THE IMPACTS OF DIGITAL TECHNOLOGY ON SUSTAINABILITY CAN BE CLASSIFIED INTO FOUR CATEGORIES THAT ARE INTERRELATED

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EXAMPLES OF ENVIRONMENTAL CHALLENGES CAUSED BY DIGITAL TECHNOLOGY, CITED IN THE LITERATURE

- Pollution [5, 9]
- Hazardous electronic waste [1, 2 ,4, 5, 6, 7, 8, 9]
- High energy consumption [2, 3, 5, 6, 7, 8]
- CO2 and GHG emissions [2, 3, 4, 6, 8, 9]
- Depletion of natural resources, including critical materials [1]
- Degradation of natural ecosystems [4, 5]

EXAMPLES OF SOLUTIONS TO ADDRESS ENVIRONMENTAL CHALLENGES CAUSED BY DIGITAL TECHNOLOGY, CITED IN THE LITERATURE

- Ensure collaboration across countries [1] and sectors [5], such as by sharing resources to prevent duplication [3]
- Develop stricter environmental regulations [3], such as on traceability in the supply chains [1] and carbon taxes [2]
- Promote research to support the sustainable transition of digital technology [1, 2, 5, 9], such as on material substitutes for finite mining resources [1], and theoretical advancements for impact reduction [2]
- Implement responsible manufacturing practices, such as eco-design [2, 3, 4, 6], modularity [4], sufficiency practices [2, 4], responsible sourcing [2], and reduction of obsolescence through interoperability [2]
- Promote responsible changes from consumers, such as reduced consumption [2], proper ICT disposal [2], and adoption of sustainable alternatives [1, 2]
- Use renewable energy [2, 3, 6]
- Develop circular economy models [2, 4]
- Prevent physical infrastructure from cyberattacks [2]

EXAMPLES OF SOLUTIONS TO ADDRESS THE SOCIETAL CHALLENGES CAUSED BY DIGITAL TECHNOLOGY, CITED IN THE LITERATURE

- Develop regulatory frameworks [1, 5, 6, 8, 9, 11, 12], such as on transparency in supply chains [1], on the social risks associated with Industry 4.0 [11], and multidimensional policies to bridge the digital divide [12]
- Promote research to support the sustainable transition of digital technology [5, 9]
- Implement responsible manufacturing practices, such as the adoption of ethical trade practices (e.g., fair trade agreements) [1, 6], and ethical design of digital technology [3, 5, 6]
- Improve protection against security threats [3, 6, 8]
- Enhance access, connectivity, and digital skills training [6, 12]

Digital technology as...

Challenges

	A source of detrimental impacts	A tool for beneficial impacts
For the environment	**GIT** DIGITAL TECHNOLOGY LEADS TO ENVIRONMENTAL DAMAGE → *Which solutions to address those environmental challenges?*	**IT4G** HUMAN ACTIVITIES LEAD TO ENVIRONMENTAL DAMAGE → *How can digital technology adress those environmental challenges?*
For society	**HIT** DIGITAL TECHNOLOGY LEADS TO SOCIETAL ISSUES → *Which solutions to address those societal challenges?*	**IT4H** HUMANITY FACES SOCIETAL CHALLENGES → *How can digital technology adress those societal challenges?*

EXAMPLES OF SOLUTIONS THAT DIGITAL TECHNOLOGY BRINGS TO ADDRESS ENVIRONMENTAL CHALLENGES CAUSED BY HUMAN ACTIVITIES, CITED IN EXISTING LITERATURE

- Improve business intelligence for managing environmental sustainability [4, 5, 6, 7, 8, 12, 13, 14, 16, 18, 19, 23, 24], notably for pollution control [12, 19] and waste management [12,19]
- Drive improvements in energy efficiency and resource efficiency [4, 5, 6, 7, 8, 13, 14,16, 20]
- Lead to innovation for decarbonization, such as by enabling the use of renewable energies [6, 12, 19] and low-carbon solutions [5, 12, 19]
- Model climate and biodiversity changes [8]
- Substitute physical with virtual consumption [4, 9]
- Support the transition to sustainable business models, including circular [4, 6, 7, 8,12, 13] and sharing [6,12, 20] economies
- Enhance transparency and accountability, such as for sustainability performance reporting [8, 16], and monitoring sustainability in supply chains [1, 12, 16]
- Simulate systems or objects virtually to optimize their design [18, 20]

EXAMPLES OF SOLUTIONS THAT DIGITAL TECHNOLOGY BRINGS TO ADDRESS SOCIETAL CHALLENGES CAUSED BY HUMAN ACTIVITIES, CITED IN EXISTING LITERATURE

