artefacts and information in the reporting, and possible outcomes of actualized affordances

Affordances	Possible outcomes of actualized affordances
Monitoring	Common understanding of real-world situation, confidence in decision making
Transparency	Stakeholder engagement, trust, accountability
Implementation	Action towards climate goals
Coordination & collaboration	Coherent and more efficient and effective climate policy
Analysis & visualization	Fact-based decision making, identify gaps and progress, effective climate policy
Re-use of information	**Innovation, not yet known affordances**

4. Conclusions

The aim with this article was to explore affordances of the IT artefacts and information in the climate reporting to the UNFCCC, understood as an element of digital global governance. The reporting practice highlight how information and IT artefacts together provide action possibilities in governance. Affordances that were identified in the study was monitoring, transparency, implementation of agreement, coordination & collaboration, analysis & visualization, and re-use of the reporting information. It is crucial to consider both the role of information and IT artefacts involved in the reporting in analysis of affordances in a governance setting.

4.1 Implications

The research sheds light on an ongoing process in digital global governance. The point of departure was to examine international climate reporting at national level, but affordances are also related to the international level. The results contribute to an improved understanding of what affordances the IT artefacts and information in the climate reporting to the United Nations contribute to governance. In practice, a greater understanding of affordances can be used to make implementation and development of climate policy more effective. The use of affordances of IT artefacts and information in the reporting, provide a theoretical perspective that is promising for analyzing the role and impact of IT artefacts in digital governance. The recognition of the role of information that the IT artefacts manage related to affordances is a contribution to the use of affordance theory in the IS field. Further research could engage in deeper analyses of what properties of information and information systems, along with capability of actors and institutional conditions, that would facilitate actualization of affordances in the UN climate reporting and inspire and empower actors to take actions required to achieve the climate goals.

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Affordances of e-reporting on a supranational level: the case of Reportnet

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Abstract: An increasing emphasis on data driven and evidence-based policy making gives information and information systems a key role in governance processes. It is also argued that digital governance can support the implementation of the Sustainable Development Goals (SDGs). A number of grand challenges, such as climate change, need to be addressed at an international level. In climate governance, reporting has a central role to monitor progress, both under the Paris Agreement at a global level, and within the European Union (EU). Within the EU, reporting is also used to assess implementation and compliance with EU regulations. This paper is based on an interpretive study of the e-reporting platform, Reportnet, which is used to manage climate reporting within the EU. Affordance theory is applied as an analytical lens to uncover the possibilities of e-reporting in a supranational context. Our study identified six key affordances in the areas of submission of reports, quality controls, compliance, monitoring, transparency and communication and visualization. The study also suggests that an important area for improvement is to make the reported information more usable, particularly in further policy processes.

Keywords: Digital governance, e-reporting, affordances, EU climate governance

1. Introduction

The Sustainable Development Goals (SDGs) has been adopted within the United Nations (UN), as a global agenda for action towards 2030 (Nations, 2022). Arguably, digital governance can facilitate the implementation of the sustainable development goals (Estevez, Janowski, & Dzhusupova, 2013; Medaglia, Misuraca, & Aquaro, 2021), but more research is needed on how this is materializing in practice. Goal 13 of the SDGs is climate action (United Nations, 2022).

The European Union (EU) works strategically to align digitalization with climate action (European Commission, 2019b, 2020). The strong emphasis on evidence-based and data driven policy making, implementation and evaluation (European Commission, 2018), suggests that digital technologies have a key role in governance. However, little research has been done on IT´s role for

policy activities (Hochtl, Parycek, & Schollhammer, 2016), in particular in the area of environmental policy, where there is a significant implementation gap (Bürgin, 2021). One of the problems in environmental policy implementation relates to reporting, with problems of completeness, timeliness, comparability, and accuracy of data (Bürgin, 2021; European Commission, 2019a). It is argued that possibilities of digital technologies to improve data quality and to track progress of policy implementation should be further investigated (Bürgin, 2020).

The UN Paris Agreement sets a global climate goal that individual nations work towards. A central element of the Paris Agreement is that countries are required to report on their emissions, commitments, and actions in order to monitor progress (UNFCCC, 2018). EU member states also report to the EU, which is used to compile the EU´s international reporting and assess compliance with EU climate legislation, which ensures the EU´s international commitments (EU, 2018c). Environmental reporting is used to monitor the state of the environment, assess compliance with regulation, evaluate policy effects and effectiveness (Jensen, Saarenmaa, & Martin, 2002; Vaz, Martin, Wilkinson, Newcombe, & Ribeiro, 2001), and inform policy makers to take adequate measures and decisions (Kotsev, Peeters, Smits, & Grothe, 2015). The use of digital technologies in reporting situates e-reporting in the digital governance field (Lee, 2006). E-reporting offers means to enhance transparency and accountability on how governments perform in achieving policy goals, and hence handling societal challenges (Kloby, 2012; Lee, 2004). However, challenges with information quality, administrative burden and issues of interoperability have been raised (Schleidt, 2013; Siedschlag, 2011), and it is worthwhile to further investigate how possibilities and challenges with e-reporting are applied and addressed to support governance.

The European Union´s (EU) digital platform for climate reporting, Reportnet, was selected as a case for studying e-reporting in the context of climate governance. Reportnet was launched in 2002 and has undergone 2 major updates. The current version, Reportnet 3.0, is expected to improve efficiency and coherence by streamlining and simplifying reporting in accordance with the goals in the Digital Strategy (Kampa, 2018). The information reported to Reportnet is a foundation for evidence based and data driven policy processes. The EU is further considered an appropriate case for a study in a global governance context because it represents a supranational level which has legal authority as a means for implementation of international agreements.

A promising theory for analyzing and understanding possibilities with digital technologies in certain contexts is affordance theory. Affordances can be described as action possibilities (Hatakka, Thapa, & Sæbø, 2016) that emerge in the relation between technology and goal-oriented users (Volkoff & Strong, 2013). This study therefore adopts affordance theory as an analytical lens to understand the possibilities that digital technologies offer in a supranational climate governance context. The research question guiding the paper is 'What affordances does Reportnet provide in a supranational climate governance context?' The rest of the paper is structured as follows: first we introduce related research relevant to the topic, then the theoretical lens and description of method. This is followed by reporting of results, discussion, conclusions and implications for research and practice.

1.1. E-reporting

In the digital governance literature, studies about reporting address different types of relationships, such as government reporting to the public (G2C), citizen reporting to public agencies (C2G), and business reporting to government (B2G). Government reporting enables transparency, accountability (Filipovic, Martic, & Demirovic, 2018; Ghani & Said, 2010), and communication of government performance (Mullen, 2007). Measuring and reporting on performance enable governments to show results, increase transparency, validate policy decisions, and build trust (Kloby, 2012). E-reporting provides tools for data analysis (Sikiru A. Fadairo, Williams, & Maggio, 2015), utilizes ICT to advance reporting, and offer functions to communicate complex information in comprehensible ways to show how governments achieve their goals (Kloby, 2012). Access to information on how governments perform in handling societal challenges is an important democratic issue, and central in developing trust between government and citizens (Lee, 2004). Effective policy activities depend on data and systems that manage the data (Abramic et al., 2017). A challenge is to convert large volumes of data to actionable information that is made useful to support decision making, transparency and accountability (Lewis et al., 2012). Although digital technologies provide means for enhanced accessibility, it is important that information is presented in a meaningful way (Lewis et al., 2012; Morehead, 2012). Essential is also to ensure the accuracy, timeliness, and completeness of the information to secure the trustworthiness of data, which is crucial in building trust with citizens (Lewis et al., 2012). Electronic reporting is argued to provide means to ensure these qualities better, for instance by support of automated controls. Furthermore, e-reporting is argued to help regulatory agencies to identify violations of compliance more accurately. Automated controls can both check data quality, but also support assessment of compliance with regulations (Lewis, Neiberline, & Steinhoff, 2014; Siedschlag, 2011). An important foundation for efficient reporting is standardization, which makes data comparable, and machine-readable formats enable computer supported advanced analysis (Zhu & Peng, 2010).

