

Policy Brief

S. Gupta, J. Campos Zeballos, M. Motlagh, J. Rhyner ¹
University of Bonn

***digitainable*: Tools for the assessment of the impact of digitalization on sustainable development**

Introduction

Digitalization is a complex and dynamic process distinguished by its extraordinary power to transform our living conditions. Digitalization has emerged from the advancement in several technologies, which is viewed not only to promote economic growth but also to enable a sustainable green future, considering the UN Agenda 2030 for sustainable development with its Sustainable Development Goals (SDGs) to promote the economic, social and ecological conditions in a balanced way. However, the impact of digitalization on achieving the SDGs has not been investigated systematically so far. A better understanding of the complex link between digitalization and the SDGs would support policy and decision makers to mindfully use the technological advancements in transforming and blending policies and strategies for different sectors, including education, health, industry, and governance, in a sustainable manner. With mindful use of digitalization, we are referring to the capability to be aware of where we are in the digitalization development process and how we plan to utilize it further, considering it in a comprehensive sustainability context. This protects us from being overwhelmed by uncritical optimism on the one hand or by unjustified skepticism on the other hand, but rather being rooted in the explicit contexts for sustainable development.

With digital technologies evolving as an integral part of our lives, from applying Artificial Intelligence (AI), Big data analytics, Industry 4.0 in the workspace to applying blockchain for enabling transparent services, it is crucial to address the knowledge gap at the cross-section of digitalization and sustainability. Debates have emerged about the positive as well as negative impacts of digital technologies on sustainable development. However, the net impact technologies can have is not well explored. Digitalization is stimulated using disruptive innovative technologies by various stakeholders and business models. These rapid transformations have been considered a holy grail of progress though it did not take long to apprehend that various sustainability dimensions have been neglected. Recent literature points to a whole array of ethical and environmental concerns regarding applying various digital interventions (DIs). As much as technological upgrades help attain productivity by efficiency, they also have cascading impacts that must be acknowledged for sustainable development. Problematic impacts such as energy consumption, emissions, digital footprint, material footprint, digital divide and rights violations often hinders the progress towards holistic sustainability. The narrow understanding of the impacts of digitalization on sustainability poses a particular threat to the goals of Agenda 2030.

¹ Corresponding author (rhyner@uni-bonn.de)

Unless the mindfulness about the impacts is considered holistically, the progress will fall short of its ultimate goal.

To endure holistic sustainability, a considerable shift in the principles and standards governing the digitalization transitions for positive social, ecological, and economic impacts is required. New values focusing on more mindful, accountable, and stakeholder inclusive actions are needed. Shared responsibilities, values, and standards need to be adopted to understand the impact of digitalization, considering its design, development, and deployment are inevitable. As the fast pace of DIs implementation unwinds, it highlights the need to share responsibilities at all the phases of DI applications to understand and ensure the mindfulness in catalyzing action toward sustainable development. In-depth collaboration with diverse stakeholders and multidisciplinary perspectives must be undertaken to utilize digitalization for sustainability successfully. The project *digitainable* is an attempt to stimulate collaboration and develop essential tools to bridge the knowledge gaps at the cross-section of digitalization and sustainability by assessing the impact of digitalization on sustainability in the light of the Agenda 2030.

The project *digitainable*

The project *digitainable*, funded by the German Ministry of Education and Research (BMBF), started in 2019 as an effort to understand and assess the positive as well as negative impacts of digitalization on sustainable development. The project aimed at evaluating a digital intervention (DI) with respect to its performance vi-à-vis the SDGs. Practically, in order achieve this goal, processes were developed that allow for a mapping of a DI into the SDG indicator system, which includes more than 200 different indicators. The project addressed the research questions in a participative manner, organizing workshops

that brought together experts from both digitalization and sustainable development. In this way the project also helped to establish an inter- and transdisciplinary community of stakeholders, interlinking the various dimensions from technical as well as from the socioeconomic, political and ethics perspectives.

