United Nations E/CN.16/2024/2

Economic and Social Council

Distr.: General
5 February 2024

Original: English

Commission on Science and Technology for Development
Twenty-seventh session
Geneva, 15–19 April 2024
Item 3 (a) of the provisional agenda
Science and technology for development: Priority themes

Data for development

Report of the Secretary-General

Summary

The intricate relationship between data and sustainable development and the complexity of data governance are discussed in this report. The potential of data for development is elaborated on, highlighting its formidable capacity to support innovative solutions to challenges across all the areas of sustainable development. While data have become a key economic resource and a decision-making tool, consideration is also given to the risks that must be addressed to avoid data mismanagement leading to increased inequalities, widening social divides and threats to human rights. Based on this analysis, the need for global data governance is examined, and desirable characteristics are discussed. Overall, the need for creating an inclusive digital environment and the responsibility of all stakeholders in upholding the balance between ethical, policy and economic and business considerations in data governance are highlighted. Finally, there is an emphasis on the need for reinvigorated multilateralism and the application of a multi-stakeholder principle to develop global standards and promote best practices in data governance, taking into account major international agreements and frameworks.

Introduction

1. At its twenty-sixth session, held in March 2023, the Commission on Science and Technology for Development selected "Data for Development" as one of its priority themes for the 2023–2024 intersessional period.

2. The secretariat of the Commission convened an intersessional panel from 6 to 7 November 2023 to better understand this theme and assist the Commission in its deliberations at its twenty-seventh session. This report is based on the issues paper prepared by the Commission secretariat, the panel's findings and recommendations, and country case studies contributed by Commission Member States, international organizations and other stakeholders.[1]

3. Data are a critical economic catalyst, driving market expansion and creating new growth opportunities.[2] Data can also enable evidence-informed decision-making, raising the effectiveness and efficiency of public administrations. Handled wisely, data can address global challenges, from poverty and climate change to food security, disaster management and pandemic responses. However, mismanagement can exacerbate developmental disparities, widen the digital divide and potentially lead to market monopolies, discriminatory practices and threats to human rights.

4. A global framework for data governance that promotes consistency between national and regional data regulations is essential for benefiting from the potential of data to tackle global challenges, such as pandemics and climate change.

I. Understanding the multifaceted nature of data

5. Data can be defined as "observations that have been converted into a digital form that can be stored, transmitted or processed, and from which knowledge can be drawn."[3] Observations, in the broadest sense, refer to any form of information or facts about the world, captured through various means, such as sensors, human inputs and automated systems. These observations can encompass a multitude of aspects – from physical quantities, such as temperature and pressure – to more abstract concepts, such as human emotions and market trends.

6. Unlike traditional production inputs, such as raw materials and labour, data do not occur naturally but are produced by complex technological systems and social interactions. When generating data, individuals and organizations make choices influenced by their goals, values and biases, as well as wider societal factors.[4] Data, therefore, are not objective but reflect these influences, shaping perceptions and interactions.

[1] Contributions from the Governments of Belize, Brazil, Burundi, Cameroon, China, Cuba, Djibouti, Ecuador, Egypt, France, the Gambia, Hungary, Japan, Latvia, Peru, the Philippines, Portugal, the Russian Federation, South Africa, Türkiye, the United Kingdom of Great Britain and Northern Ireland, United Republic of Tanzania and the United States of America, as well as the Economic and Social Commission for Asia and the Pacific (ESCAP), Economic and Social Commission for Western Asia (ESCWA), International Atomic Energy Agency (IAEA), International Telecommunication Union (ITU), United Nations Educational, Scientific and Cultural Organization (UNESCO), United Nations Office for Outer Space Affairs (UNOOSA), World Food Programme (WFP) and Group on Earth Observations (GEO) are gratefully acknowledged. They are available at https://unctad.org/meeting/commission-science-and-technology-development-twenty-seventh-session. For all documentation from the intersessional panel meeting, see https://unctad.org/meeting/cstd-2023-2024-inter-sessional-panel.

[2] Contribution from the Government of Djibouti.

[3] UNCTAD, 2021, *Digital Economy Report 2021: Cross-Border Data Flows and Development – For Whom the Data Flow* (United Nations publication, Sales No. E.21.II.D.18, Geneva).

[4] Aaltonen, A et al., 2023, What is missing from research on data in information systems? Insights from the inaugural workshop on data research, *Communications of the Association for Information Systems*, 53(1):17.