A significant challenge with reporting is the administrative burden, and electronic reporting is argued to reduce duplication of reporting, enable seamless transition of data, make the information easier to manage and organize, enable tailored e-reports to different audiences, provide accessibility through the web (Siedschlag, 2011), and reduce costs (Ghani & Said, 2010). Efforts have been made in the EU to streamline and simplify reporting, reduce administrative burden, provide cost-effective solutions, eliminate double reporting, and facilitate exchange of information, semi-automated aggregation of information, and faster availability of information (Schleidt, 2013).

As environmental problems do not stay within national borders, their resolve require collaboration across countries (Kotsev et al., 2015) and hence the exchange of environmental data. In a European context, there are challenges with differences in data structures, languages, workflow, cultures, and approaches to sharing of data. Other challenges are data silos that hinders re-use. Standards are key to enable interoperability and information exchange (Abramic et al., 2017).

To sum up, the literature suggests that e-reporting provides means to communicate how policy goals are achieved and may enhance Government transparency and accountability. Key challenges include issues of information quality, administrative burden as well as interoperability. While the literature contains examples of the possibilities digital technologies represent for reporting and thus

also governance, there is a need for a systematic approach to understanding how such possibilities can be identified and categorized. Affordance theory offers this possibility and was therefore selected as our analytical lens.

1.2. Affordance theory

Affordance theory was originally developed by the ecological psychologist J.J. Gibson (Strong et al., 2014; Volkoff & Strong, 2017). Affordances is based on the idea that goal-oriented actors perceive objects in their environment in terms of what the objects afford, how they can be used to meet a goal. Affordances are relational between an object and its user. In the IS domain, affordances emerge in the relation between users and technology (Chemero, 2003; Leonardi, 2011; Volkoff & Strong, 2017). Affordances are perceived related to the intentions and objectives of the user (Seidel, Recker, & vom Brocke, 2013). Volkoff & Strong define affordances as "the potential for behaviors associated with achieving an immediate concrete outcome and arising from the relation between an object (e.g., an IT artifact) and a goal-oriented actor or actors" (Volkoff & Strong, 2013, p. 823). Affordances can be seen as action possibilities (Hatakka et al., 2016; Volkoff & Strong, 2017). Properties of an object as well as ability of an actor are necessary conditions for affordances to emerge (Markus & Silver, 2008).

A distinction is made between potential and actualized affordances. Actualized affordances require that a user with action capability interacts with the IT artefact to achieve some goal (Hatakka et al., 2016). Otherwise, the affordances will only be latent (Arto, Thapa, & Stendal, 2016, p. 132). Some researchers also distinguish between perceived and actual affordances (Norman, 1999). Perception and actualization of affordances are influenced by social, cultural, organizational, and technical factors, and contextual differences and abilities of users will affect how and to what extent affordances are actualized (Thapa & Sein, 2018; Volkoff & Strong, 2017). Actualization of an affordance may also lead to new affordances and enhanced capabilities (Hatakka et al., 2016). Strong et al. (Strong et al., 2014) defines actualization of affordances as "the actions taken by actors as they take advantage of one or more affordances through their use of the technology to achieve immediate concrete outcomes in support of organizational goals" (Strong et al., 2014, p. 70). Actualization of affordances generate some effect, which relates actions for actualization of an affordance with organizational goals (Strong et al., 2014). Affordance theory is used in this paper because it contributes with an understanding of the possibilities of IT artefacts in specific contexts, related to the goals in that context. In this case it is the affordances of Reportnet in a climate governance context, with goals of efficient and high-quality reporting that contributes to a data driven administration and policy processes that supports the achievement of governance objectives.

1.3. Method

The paper is based on an interpretive case study of the EU digital reporting platform Reportnet. Semi-structured interviews were carried out with experts at the European Environment Agency (EEA), an expert at DG CLIMA in the European Commission administration, reporters from eight countries, and an expert reviewer. The organizations were purposefully selected as they are key stakeholders to Reportnet. The European Commission is an important user of the information reported through Reportnet, for assessing compliance and progress towards policy goals. EEA hosts

Reportnet and manages reports from EU member states, makes analyses based on the reporting, and develop an aggregated report for the EU (R2). Thereby, EEA is both an expert on the system and a user. The reporters from EU member states are reporting to Reportnet. The expert reviewer carries out review of EU member states´ reports to the EU. The respondents are listed in Table 1.

Table 1: Respondents

Role	Authority	Reference code
Expert	European Commission, DG CLIMA	R1
Expert	European Environment Agency (EEA)	R2
Expert	European Environment Agency (EEA)	R3
Reporter	Swedish Environmental Protection Agency	R4
Reporter	Slovak Hydrometeorological Institute	R5
Reporter	Netherlands Enterprise Agency	R6
Reporter	Malta Resources Authority	R7
Reporter	Environment Administration Luxembourg	R8
Reporter	Environmental Protection Agency Ireland	R9
Reporter	Environment Agency of Iceland	R10
Reporter	Danish Ministry of Climate, Energy and Utilities	R11
Expert reviewer	**Expert reviewer for the EU**	**R12**

The European Commission, EEA, and authorities responsible for climate reporting in EU member states were contacted with a request for participation in the research and interviews were made with those that the organizations assigned. The eight EU member states that were selected were those that responded to the request. Interviews were carried out and recorded via Zoom and lasted about 50 minutes with some additional follow-up questions by e-mail. Exceptions were one of the reporters (R11) and one of the experts at the EEA (R3), who responded to questions by e-mail. Questions included the role of reporting and Reportnet in a governance context, for instance how it is used in policy evaluation and analysis of progress towards governance goals; what action capabilities Reportnet 3.0 has; how it differs from earlier versions and how this was experienced by users; and what technological capabilities that are applied. The interview transcripts were coded, and themes were identified and aggregated. The themes emerged inductively from the data, based on questions to the material on what affordances that could be identified. This part served to uncover insights about actors´ views and experiences on the affordances of Reportnet.

Strategic documents, such as the EU Digital Strategy, the European Strategy for Data, the Green Deal, and the Business Vision for Reportnet have been used to understand the context. The study

has taken a hermeneutic approach in the sense that it intends to interpret meaning and make sense of the phenomena by developing a dialectic understanding of the parts as well as the whole (Myers, 2004). In the IS field hermeneutic analysis has for instance been used to develop understanding of the use and impact of IT in a certain social setting (Myers, 2004). In this paper, the affordances of Reportnet are related to governance, to develop an understanding of the role of technology in this context. In this way, it relates a part (Reportnet) to the whole (climate governance). Affordance theory was applied as an analytical lens to develop an understanding of the action possibilities of Reportnet related to the governance context. Affordance theory informed the data collection by asking questions on what Reportnet provides to the user, and how it is experienced. Based on that, affordances with Reportnet were identified and presented in the results section. Key concepts from affordance theory are then applied in the discussion section.