***Digitainability* Assessment Framework**

There are numerous assessments of the impacts of digitalization. In contrast to conventional technology assessments, which anchor on certain properties of the DIs and their influence on socio-technical setups, DIs continuously evolve at a fast pace and are strongly dependent on the context, the targeted end goal, and the actors responsible for implementing and operating it. Regardless of how DIs are being framed, an iterative review of the impacts of the DIs is essential not only from the technological aspect but also from the targeted ambition and practices involving all the key stakeholders affected by it, e.g. the end users/communities, policy makers and developers. The positive or negative impacts of DI are the consequence of how its applications and services are implemented and regulated.

The assessment approaches to understanding the real-world role of digitalization for sustainability is in their nascent stage. Research regarding green digitalization is emerging, often focused on sectoral viewpoints, such as energy and carbon footprints, represented by the terms such as “Green IT” or “Sustainable IT”. Despite the growing literature with conflicting viewpoints, our understanding of the net impact of the DIs has remained limited. Practical approaches to address accountability and reporting concerns are important to avoid the rebound and induction effects of digitalization for sustainable development. Thus, methods which help in systematically assessing the in-depth impacts of managing DIs for sustainability are essential.

Moreover, achieving the net alignment of the DIs for sustainable benefit is challenging because of complex interlinkages between key dimensions. Sustainability requires a well-balanced approach within well-defined boundaries. In the project digitainable, we developed several methodologies supportive of systematically assessing the impact of the DIs for holistic sustainability. The core goal was to develop scientifically sound approaches which provide better insights about the nexus between sustainability and digitalization.

To address the gap in understanding the mutual relationships between the DIs and the 17 SDGs, we initially developed the *Digitalization–Sustainability Matrix* (DSM)², shown in Figure 1. It maps the different digital technologies into the SDG indicator system. The DSM serves as a collaborative method for the knowledge production process. It helps in systematically capturing diverse perspectives of key stakeholders in a systematic manner. Based on practical exercises with diverse experts, the DSM effectively triggers discussions that are crucial for realizing the relationship between digitalization and sustainability. This brings us a step further in bridging the knowledge gap about mapping transdisciplinary perspectives for meaningful use of the DIs for SDGs.

After the DSM mapping on the level of technologies, it is essential to examine and categorize the impacts of individual digital interventions (DI) for holistic sustainability, including the specific context for which the interventions are targeted.

The anatomy of digitalization for SDG 13: Take urgent action to combat climate change and its impacts

		Data Driven			Analytics Driven			Design Driven	
Relevance	Icon	Mobile internet technologies/App	Blockchain	Internet of Things/Digital twin technologies	Big data	Cloud computing/Edge computing	AI/Machine learning/Deep learning	Virtual/augmented reality	Adaptive manufacturing/3D printing
SDG13 Indicators									
13.1.1	Reduce directly related attributable deaths	✓	○	✓	✓	✓	✓	○	○
13.1.2	Adoption and implementation of disaster risk strategies for countries	✓	○	✓	✓	✓	✓	○	○
13.1.3	Adoption and implementation of local disaster risk strategies by local governments	✓	✓	✓	✓	✓	✓	○	○
13.2.1	Establishment or operationalization of an integrated policy or strategy by countries	✓	✓	✓	✓	✓	✓	○	○
13.3.1	Integrating mitigation, adaptation, impact reduction and early warning in education curricula	✓	✓	○	✓	✓	○	○	○
13.3.2	Capacity building to improve education, mitigation and technology transfer	✓	✓	✓	✓	✓	✓	○	○
13.A.1	Mobilized funds per year between 2020-25 towards the commitment	○	✓	✓	✓	✓	○	○	○
13.B.1	Support least developed countries/least developed that are receiving operational support	✓	✓	✓	✓	✓	✓	○	○

Figure 1. Digitalization Sustainability Matrix (DSM) for the indicators related to SDG 13 (climate action), with results of an expert discussion (for details see Ref. 2).