7. The transformation of data into digital form hinges on the capabilities and limitations of digital technologies. This relationship affects how data filter perceptions.[5] The value and significance of data are not inherent but emerge from the systems in which they are embedded. Within these systems, data are transformed into facts that underpin evidence-based decisions. However, this "evidence" has limited objectivity, being shaped by both social perceptions and technological capacities. The importance of algorithms, models, and analytical tools in the data value chain is paramount, as they become filters of reality. Organizations must thoughtfully design and manage their data infrastructures and algorithms, ensuring accuracy, reliability and fairness in the tools and methods used.

8. In order to understand fully data impacts, it is essential to distinguish between different types of data. Data taxonomies are systematic classifications used to organize and categorize data based on certain criteria or attributes (see box). These taxonomies play a crucial role in data management and analysis by allowing for the efficient organization, retrieval, and analysis of data. Different taxonomies are employed depending, among other factors, on the context, needs, and purposes of data usage.[6]

Data taxonomies

Purpose of collection. The purpose of data dictates their classification. Commercial data include customer preferences and market trends for business strategy. Governmental data, such as population demographics, aid in policy and governance.

Entity of use. Data can be classified based on the entity that uses it, whether private or public. Private sector data, used by businesses for market analysis, contrasts with public sector data utilized by Government for governance and policymaking.

Time frame. Data can be either short-lived, such as live traffic updates used under a year, or long-lived, such historical weather data for trend analysis.

Sensitivity. Based on potential harm from disclosure, data are either sensitive (e.g. financial records, health information) or non-sensitive.

Nature of data. Data are personal if they identify individuals (protected by privacy laws) or non-personal, such as anonymized statistics.

Source: UNCTAD, 2021.

9. The generation and utilization of data are fundamentally linked to the rise of digital technologies, such as broadband networks, the "Internet of things" and mobile phones. Broadband networks facilitate high-speed, long-distance data transfer. Internet-of-things devices, from smart home systems to industrial sensors, continuously produce data about their functions and surroundings. Mobile phones, ubiquitous worldwide, generate vast amounts of user data, from location tracking to social media activity. These technologies are critical in the data life cycle, acting as sources and channels for data. Data generation is just the beginning of the data value chain. Effective use requires data collection, storage, and analysis, often across multiple systems. Data represent a unique resource, deeply connected to the technological infrastructure that creates, manages and utilizes these data. Understanding the interplay between new technologies and data is key to leveraging data for sustainable development. Data governance should recognize the interdependence of data and digital technologies and involve all relevant stakeholders.

[5] Alaimo C and Kallinikos J, 2022, Organizations decentered: Data objects, technology and knowledge, *Organization Science*, 33(1):19–37.

[6] UNCTAD, 2021.

II. The promise of data for development

10. The relationship between data and development is multifaceted. From one perspective, data are seen as an economic input within the value chain. This occurs when raw data are transformed into digital intelligence or products, turning data into strategic assets that drive innovation, enhance operational efficiency and lead to data-driven business models. Such innovations can boost productivity and generate transformative changes, leading to the emergence of new markets and novel sources of value.

11. Appropriately managed and shared data can also offer societal benefits beyond corporate gains. Data serve as a crucial decision-making tool, aiding in achieving economic, social and environmental objectives and advancing Sustainable Development Goals.[7] Given the need to leverage data at the global level to address the global challenges embodied in the Goals, including existential threats, such as climate change and pandemics, a global approach to data governance is necessary. Crucially, data can enable a systems approach, offering a holistic perspective on the interactions among the Goals. This enables the formulation of integrated interventions that address multiple Goals simultaneously, without compromising any. Such an approach is in line with ongoing efforts to define and monitor progress towards each Sustainable Development Goal, ensuring a comprehensive and balanced advancement across all goals.

12. Quick access to reliable data can determine the success or failure of policy interventions. For instance, in managing a pandemic, real-time data about infection rates, vaccine efficacy, and public health measures across borders can significantly influence the strategies adopted by different nations. Moreover, data with global relevance is essential for monitoring the Sustainable Development Goals. Reliable data are needed to understand where to allocate scarce resources, when to enforce actions, and how to respond to rapidly evolving scenarios at the global scale. Therefore, establishing robust global data governance frameworks for cross-border data sharing is key to achieving the Goals and effectively combating global challenges.

A. Transforming innovation in the data age

13. Data act as a foundation for economic production and innovation, offering solutions to optimize processes and balance economic and sustainability demands.[8] Data-driven innovations have given rise to distributed value creation ecosystems where companies operate as interconnected nodes, collaborating with external partners and customers. A major contribution of data is the ability of data to enable new innovation forms and redefine organizational structures, presenting novel opportunities for organizational governance and value creation.