2. Results

2.1. The case

The EU´s Digital Strategy (European Commission, 2018) and European strategy for data (European Commission, 2020) set the EU vision for digital transformation in Europe, with an intention to promote a digitally advanced administration. Regarding climate policy, the Green Deal establishes the EU´s climate objectives (European Commission, 2019b), which are further specified in the EU Climate Law (EU, 2021). The Effort Sharing Regulation states how much each member state should reduce its emissions (EU, 2018a). The Governance Regulation (EU, 2018c) then explicates a governance mechanism for the implementation of the EU climate objectives and commitments under the Paris Agreement based on planning, reporting and verification. Member states should develop and submit an integrated national energy and climate plan, as well as a long-term strategy. Every second year they should report on implementation of the plans in a Biennial progress report. Member states should annually report a greenhouse gas inventory to track progress of emission reductions. Reporting to the EU serves two purposes, both for the EU to monitor progress within the EU, and also to compile the EU´s reports to the United Nations Framework Convention on Climate Change (UNFCCC) (EU, 2018b). The European Commission monitors and assesses the progress of each member state as well as for the EU as a whole. At the European Commission, the DG CLIMA is leading the Commission´s work on climate change and implementation of policies and legislation to achieve the objectives of the Green Deal (European Commission, 2021).

The European Environment Agency (EEA) is responsible for coordinating and managing the reporting for the EU and receives member states climate reporting (European Commission, 2022). EEA hosts the digital reporting platform Reportnet, which is used for environmental reporting in the EU. This means that it is not only climate data that is reported to Reportnet, but also other types of environmental information. Reportnet has been in operational use since 2002. In 2018, a third version (Reportnet 3.0) was initiated in order to improve e-reporting by taking advantage of more advanced IT solutions (EEA, 2017; Eionet, 2021). Implementation of Reportnet 3.0 is carried out successively in accordance with reporting cycles and commitment periods on different environmental reporting. Some of the climate reporting has been submitted to Reportnet 3.0, and

some will be implemented 2023. The aim of Reportnet 3.0 is to modernize e-reporting and to make exchange of environmental data more efficient. The Business vision of Reportnet 3.0 is that it should simplify and streamline data flows across environmental domains and act as a central hub for e-reporting activities. It aims to improve effectiveness, efficiency, and coherence and to make use of new technologies to deliver the ambition and goals by the European Commission (Kampa, 2018).

2.2. Affordances of Reportnet

Based on an inductive analysis of the interviews, affordances of Reportnet were identified. The key affordances of Reportnet are presented in Table 2, and explained and discussed in the text below.

Table 2: Affordances of Reportnet

Area	Affordance
Submission	Efficient & secure submission of reports which can be semi-automated
Quality controls	Rigorous and automated quality controls ensure information quality
Compliance	Reportnet facilitates compliance with reporting requirements and assessment of compliance with climate legislation
Monitoring	Data in Reportnet is used for monitoring and evaluation
Transparency	Reportnet facilitates a transparent and traceable reporting process and access to reports
Communication & visualization	**Reporting formats enable visualization of data. Database-website integration enables real-time visualization of data.**

2.2.1. Submission of reports

According to one of the respondents at the EEA (R2), the main difference between the old reporting system and the new is that the EEA is not collecting templates anymore but focus on the data. Previously, countries would use templates that would be uploaded to the EEA, who would take the data out and put it into a database.

> *"With Reportnet 3.0, a country can either type directly into the interface of Reportnet 3.0, they can take a filled-out template and upload the data to the data schema, or they can connect their national database to the system and pull the data automatically. But when they press the button to deliver to us, the data goes straight into the database. We don´t keep whatever format the data are submitted in" (R2).*

In this way, there are not manual operations in the transfer of reports that can introduce errors and be inefficient (R2). The reporter from Sweden (R4) said that by uploading the data directly into the EEA`s database, it is more secure also for them because it reduces the risk of loss of integrity of

the data. One respondent (R11) thought that the new procedures were rather a burden because they had to use new templates. Based on the submissions from the member states, Reportnet automatically calculates an aggregated dataset for the EU as a whole. The aggregated EU data set is used both for analysis in the EU, but also for obligations for the EU to report its´ greenhouse gas inventory to the UNFCCC (United Nations Framework Convention on Climate Change).

2.2.2. Ensuring information quality through rigorous quality controls

When member states submit their greenhouse gas inventories with statistical data, there is an extensive QA/QC process (Quality Assurance and Quality Controls). Member states do QA/QC before submitting their inventories to the EEA, and then EEA do QA/QC and review member states inventories before the EU then submits its inventory to the UNFCCC (EEA 2). Some of the QA/QC are embedded in Reportnet (R3). According to the expert at EEA (R2), when a country submits their data to the EEA, the QA/QC automatically performs several checks on the data that can trigger warnings, errors messages and blockers. The interface guides users through a process of uploading the data, validating the data, and correcting eventual errors. The automatic quality controls are designed based on expertise on what are reasonable values. When the EEA sets up a dataflow, they define what parameters there should be for each field and what kind of error breaking these parameters should be (R2). The quality controls check primarily completeness, if correct notation keys are used, time series inconsistencies (R5), and if numbers are added correctly (R9). After the automated quality checks in Reportnet, expert reviews are carried out. The expert reviewers assess the reports related to reporting guidelines. They verify information quality and assess if estimations are reasonable. A digital tool is used that applies so called implied emission factors, which compares emissions in a particular sector between countries (R12).

One of the reporters (R10) said that the QA/QC helped them to identify errors and mistakes. Another reporter (R5) appreciated that they could see the errors directly. One of the reporters (R9) pointed out that many countries have also developed QA/QC systems and argued that

> "*Because there could be thousands of rows, thousands of cells of data, it is difficult to find the mistake without automating it" (R9).*

However, the experience with the quality controls differs between reports. One respondent (R6) thought that they could be cumbersome for large tables with many errors. Security was also emphasized, to ensure that there is no hacker attack that manipulate the numbers (R8).

2.2.3. Compliance

Reporting requirements in legal directives and regulations are transferred into specifications that are implemented in Reportnet, which thereby facilitates compliance with regulations. One of the respondents at the EEA (R2) said that the schemas and the quality checks were a direct implementation of the Governance Regulation, and that Reportnet works as a conduit for the countries to report according to legislation. Some of the reporters (R6, R8, R11) also highlighted that Reportnet made it easier to follow reporting requirements in legislation. On the question whether Reportnet and reporting would impact climate policy at national level, respondent R8 said that the

Commission assesses compliance based on the data reported. Respondent R10 said that it has had some effect on a higher level, because the ministry and the government need to be involved, they might have thought more about it. Another respondent (R7) said that the next step would be to use the reports more in policy making.