- Reduce economic disparities between developed and less developed regions or countries, mainly by enabling economic growth through the digital economy [8, 11]
- Reduce inequalities [5, 10, 11, 15, 21]
- Promote social inclusion [15, 16, 26, 27], such as by using digital tools to strengthen social ties among the elderly [26, 27]
- Improve work conditions [8, 10, 11, 14, 15, 24], such as by lowering hazardous workload [10, 11, 15], automating repetitive tasks [10]
- Lead to the creation of job positions [9, 10, 11, 15]
- Contribute to human health [8, 10, 14, 15], such as by enabling customization of biomedical devices tailored to the patient's needs [22]
- Improve safety and crime levels [8, 10, 14, 15], such as by detecting fraud with artificial intelligence [14] or securely storing work contracts with blockchain [10]
- Enhance transparency and accountability, such as for sustainability performance reporting [8, 16], and monitoring sustainability in supply chains [1, 11, 16]
- Improve living conditions, such as by reducing loneliness of older adults [26], and managing over-tourism [25]
- Promote access to and quality of education [5, 13, 14, 15, 21], notably through tailored learning programs [14], automated error identification [14], unrestricted information availability across time and space [21]
- Ensure food security, such as by optimizing food production [8, 17, 20, 24] and distribution [20, 24]
- Drive social change, such as by enabling collaboration between organizations and consumers [6, 16], and raising awareness through information sharing [6, 8]

EXAMPLES OF SOCIETAL CHALLENGES CAUSED BY DIGITAL TECHNOLOGY, CITED IN THE LITERATURE

- Exacerbation of economic inequality between developed and less developed countries or regions [1, 3, 6, 10, 11]
- Digital divide and exacerbation of inequalities [2, 3, 5, 6, 8, 9, 11, 12]
- Social exclusion [8, 11]
- Worsening of work conditions [2, 11, 15]
- Loss of job positions [2, 6, 9, 10, 11, 13, 15]
- Health risks [2, 5, 9, 11]
- Worsening of safety and crime levels [2, 3, 5, 9, 14, 15]
- Human rights violations related to minerals extraction in conflicting zones [1,5]
- Data misuse and privacy issues [3, 6, 9, 10, 11, 13]
- Ethical issues, such as misinformation, bias, transparency, and intellectual property [3, 5, 13]

CONTEXT

- Studies have emphasized the need for further research into the underlying mechanisms through which digital technology affects sustainability [9], particularly its societal impacts [13, 15].
- Limited research offers a comprehensive view of how digital technology affects sustainability.
  - The prevailing emphasis of the existing literature appears to be primarily on the positive contribution of digital technology to sustainability [2]. The drawbacks of digital technology appear to be overlooked, and when acknowledged, environmental concerns tend to receive more attention than social ones [15].
  - Limited attention has been given to the interrelations between the impacts of digital technology on the environment and society.
- We offer a conceptual framework in which the impacts of digital technology on sustainability are classified into four different categories, that are interrelated.

METHODS

- Studies have emphasized the need for further research into the underlying mechanisms through which digital technology
- A scoping review of reviews is currently underway to identify how the development and use of digital technology are intertwined with sustainability challenges.
- The study draws on the methodological guidance for scoping review [28, 29, 30].
- The sources included were peer-reviewed articles and reviews from academic journals, written in English, retrieved from the databases Scopus and Business Source Premier.
- The keyword search included terms related to (1) research encompassing existing body of knowledge, (2) digital technology, and (3) sustainability, resulting in 509 studies.
- Publications that were not relevant to the objective of the study were excluded. In addition, those focused exclusively on industry-specific digital technology or applications, thus preventing them from offering broader or generalizable insights, were also excluded. The full texts of the remaining 105 studies are being assessed.
- The coding framework was constructed based on an inductive approach [29], where the four categories presented above were coded, including subcategories for the challenges and solutions that digital technology brings in relation to sustainability. Attention is given to the interrelations between the subcategories.

KEY ASSUMPTIONS

- Our conceptual framework classifies the impacts of digital technology on sustainability into four different categories, according to two axes.
  - Digital technology brings both beneficial and detrimental impacts on sustainability.
  - Digital technology has an impact on both the environment and society[1].
- **This classification yields four distinct approaches for aligning digital technology with sustainability, namely: «Green IT », «Human IT», «IT for Green», and «IT for Human».**
- The four categories are interrelated:
  - Digital technology as a tool for beneficial impacts leads to detrimental impacts on the environment and, potentially, on society.
  - Digital technology as a tool for beneficial impacts on the environment can bring positive outcomes for society, and its contribution to societal benefits could also have a positive impact on the environment.
  - Digital technology has detrimental impacts on the environment, which can lead to adverse outcomes for society; and potentially, its detrimental impacts on society could also negatively impact the environment.
- We noticed a mirroring effect between the beneficial and the detrimental impacts of digital technology on societal sustainability, also noted by [11]. There appears to be some uncertainty regarding the impact of digital technology on societal sustainability, which may be attributed to the influence of contextual factors.
- Overall, digital technology is simultaneously a source of detrimental impacts and a tool for beneficial impacts for parallel environmental challenges or, respectively, parallel societal challenges.

1 We choose to reflect the economic dimension of sustainability in societal sustainability.

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