14. Data can contribute to democratizing and enriching innovation, as seen in online communities, such as GitHub and Wikipedia, where collective effort transcends geographic barriers.[9] Online communities operate without a formal managerial hierarchy and under a copyright licence that prevents any entity from having proprietary control.[10] Yet, the results of collaboration in online communities can be not only innovative but also highly competitive. Linux is a prime example of successful peer production. Over the years, thousands of contributors have improved and expanded upon it. Today, Linux powers

[7] UNCTAD, 2022a, *Digital Economy Report 2022, Pacific Edition: Towards Value Creation and Inclusiveness* (United Nations publication, Sales No. E.22.II.D.52, Geneva).

[8] Plekhanov D, Franke H and Netland TH, 2023, Digital transformation: A review and research agenda. *European Management Journal*, 41(6):821–844.

[9] Benkler Y, 2017, Peer production, the commons and the future of the firm, *Strategic Organization*, 15(2):264–274; Aaltonen A and Seiler S, 2016, Cumulative growth in user-generated content production: evidence from Wikipedia, *Management Science*, 62(7):2054–2069.

[10] Faraj S, Jarvenpaa SL and Majchrzak A, 2011, Knowledge collaboration in online communities, *Organization Science*, 22(5):1224–1239.

everything from supercomputers to mobile phones, and no single entity controls it.[11] For low- and middle-income countries, the rise of open-source online communities is especially significant. It offers them a unique advantage in bridging the technological gap. These communities also promote entrepreneurship and globally oriented ventures, contributing significantly to their economies. Instead of investing time and resources in developing software from the ground up or procuring it from expensive vendors, the global South can tap into open-source communities and leverage them to catch up with the technological frontier.[12]

15. The data revolution is reshaping innovation into a more participatory and inclusive process.[13] This new paradigm enables organizations to address complex challenges more effectively, paving the way for novel growth and development opportunities. Data-enabled collaboration and reduced transaction costs enable organizations to tackle complex problems, ushering in new development opportunities.

16. The progress in data and data-enabled technologies stands as a cornerstone for the advancement of scientific research, arguably being its most significant contribution.[14] The advent of data-driven innovations has the potential to significantly reinvigorate scientific advancement, laying the groundwork for breakthroughs in various critical fields. This encompasses a wide spectrum, notably including climate change research, which is increasingly reliant on the analysis of large and complex data sets to understand and predict climate patterns and their impacts.

B. The rise of data-based platform ecosystems

17. Platform-based ecosystems, such as search engines, social media and e-commerce, stand at the forefront of the data revolution. Digital platforms, powered by vast data volumes and advanced algorithms, offer tailored user experiences, connect consumers with merchants, provide targeted advertising opportunities and generally enable innovation. A few prominent platforms based in China and the United States dominate global data traffic. They have turned data into a strategic asset, catalysing decision-making, innovation and value creation.[15]

18. Platform-based digital ecosystems have given rise to markets, such as for mobile applications, and spurred innovations across industrial sectors. Within these ecosystems, there are typically four participants: platform owners, providers, producers and consumers.[16] These platforms function as “semi-regulated marketplaces” where the platform owner plays a key role in fostering entrepreneurial activities. By providing a structured environment, digital platforms enable diverse entities to collaborate, creating new products and services that leverage their complementary strengths.

19. These digital platforms function as interactive spaces, facilitating co-creation and value exchange among participants. This leads to outcomes that no single entity could achieve independently. At their core, sophisticated algorithms personalize user experiences, and optimize processes, thereby enhancing the overall value of each interaction within the ecosystem.

[11] Dahlander, L and Wallin MW, 2006, A man on the inside: Unlocking communities as complementary assets, *Research Policy*, 35(8):1243–1259.

[12] Agrawal A, 2016, Does standardized information in online markets disproportionately benefit job applicants from less developed countries? *Journal of International Economics*, 103:1–12.

[13] McIntyre DP and Srinivasan A, 2017, Networks, platforms and strategy: Emerging views and next steps, *Strategic Management Journal*, 38(1):141–160.

[14] Contribution from the Government of the United States of America.

[15] UNCTAD, 2021.

[16] Van Alstyne MW, Parker G and Choudary SP, 2016, Pipelines, platforms and the new rules of strategy, *Harvard Business Review*, 94(4):54–62.

20. Over time, platform-based ecosystems have evolved from merely facilitating transactions to actively generating new ideas and fostering the creation of novel business solutions. These ecosystems break down traditional geographical barriers, enabling a global network of contributors to connect and collaborate. To support this large-scale collaboration, they employ algorithms that play a crucial role in mediating interactions and establishing community norms, ensuring the smooth operation and continuous evolution of these ecosystems.