> *"In reality, the reports provide a lot of information that one requires for policy making. And this is also why we do these reports. We use a lot of the data we produce for the reporting for policy makers. The next step is for people to become more familiar with these reports and use them on a more regular basis in the policy making process." (R7).*

2.2.4. Monitoring of emissions, policy implementation and performance

There are reporting from EU member states on emissions, as well as on policies, measures, and projections. In that way there is both a monitoring of emissions, as well as monitoring of compliance with EU climate legislation and evaluation of progress on climate goals. Progress monitoring is done both at the level of individual legislative instrument and more broadly (R2). According to the respondent at the EEA (R2), the European Commission can access the data on the Reportnet 3.0 public site, and the EEA also supply them with data after the QA/QC process is completed. For some dataflows the Commission is also an observer within the system. According to one of the respondents (R4), the national climate and energy plans and follow up reports, along with emission data, enable for the Commission to compare the development over time, evaluate progress and analyze scenarios and effects of policy instruments, and Reportnet will be the source for that information. As the respondent at DG CLIMA (R1) argued; monitoring, reporting and verification is an important pillar of the Governance Regulation and is a governance mechanism that will ensure the implementation of the EU´s climate objectives.

> *"It is the very core of climate policy. When you try to regulate a sector, you always start by monitoring and reporting because you can´t regulate what you don´t measure. Then there is also reporting on policies, measures, and projections. A lot of the reporting is really about the how. The how is what makes the target credible. One of the issues in general with policies is that defining targets is not that difficult. What way more matters is what you put into account, so that you have some guarantees that you are going to reach those targets" (R1).*

According to the respondent at DG CLIMA (R1), EEA first does some analysis based on reported data and then the Commission is adding an additional layer to the analysis in evaluation of member states reports. Then they evaluate how the member states´ national plans are adding up and compare that to the targets and where additional measures are needed. In that way, the reporting functions as a feedback loop. The respondent (R1) noted that a challenge in this task is not primarily a lack of information, but how information is presented. The information should be presented in a way so that gaps and needs for measures, as well as what measures have been successful can be identified easily. The respondent (R1) argued that not just the Commission, but also the EEA, EU member states and other stakeholders could be better at presenting information in various useful ways.

2.2.5. Transparency

An important aim of reporting is transparency, and this is also strongly emphasized by the EU. According to the expert at the EEA (R2), they publish the data on their website, even before the quality checks start, unless some country chose to hide their data for confidentiality reasons. In that way, various stakeholders can follow the process from submission of member state reports to an aggregated EU data set, which makes it transparent and traceable, which also facilitates accountability. The respondent further said that MRV (monitoring, reporting and verification) is foundational for the EEA´s mission, ambition, and strategy; to support policy making with actionable knowledge based on trustworthy data (R2). One of the reporters (R7) expressed that Reportnet 2.0 had been useful from an information access perspective in that they could just give the link to the report to those who asked for it. The respondent further emphasized that Reportnet 3.0 should not just be a repository, but a more intelligent tool to access and use information

"I hope that eventually we can move towards a system where we don´t necessarily submit one big, massive pdf report that you can only read if you download the whole document, but rather smaller reports for different sectors separately. And then, when someone wants to investigate this library, instead of going into the whole massive reports, you just go directly to the chapters you are interested in" (R7).

2.2.6. Communication and visualization of information

With large volumes of information, visualization is used to make data more comprehensible. A new EU climate and energy website has recently been developed (EEA, 2022a), which shows progress of each member state´s emissions, energy consumption and projections, related to the EU targets. The website is integrated with Reportnet, and when the data in Reportnet is updated after the QC, visualizations on the website should update automatically (R2). On the EEA website there is also a tool to visualize emission data (EEA, 2022b). It shows the development of emissions over time, and trends in individual sectors or gases can be explored.

"the inventory data set is so enormous so a viewer like this is really useful to identify and download a share of the data set rather than the whole thing. It is important not just to be able to access the data but also to find out what the data is showing" (R2).

Another visualization is of policies, measures, and projections of emission reductions (EEA, 2022c). According to the respondent at the EEA (R2), even though it is qualitative reporting, because it is broken into fields in the reporting schema in Reportnet, it enables them to make it navigable in a database and make visualizations. As R2 further explicated, reporting can be seen as a data value chain, where submission of data is on one side of the value chain and communication of the data is on the other end of the value chain, with data management and QA/QC checks in the middle.

3. Discussion

This section applies key concepts from affordance theory in a discussion of the findings and relates the findings to selected literature in digital governance on e-reporting.

This study has found that Reportnet has affordances related to qualities of governance, within the areas of transparency, compliance, monitoring, and communication & visualization of government actions and progress. The study further found affordances related to the reporting process, where digital capabilities enabling automated quality controls and semi-automated submissions make the process more efficient and ensures information quality. Trustworthy information that is accurate, timely, and complete is the basis for data-driven governance, and processes and IT functions that facilitates this will also contribute to governance. The affordances that were found also resonates with what has been highlighted in previous research, which is an interesting finding as the literature review was done in parallel to the empirical investigation and was not used as a pre-understanding for the interviews. The digital governance literature on e-reporting in Section 2, suggests that e-reporting has affordances that enable improved transparency and accountability (Filipovic et al., 2018; Ghani & Said, 2010; Soverchia, 2015), communication of government performance (Kloby, 2012), improved efficiency (Schleidt, 2013) and information quality (Lewis et al., 2014) and support assessment of compliance (Siedschlag, 2011). The literature further emphasizes the importance of presenting information in meaningful ways (Lee, 2004). Reporting formats in Reportnet facilitates visualization of information and it is also integrated with a website which visualizes data in Reportnet. However, there is still a potential for further re-use of the information reported. The reports contain a lot of information that is useful for policy making, societal debate, learning among member states, and innovation. More possibilities to utilize digital technologies for analysis and presentation for different purposes should be explored, for instance as the respondent (R1) from the European Commission suggested, to clearly show gaps, needs for action, and success. The information reported is also a valuable source that, connected to the EU´s work on the strategy for data and Digital Europe, could support climate positive innovation and stakeholder engagement. The suggestion by one of the respondents (R7) to enhance the re-usability of the information in Reportnet should also be further investigated. These suggestions could be seen as potential affordances of the information, but which requires system development to be actualized. Central to actualization of affordances in areas of qualities of governance, related to transparency, compliance, and communication of performance, depends on facilities to make the information reported re-usable and actionable.

Reportnet has functionalities that enable different affordances which can be actualized when they are enacted. Actualization of affordances is affected by contextual differences, such as social, cultural, technological, economic, and organizational factors, as well as capabilities of users (Thapa & Sein, 2018; Volkoff & Strong, 2017). Therefore, there might be differences in actualization of affordances among member states. Some of the reporters (R4, R6, R10) expressed appreciation of the training that had been organized when Reportnet 3.0 was implemented. The training organized during the implementation of Reportnet 3.0 enhance the capability of users, and thereby increase the likelihood of actualization of affordances. The general experience by the reporters were also that Reportnet is easy to use, even though Reportnet 3.0 currently has some 'child diseases' (R7). Different stakeholders may also perceive and emphasize different affordances, which is important to consider in further system development.

The Paris Agreement implies expectations that countries make voluntary climate commitments. What measures countries take and what legal and institutional arrangement they establish differ.

EU offers a supranational level with legislative power, which thereby has enforcement capabilities which can also ensure that the EU delivers according to its international commitments. The reporting from EU member states to the EU serves two purposes, both to assess compliance with EU legislation, and to be the basis for EU´s international reporting to the UNFCCC. Reportnet facilitates both tasks, and the reporting to the EU is also in alignment with international standardization and agreements. Although reporting to the UNFCCC is standardized, the EU offers yet another level of standardization. For instance, the quality controls at EU level are stricter compared to the UN level.