Consideration of context is essential part, since e.g. the benefits of an early warning system for disaster risk may depend significantly on the political and societal conditions in this it supposed to work. Against this background, we introduced the new *Digitainability Assessment Framework* (DAF)³ for context-aware practical assessment of the impact of DIs on the SDG indicators. The DAF facilitates an in-depth assessment of a digital intervention's many diverse technical, social, ethical, and environmental aspects by systematically examining its impact on the SDG indicators. The DAF should support developers, users, and policymakers by providing a 360-degree perspective on the impact of digital services or products and providing hints for its possible improvement with concrete evidence. The inclusive framework gathers information about a DI, contexts, process, and outcome to reflect the overall impact on the SDGs at the indicator level. Realizing what follows when the DI is brought to practice, e.g., intervention or service is "rolled out" with stakeholders, is vital to address implementation challenges and align them for advancing the SDGs for holistic

² S. Gupta, M. Motlagh, J. Rhyner. "The digitalization sustainability matrix: A participatory research tool for investigating digitainability." *Sustainability* 12.21 (2020): 9283. [doi:10.3390/su12219283](https://doi.org/10.3390/su12219283)

³ S. Gupta, J. Rhyner. "Mindful application of digitalization for sustainable development: The Digitainability Assessment Framework." *Sustainability* 14.5 (2022): 3114. doi.org/10.3390/su14053114

sustainability. The DAF is particularly helpful in identifying not only synergies (the “green dots” in column 3, Figure 2), but also the trade-offs (“red dots”).

1. Digitalization Intervention	2. Purpose	3. Impact
<p>DESCRIPTION Disaster Assessment from Satellite Imagery by Analysing data using Deep Learning</p>	<p>NARRATIVE/CONTEXT Identifying the regions impacted by a disaster is critical for effective planning of relief efforts. Satellite images are a valuable resource in monitoring. However, the task of analysing a satellite image to detect regions impacted by disaster is challenging, we employ Convolutional Neural Networks to semantically segment topographical features like roads on pre and post-disaster satellite images and find the regions with maximal change</p>	
<p>MEASURES The technology helps in identifying the disaster impact zones using satellite image data.</p>	<p>TARGETED SDG INDICATORS 13.1.1, 13.1.2, 13.1.3</p>	
<p>ACTORS Academic and/or Research Institution</p>	<p>TARGET GROUP Local and/or Regional Governmental Organization International Development Agency Non-governmental Agency Governmental Ministry or Agency</p>	
<p>No additional comments</p>	<p>No additional comments</p>	
<p>COMMENTS Data handling, privacy and divide aspects are not covered in the SDG framework</p>		<p>ADDITIONAL INDICATORS Remote sensing and privacy related indicator.</p>

Figure 2. Digitainability Assessment Framework (DAF). for the indicators related to SDG 11, applied to the use of satellite data and machine learning for disaster risk management (for details see Ref. 3).

The DAF supports the step-by-step impact assessment of the DI, which serves as an essential means for key stakeholders to mindfully articulate, collaborate, and deliver the systems change required to harness the opportunities offered by digitalization for sustainable development. It offers stakeholders a strategic

tool for spotting the potential opportunities and risks while maintaining its responsibility for sustainable development. Integrating practical insights with a theoretical outlook helps to assess potential future scenarios. In particular, the framework also helps to identify traits that are not covered by the current indicator framework of Agenda 2030 and that might be taken up in a future elaboration of the UN Agenda 2030. This holds e.g. for data protection and privacy.

Deployment of the two *digitainable* tools DSM and DAF in a participatory manner should facilitate collective intelligence, with multi-stakeholder involvement from diverse disciplines to support recognizing the capabilities required for digitainability assessment. The DSM and DAF together are valuable in developing a knowledge base that can convey the kind of shift required in a particular context and with which actors and enablers, with the ultimate goal to:

1. Align DIs for holistic SDG progress
2. Identify of potential negative and uncertain impacts
3. Making use of synergies and alleviate negative impacts.

With the help of a systemic transformation plan, coherent policies, and active multi-stakeholder participation, the tools can be instrumental in sculpturing a sustainable planet in the digital era.