Affordance theory has been useful for identifying and classifying affordances of digital technologies in reporting in an EU supranational climate governance context, and is also related to a global governance context within the UNFCCC. However, the theory was found to be on a quite general level. It has been difficult to estimate to what degree capabilities of digital technologies are utilized and affordances are actualized. Research in digital governance could benefit from complementing affordance theory by some framework that can also reveal the degree of actualization of affordances. Affordance theory has traditionally been applied in the direct interaction between user and information system. This paper contextualizes this in a governance context. A suggestion is a further theoretical discussion on the applicability of affordance theory on the possibilities of digital technologies in a digital governance context. This includes multiple levels, from direct use of IT systems to the contribution of their effects on a more strategic level.

4. Conclusions

This paper contributes an overview of affordances of e-reporting based on the case of the EU reporting platform Reportnet in a supranational climate governance context. In doing so, it informs the discussion on the role of digital technologies in the global governance of critical societal challenges and implementation of the SDGs. The six key affordances of Reportnet identified in this study are in the areas of submission, quality controls, compliance, monitoring, transparency, and communication & visualization. Semi-automated tasks and standardization contribute to more efficient and secure reporting processes, better information quality, and enable interpretation and analyses of the reported data. The main areas for improvements were found to be further use, analysis, and communication of the information, to improve its usefulness for climate policy processes, as well as for innovation and societal discourse.

4.1. Implications

Research: The paper contributes to the digital governance field with knowledge on the possibilities of digital technologies in reporting in a supranational governance context, which is also related to a global governance context. It highlights how digital technologies can support implementation of policy objectives, in particular climate goals and evaluation of climate policy implementation. The use of affordance theory in a societal governance context is novel and connects affordances that occur in the use of a system with organizational goals (digitalization strategies) and societal goals (climate policy).

Further research could investigate how information in Reportnet could be made actionable and facilitate re-use in policy processes. It has been argued that more research is needed on the role of digital technologies in monitoring and policy evaluation (Bürgin, 2021) as well as on the interaction between digitalization and political transformation (Hochtl et al., 2016). A suggestion is a deeper analysis of the effects of actualized affordances (Strong et al., 2014) of Reportnet and related IT artefacts on policy processes, at both national and EU level.

Practice: The paper provides insights on how Reportnet is experienced by various users, and some suggestions are made on further improvements. In particular, emphasis should be on making the information useful, with the aim to further inspire climate action by various stakeholders and thereby enhance implementation of climate policy.

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Sharing, Cooperation or Collective Action?
A Research Agenda for Online Interaction in Digital
Global Governance

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Abstract. Digital technologies are increasingly used to support governance at the global level. However, the global level has received very little attention in digital governance research. Global governance differs from national governance contexts in that it does not have a central government with authority of enforcing decisions. Consequently, as engagement of stakeholders is vital for taking appropriate action, possibilities and challenges in using digital technologies to facilitate response to common challenges should be further investigated. To address this shortcoming, we explore how digital technologies and online communities can leverage participation and co-production in the context of global governance. Based on an existing classification of online interaction (sharing, cooperation, collective action) we suggest a research agenda that can move the knowledge front related to online interactions in global governance contexts.

Keywords: Digital governance, digital global governance, online communities, co-creation, citizen engagement, sustainability, UN Global Stocktake

1   Introduction

Digitalization transforms the way public sector organizations work and interact, both within and between organizations, as well as with external stakeholders. Digital technologies offer new venues for political discussions [1] and for organizations to interact with stakeholders [2]. With societal challenges being increasingly global in character, the need for global coordination and response increases. A pertinent question is then how digital technologies could contribute to enhance global governance as a response to global challenges. 'Digital governance' is the research field that investigates the use of digital technologies in governance structures and processes, and it has evolved through the concepts of eGovernment, eGovernance and digital governance. The term 'Digital global governance' refers to the use of digital technologies in global governance structures and processes. Unfortunately, little research in the digital governance field addresses the global governance level but tends to focus on either the national or

municipal level. International studies are primarily national comparisons of eGovernment development in different countries [3-6], where common themes are digital divide [7] and diffusion of digital governance [8]. A few notable exceptions exist on initiatives of global character focusing on global digital citizenship [9], global ICT programs [10] and global civil society networks [11]. However, studies on digitalization of global governance structures and processes seem to be largely missing

Triggered by the Covid pandemic, online tools have increasingly been used in global governance processes. For instance, the annual meeting in Glasgow 2021 of the supreme decision-making body of the Climate Convention, COP (Conference of the Parties), used an online platform to increase possibilities for participation. Some of the sessions were streamed to the public, and multiple social media channels used [12]. In May-June 2021, the UN Climate Change subsidiary bodies sessions were carried out fully online, including dialogues and discussions to prepare for negotiations [13]. It has further been argued that digitalization may enable a larger change of the climate governance process, which has been requested by various stakeholders. The critique of the current process includes mistrust, power imbalances and polarization, as well as insufficient outcomes that fail to adequately address the climate change challenge [14].

Governance can be understood as the steering of society according to common goals, through collective action [15]. Governance in a global context differs from governance at national level. An important difference is that governance beyond nation states lacks a central authority of a government, which has a legitimate use of force [16]. Instead, common agreements, consensus, and trust are significant. Global governance engages multiple actors with different roles. Stakeholder interaction, both within an organization and with external stakeholders, is important from a democratic perspective, regarding both a capability to make agreements, consider various perspectives, and collaborate. Stakeholder engagement also has an important role in strengthening implementation capability of international agreements.

Research on Online Communities has shown how people use digital technologies to organize collective action in the online environment, characterized by not having a traditional organization with a central authority [17]. In that sense, it has commonalities with consensus-based global governance. We argue that facilitation of collective action strengthens the global community´s capability to respond to common societal challenges, and experiences from research in online communities on collective action can inform how digital technologies can be used to enhance responsiveness to global challenges. Based on a classification of different degrees of involvement of stakeholders; information sharing, cooperation, and collective action [18], this research note develops a research agenda for online interactions in global governance settings. Research notes often follows a less strict paper outline than research papers and are typically used to advance new ideas or, as in our case, research agendas. Thus, research notes are often less reliant on formal research methods but equally reliant on quality through polemic clarity and rhetoric rigor [19].

We use climate governance as an illustrative example to demonstrate the relevance of the research agenda. The guiding research question for this research agenda is: how could online interaction be developed in global governance and what research questions ought to be considered?

2 Theoretical foundation

Our conceptual framework draws on research on online communities and situates it in the field of digital governance research. The digital governance domain addresses digitalization of governance structures and processes. Research on online communities provides understanding of socio-political engagement and interaction in online contexts. We suggest that bridging these strands of research offers novel ways to generate knowledge to better understand what happens when governance processes shift from physical to virtual arenas.

2.1 Digital governance

Governance can be defined as *"The process of steering society and the economy through collective action and in accordance with common goals"* [15]. Global governance means that authority is exercised across national borders, and justified by transnational problems or global common goods [20]. Global governance differs from national governance in that it does not have a central government with authority to enforce decisions [16]. Therefore, engagement of stakeholders (both governments and other stakeholders) to take appropriate action for the benefit of the common good is crucial.

Digital governance can be defined as *"digital technology ingrained in structures or processes of governance and their reciprocal relationships with governance objectives and normative values. Digital governance includes the utilization of digital capabilities and involves a transformation of structures, processes or normative values."* [21]. Transformations of governance can be structural and normative, where structural transformations are changes of structures and processes, and normative transformations are related to the qualities of governance, such as transparency, accountability, efficiency and effectiveness [22]. 'Digital global governance' is this understanding of digital governance applied to global governance.

Digital governance is increasingly ingrained in modernization strategies in the public sector, to improve processes and to create public value. EU´s agenda towards evidence based and data driven policy making is for instance argued to improve policy processes and decision making, and support collaborative working processes with participation of stakeholders [23, 24].

Digital governance has emerged over time, also conceptually. While eGovernment primarily focused on digitalization of public administration, eGovernance is a broader concept which also transforms various relations (such as Government - Citizen (G2C), Government – Businesses (G2B), Government – Government (G2G)). Digital governance is based on this, with slightly more emphasis on computational capabilities, including data analysis, modeling and visualization [21]. Global governance includes both G2G, G2B and G2C relations. Digitalization increasingly transforms governance in various ways, and it is argued that broader questions of governance in the digital era [25] and the integration of digital technologies in policy processes [26, 27] are needed.

Digital governance is often argued to contribute to increased transparency, good governance and to enable new forms of participation [21]. Public sector organizations that are traditionally recognized as being hierarchical and bureaucratic, are now

opening up for various forms of broader participation, within organizations and with external stakeholders, with the aim to improve public value creation. Digital technologies can support co-production, sharing of information and provide tools and methods for citizen-government interaction. However, a move towards public participation and co-production requires both technological, organizational, cultural and competence-related changes [28]. To transform into more participatory models, fostering a participatory culture is key. A participatory culture is characterized by participants experiencing a connection with others and that their contributions matter. The concept of participatory culture elucidates the shared social practice and culture of engaging, participating, and contributing to a community. A participatory culture may encourage empowerment, civic engagement and improve legitimacy of public sector organizations. Digital technologies can enable new ways for stakeholders to engage, participate, contribute, and interact.

An advanced form of participation is co-production. Co-production and collaborative innovation are processes where organizations work with external stakeholders to achieve some outcome together. "Collaborative innovation is a process of creative problem solving through which relevant and affected actors work together across formal institutional boundaries to develop and implement innovative solutions" [28]. The role of the public administration is in this context to facilitate co-production. In order for public sector organizations to develop a participatory culture, they need to "establish a range of processes, infrastructure and policies that ensure that stakeholders can participate" [28], and external stakeholders need to develop skills and capabilities to participate meaningfully.

However, participation may not always lead to desired outcomes, but rather sometimes to destruction of value. It may involve conflicts, marginalization of certain actors and domination of others, power imbalances, misinformation, and misuse of public resources, caused by either internal or external barriers and challenges [28]. Concerns have been raised about the relationship between social media, political polarization, and political disinformation, and its democratic effects. A part of this complexity are automated online propaganda bots [29]. More research is suggested on the role of public organizations and also whether anticipated effects of digitalization are actualized [28].

In general, digitalization and digital governance have associated risks and challenges, such as digital divide, misinformation, challenges of trust, illicit surveillance, cyber security issues and information overload [21]. In a participatory environment, the vulnerability to these risks may increase. A holistic approach that considers both possibilities and risks with digitalization ought to be acquired to deliberately design solutions for appropriate levels of online interaction.

2.2   Online Communities

The concept of community relates to the social relationship of members of a closed area of people, characterized by a defined size, membership and geographical boundaries as well as shared beliefs, values and historical experiences [30]. Weber argues that social action is based on common membership in a community, defined on the orientation of mutual attitudes of individuals´ subjective awareness of specific situations [31].

Online communities (OC), is the persistent collections of people with common interests whose primary method of communication is the Internet, typically by the use of social media [32]. OC offers new channels for organizations to connect with stakeholders and provide venues for political and social discussion [1]. OCs are being increasingly explored by organizations for a variety of purposes, including managing relations with customers and partners [33, 34], cooperating on knowledge generation [17, 35] and sharing information of public interest [36]. Unlike traditional communities, pre-existing social ties and material benefits for contributions are weak or non-existent in online groups [37], allowing for broader organization-wide online sharing [35] to become more flexible and fluid than in traditional communities [17].

With the introduction of digital technologies, the transaction costs of communication drops, making it easier for people to get together and organize [18]. IT changes and supplants the role of hierarchy into networks [38], characterized by being organized based on strength and competence, relational communication patterns, conflicts resolved through norms, flexibility, commitment based on mutual benefits and relationship governed by interdependencies [39].

The management of online communities may be influenced by complexity regarding size, diversity and the type of work being created. Work- related activities often foster interpersonal ties, whereas groups focusing on non-work- activities such as political causes [40, 41] often share a common purpose and are likely to behave differently than online groups organized around work- related topics [37]. Ren et al [2] found that identity-based features needed in online communities sharing common purpose, had stronger effects than bond-based features needed in work- related online communities, arguing that more research is needed to explore these differences.

Shirky [18] provides a simplified, yet illustrative classification of various forms of group undertakings in electronic networks by proposing a three-step ladder of online group interaction.

Sharing represents the easiest group of compilation with fewest demands on the participants. Sharing platforms allow everyone to share and receive in a "take it or leave it fashion" which allows for freedom for individuals and few complications for the group's life, where the group is mainly the aggregate of participants [18]. Digital tools may be used for knowingly sharing for instance pictures, messages, or work files with others.

Cooperation is the next rung on the ladder, representing a more complex situation than simply sharing, since it involves changing behavior to synchronize with others. Cooperation creates group identity since you know who you are cooperating with. Conversation represents a simple form of cooperation, either face to face or by the various use of ICT. While the increased sense of community using online tools should be seen as a positive effect of cooperation, it is also difficult to keep online communication targeted around a specific topic. As a result, some sets of common agreed mechanisms are often needed. Collaborative production/co-production represents a more involved form of cooperation, where no individual can take credit for the results of the process, which could not come into being without the participation of many. Here (unlike sharing) some collective decisions must be made to negotiate about the results, for instance the resulting Wikipedia article.

Collective Action represents the more advanced kind of group efforts. Here, shared responsibility is of critical importance to link individual user identity with the identity of the group, which holds the power in making group decisions which are binding for all individual members. As argued by Shirky [18]: For a group to take collective action, it must have some shared vision strong enough to bind the group together, despite periodic decisions that will inevitably displease at least some members. For this reason, collective action is harder to arrange than information sharing or collaborative creation.

The more common collective action problem is the "tragedy of the commons", wherein individuals have an incentive to damage the collective good. For instance, when all countries agree that CO_2 emissions need to be reduced, but every individual country may benefit from not reducing their own emissions. Therefore, rules are needed, making collective action harder to arrange than sharing or collaborative creation (cooperation). While ubiquitous access to communication tools makes it easy to initiate various forms for group activities, the main challenge is to use tools to promote collaborative collective actions to avoid the adverse outcomes of independent actions [42].

Below is a table that explains the different levels of group interaction according to Shirky [18]:

Table 1. Level of online interaction

	Outcome	Level of interactions	Level of coordination/rules
Sharing	Sharing of content among a huge (un-restricted?) number of individuals	Limited need for channels to distribute content	Providing access for every-one to share content
Cooper-ation	Content produced because of the ef-forts made by many	Interactions needed to support conversation, ne-gotiations and collective decisions resulting in an agreed outcome	Common agreed rules on how to navigate from indi-vidual ideas to a joint result
Collec-tive Action	Collective decisions binding for all indi-vidual members	Interactions needed to agree and maintain a shared vision strong enough to bind members being displeased with some decisions	Rules to reduce the problem of the "tragedy of the com-mons"

2.3   The example of the Global Stocktake in global climate governance

To illustrate the different levels of interaction, the Global Stocktake of progress towards the goals in the Paris Agreement is selected as an example. It was selected because it has a process that illustrates different levels of interaction among participants.

The Paris Agreement is the most recent international agreement on climate change, adopted within the United Nations Framework Convention on Climate Change (UNFCCC). The Paris Agreement has established common goals on climate governance (on emission reduction, climate adaptation and means of implementation in terms of finance and technology) [43]. Every fifth year (the first time 2021-2023), a Global Stocktake is carried out, where collective progress towards the goal in the Paris Agreement is analyzed and assessed, and further needs for action is identified. The Global Stocktake is carried out in three phases; information collection and synthetization, technical assessment, and negotiation and adoption of a declaration [44]. The UNFCCC secretariat provides technical expertise and organizational support to the process. The secretariat also hosts the registries and systems managing the reports that countries regularly submit due to reporting requirements in the Paris Agreement [45]. In this paper, the Global Stocktake is used to exemplify the usefulness and relevance of the agenda in the context of global climate governance. The research agenda is based on the three levels of interaction in online communities, namely sharing, cooperation and collective action, as outlined by Shirky [18].

3   Research Agenda for online interaction in digital global governance

This section outlines a research agenda for online interaction in digital global governance processes. Above we have discussed digital global governance, the increasing importance of digital tools in a governance context, possibilities with online participation and the need to better understand such development by exploring the role of online communities. Here, we isolate recurring themes and develop them into a more general research agenda for online interactions in digital global governance.

3.1   Sharing in digital global governance

Information sharing means that information is shared among an extensive number of individuals [18]. This includes not only dissemination activities but also the collection of information from various stakeholders, to support the data- information workflow.

A key concern within our running example of climate governance is to collect, organize and disseminate information. Based on the global challenge of climate change, information is reported to the UNFCCC by countries. The potential outcome is to provide knowledge on the global status and a common basis for identifying needs for action, decision making and a shared vision. There can also be forums for dialogues with external stakeholders, and means to provide input, for instance related to high level

meetings. Information sharing is needed to develop common awareness and under-standing of topics. A challenge is that countries have different capacities and conditions for collecting and reporting information according to reporting requirements. Another challenge is to create meaning in the large volumes of information and to make it understandable to various stakeholders. As the information is used to inform governance, it is crucial that it is of high quality and trustworthy.

As discussed above, information sharing represents the more basic level of interaction within online communities. Hence, activities here are assumingly less controversial than activities related to cooperation and collective action. Still more research is needed to better understand both the interaction and the coordination mechanism for successful sharing of information.

Digital tools allow for almost unlimited collection and dissemination of information, from various stakeholders and sources, and a question is who is considered a legitimate provider of information. A research question relating to the level of interaction is ***how technology can facilitate the collection of high-quality information from appropriate stakeholders.***

This further relate to the need for more research at the level of coordination of information management, to better understand ***how technology influences the quality, flow, and presentation of information to various stakeholders*** within the area of digital global governance. To have value, the information must be standardized and comparable to enable synthetization and coordination at global level, also over time; meet certain quality requirements; and be organized and presented in ways that inspire action by various stakeholders.

Referring to the example of the Global Stocktake, countries report regularly national information according to standards and reporting requirements, including greenhouse gas emissions, commitments, and measures on climate action, which is accessible on the UNFCCC website. These reports are the foundation for the synthesis reports that form the input to the technical assessments in the Global Stocktake process. Information for the Global Stocktake is gathered on a special side of the UNFCCC website. A digital submission portal is also set up for external stakeholders to provide input to the Global Stocktake [44, 46]. A great challenge is to organize the massive amounts of information from countries all over the world, and to present the information in ways that are understandable and engaging to stakeholders. Yet another challenge is to provide means to organize external stakeholders´ views in the Global Stocktake process.

3.2 Cooperation in digital global governance

Information sharing activities are necessary pre-requisites for the next level of group interactions, the cooperation activities. Cooperation is important in order to have conversations around a problem, current status and needs for action, to identify solutions, and establish a common ground for decision making, and to establish a common identity and a sense of community [18]. The potential outcome of cooperation in a global governance setting is an agreed knowledge status on a topic, or on progress towards an agreed global goal. In the case of the Global Stocktake, this would mean an agreement on progress and needs for action towards the goals in the Paris Agreement.

Cooperation activities may require more profound challenges to organization than information sharing activities since the main goal is to gain agreements. More research is needed to understand how such activities could be organized within digital global governance at both the level of interaction and the level of coordination through information management.

At the interaction level, focusing on how to organize conversations, negotiations and sharing of views to guide collective decisions, more research is needed to understand *the role of technology in synthesizing and leveraging actionable information.* A key concern is to organize the online discourse respecting the need for a debate characterized by rationality (logical claims and arguments), relevance (stick to the topic), equality (adequate opportunities to participate), reciprocity (listening to each other's arguments) and politeness (showing respect) [47]. A key consideration is how to use the technology wisely to be able to identify useful content within a (potentially) huge amount of information being produced by various stakeholders.

Procedures and rules are clearly needed guiding the process of reaching agreement. Hence a main research topic relates to *the relationships between rules and regulations, digital solutions and consensus forming.* Questions of concern involve issues like whom to include at what level, how to resolve disagreements, who has authority to make decisions, how and when to open and close the processes needed to come to an agreement, and how to manage informal power imbalances. Research should also investigate *how technological, organizational, cultural and competence-related factors influence cooperation* and active engagement, participation and contribution, where participants feel that they have a connection with others in the community and that their contribution matters [28].

In the example of the Global Stocktake, there is a procedure for the technical assessment in the Global Stocktake, with decisions on what information that will be considered and how information input can be provided [46]. A challenge is the large volume of information that should be synthesized to a global picture, based on what is reported by countries. This is used in the technical assessments and should be communicated in a way that inspires confidence among participants to take appropriate action. Another challenge is further to facilitate the technical assessment dialogues, and to synthesize the outcome of those dialogues into a synthesis report that participants agree on. This relates to the question of how technology can be used to synthesize and leverage actionable information. There could as well be potentially very large volumes of information submitted by other stakeholders as input to the Global Stocktake. A research question is *how technology can be used to synthesize information from external stakeholders and include it in a meaningful way in the process*.

3.3 Collective action in digital global governance

Collective action, where people create something together, share responsibility and make decisions that are binding for all participants [18], represents the most advanced level of group interactions within online communities. The potential outcome in global governance is collective decisions that are binding for all individual members.

Research related to the level of interaction now includes the exploration of *the roles of technology in decision making processes.*

The previous levels of information sharing and cooperation activities are necessary to succeed with collective action. The levels of interaction can be viewed chronologically. First, there is a need for shared knowledge on a topic, then dialogues to establish a shared understanding on the needs for action is required, which lays the ground for collaborative decision-making based on a shared vision and goals. Research is needed to better understand how technology could support the voting procedures, and to support accountability and evaluation of implementation efforts. These questions relate directly to the level of coordination, where a key research question is *what the relationship is between technology and trust in the negotiation process, and how to mitigate decisions resulting in "tragedy of the commons".* Further on, a relevant question is *what the role technology could have in processes of accountability and follow up on adopted decisions.*

Research should further investigate *the relationships between technology and co-production* that enhance implementation capability. Co-production means that organizations work with external stakeholders to together achieve some outcome [28]. In a global governance setting, this could include both collaboration between governments, but also between governments and other stakeholders. Research is suggested to investigate how co-production and collaborative innovation as a process of creative problem solving through collaboration could be facilitated. In order to do that, processes, policies, technologies and skills and competencies required by involved participants should be developed [28]. One prominent issue is the matter of power balances between stakeholders and the concept of salient stakeholders, i.e. who has influence in the process [48]. Currently, the UNFCCC process has been criticized for power imbalances, also with concerns that technology might serve to consolidate existing power structures rather than challenge these. However, it is also argued that digitalization may be a means to change such power imbalances [14]. It is further important to identify risks for co-destruction, which can be caused by conflicts, marginalization of some actors, misuse of public resources and misinformation. Both internal and external barriers and challenges should be identified and appropriate response developed [28]. How digital technologies influence the quality of discussions, whether actors engage constructively, whether dialogues are characterized by tolerance and resolving conflicts and disagreements, or whether they rather foster misinterpretation and increased polarization, should be further investigated [29]. It is also a matter of trust, where research for instance shows that face-to-face interactions are important in building trust and generate intention understanding in an international politics context [49], and that face-to-face negotiations have a higher level of initial trust between actors compared to online negotiations [50]. The use of technology at the different levels of online interaction (sharing, cooperation or collective action) has to be chosen deliberatively according to what is appropriate in that particular context, considering various risks. General challenges of digital divide, trust in the online context, cyber security and information overload have to be considered as well [21]. Additionally, the role of United Nations bodies in this context should be further researched, and elements that affect whether the desired effects of digitization are actualized clarified.

In the example of the Global Stocktake, a declaration will be adopted, and a question is how technology can be used to support the process of negotiating and adopting such a declaration (for instance with information provision to negotiators in the process). Another question relates to how technology could support work on implementation and follow up on decisions and commitments. A declaration that builds trust would have a clear statement of progress, commitments for climate action and means for implementation that responds to what is required to achieve the goal in the Paris Agreement.

3.4 Summary of the research agenda

In this paper we argue that while governance processes related to grand challenges such as the global climate crisis are moving online, this move currently seems experimental and largely lacking a fundamental understanding of the dynamics of online communities and online interactions. To address this problem, we discussed the example of the UN´s Global Stocktake process in light of insights from research on online communities. Based on this discussion, we identified 10 questions across the three stages of online interactions (Table 2). We suggest that the questions constitute a research agenda to establish a necessary knowledge base for designing and implementing systems for online interactions in global governance contexts. Because this is a novel research area, the questions take an explorative approach of 'how' questions, which can then be extended with other types of questions concerning 'when', 'where', 'what', and 'why' questions. The different levels of interaction will have different levels of complexity and associated design implications.

Table 2 Research agenda for online interaction in digital global governance

	Potential outcome	Suggested Research Questions	Global Stocktake example
Sharing	*Improved basis for political decision making*	-How can technology facilitate collection of high-quality information from appropriate stakeholders? - How does technology influence the quality and flow of information? -How can technology be used to organize and disseminate information in comprehensible and inspiring ways to stakeholders?	*Collect, organize and disseminate climate reports*
Cooper-ation	*Agreed upon knowledge status*	- What is the role of technology in synthesizing and leveraging actionable information? -What are the relationships between regulations, digital solutions and consensus forming? -What organizational, cultural, and competence-related frameworks are needed to facilitate cooperation that gains results?	*Synthesize national reports. Technical assessments leading to synthesis report*

Collect-ive Action	*Collective decisions binding for all individual members*	- What are the roles of technology in decision making processes? -What is the relationship between technology and trust in the negotiation process, and how to mitigate decisions resulting in "tragedy of the commons"? -What are the relationships between technology and co-production? -What is the role of technology in processes of accountability and follow up on decisions?	*Declaration*

4   Suggestions for future research

The core of our work is the identification of the research agenda for online interaction in digital global governance. While an in-depth discussion of all the potential theoretical approaches that may add value to address these questions is without the scope of our paper, we would like to propose some lenses that we find particularly interesting to address the research questions discussed above.

First, knowledge from the area of social movement organizations (SMO) could be of relevance for further studies within our context. SMO are collectives promoting social transformation through the mobilization of citizens for sustained political action [40]. Contrasting the more general concept of OC, SMO is focusing more directly on how online groups organize to achieve common objectives [51]. In particular, the research strands of SMO explore the role of collective actions, and the complex organizations needed to fulfill such goals. Future research addressing the need to understand how to organize to achieve collective actions (as proposed above) could be inspired by, for instance, the work of Mauss who almost fifty years back discussed the presence and connection between three main stakeholder groups within social movements; the outermost ring of a mass of sympathizers, the middle ring of a smaller number of active members committed to the movement's success, and the innermost ring of formal leaders and coordinators [52].

Mauss perspective is directly related to our next proposed theoretical lens. The stakeholder theory (ST) originated in management science in the 1980ies to improve organizations´ capability to understand, predict and manage stakeholders (see e.g. Freeman [53]). ST was later adapted to the eGovernment context (see e.g. Flak and Rose [54]) and has achieved considerable attention in this domain. We suggest that ST can be valuable in identifying and analyzing stakeholder complexity related to digital global governance. In particular, the theory of stakeholder identification and salience [48] may offer clarity on the salience of specific stakeholders or groups of stakeholders. Given the importance of transparency and legitimacy in digital global governance, we also argue that a recently proposed normative core of ST for the eGovernment context [55] can be used and further refined in this specific context.

Finally, we argue for the need to further investigate challenges related to the quality of the information in the context of online participation. Research on the use of OC for political participation [40, 41] show how some actors joined with the agenda of

sabotaging the process, e.g., by posting false information within these forums. Hence, more research is needed to further investigate influence of technology on the distribution of misinformation (misleading or inaccurate information shared unconsciously), disinformation (false or misleading information shared intentionally) and fake news (false information packaged intentionally as real news) [56] in digital global governance.

4.1 Implications

The proposed research agenda will hopefully sensitize researchers of a critical knowledge gap that needs to be addressed with suggestions on how to embark on studies to reduce this gap. As such studies start to emerge, our initial research agenda should be critically assessed and developed further. Multi- and interdisciplinary research seem highly appropriate in this area as deep knowledge on governance of global phenomena needs to be matched with a deep understanding of digital technologies and the dynamics of online communities. Consequently, researchers can draw on a broad theory base in the quest to develop new knowledge in this area. We have suggested a few potentially valuable theoretical lenses in this paper.

The main audience for this paper is researchers with a potential interest in how digital technologies influence the governance of global phenomena. Nevertheless, we argue that the ideas and arguments in the paper also have practical relevance. Practitioners responsible for establishing and maintaining governance structures and processes to support the governance of global issues can benefit from being sensitized about the three stages of online interactions and the general dynamics of online communities. Moreover, the questions in our research agenda can also be applied from a more practical perspective to induce reflections on how different technologies may have different strengths and weaknesses depending on the stage they are being used in.

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