21. The strength of digital platform-centred ecosystems lies in tapping into the collective intelligence of diverse contributors, fostering radical innovation. These ecosystems address key sustainable development challenges, such as resource access, knowledge sharing and collective action. By connecting vast networks, they enable resource repurposing and value creation through transactions rather than independent production, promoting sustainability.

22. Despite their potential for sustainable development, platform-based ecosystems also present challenges related to privacy, ethics, governance and environmental impact. Addressing these multifaceted challenges holistically is crucial for responsibly and effectively harnessing their potential.

C. Data-driven innovations for sustainable production

23. Integrating data-centred approaches across a product life cycle can help organizations reduce waste, increase resource efficiency and lower carbon emissions (despite emissions-related challenges addressed in chapter III below), contributing to a more sustainable future.

24. In a traditional linear economy, goods follow a "take, make, dispose" model, where raw materials are extracted, transformed into products and eventually discarded as waste.[17] This model strains finite resources and leads to environmental degradation. In contrast, the circular economy presents an ecosystem-centric business model, aiming for sustainability and waste reduction and creating closed loops for continual reuse, refurbishment and recycling of materials and resources.[18]

25. Data-driven innovations can support the transition to a circular economy and decarbonization. Advanced analytical tools and Internet-of-things sensors map material and energy flows across value chains, revealing inefficiencies, waste points and opportunities for material recovery or new revenue streams. Data analytics can also break down silos in energy production, enabling cross-sectoral communication and introducing innovative distributed models that align generation with demand. Data-centric methods have a potential to integrate renewable energy into power grids, managing the variability of sources, such as solar and wind energy.

26. The influence of data-centred approaches extends into sustainable manufacturing, where they drive operational efficiency, product and service innovations, and stakeholder alignment. They help identify patterns, anomalies and early warning signals for potential machinery or infrastructure failures, allowing for timely interventions. Pre-emptive maintenance improves operational efficiency, extends asset lifespan and reduces resource consumption and waste.

27. The refinement of manufacturing processes is another transformative implication of data. Transitioning from a centralized to a distributed production model can bring manufacturing closer to demand source, reducing long-distance transportation, carbon emissions and energy consumption. Aligning manufacturing processes with consumer

[17] See https://www.oecd.org/cfe/regionaldevelopment/Ekins-2019-Circular-Economy-What-Why-How-Where.pdf.

[18] UNCTAD, 2023, *Technology and Innovation Report 2023: Opening Green Windows – Technological Opportunities for a Low-Carbon World* (United Nations publication, Sales No. E.22.II.D.53, Geneva).

needs and demand changes enhances market optimization and supports an environment-centric future, bolstering ecological and social sustainability.[19]

28. Data analytics enhance product design, creating more durable and eco-friendly products. Advanced computer modelling and simulation can optimize product designs for durability and repairability, extending product lifespans and contributing to the circular economy. Selecting sustainable materials during the design phase supports decarbonization. For example, quantum computing can simulate systems like molecules, leading to efficient molecular designs in industries like chemicals and manufacturing.[20] Digital twins, or virtual replicas of products, allow businesses to simulate product behaviour under different conditions, refining designs for durability and efficiency. This approach reduces the need for physical prototypes, decreasing resource use and emissions.[21]

29. Data-enabled business models in the manufacturing sector add another layer of sustainability. They decouple economic growth from resource consumption, creating a more sustainable industrial landscape. Such business models enable selling the utility of products through a blend of products and services, fulfilling customer needs while minimizing environmental impact. Smart sensors and Internet-of-things technology provide data on product usage and performance, informing product refinements and service development to enhance utility, shifting the focus from value-in-transaction to value-in-use.

D. Evidence-informed policymaking and digital government

30. Policymaking is increasingly influenced by data-driven approaches, enhancing policy formulation with refined, real-time analysis.[22] Linking data across government agencies offers a broader context, promoting cohesive inter-agency policy design. Integrating diverse data systems, including housing, economic, environmental and social data, holds significant promise for more holistic decision-making processes.[23]

31. With access to vast and integrated data, policymakers can discern concrete interrelations, such as the impact of publicly funded research on economic growth or the role of regional start-ups in sustainability transitions. Real-time policy data can enable prompt modifications and trend identification, aiding in strategic planning and efficient resource allocation to areas most in need.

32. To support evidence-informed policymaking, Governments need to improve statistical systems, crucial for tracking the Sustainable Development Goals and targeted interventions. Enhancing data collection through new technologies and global collaboration, as emphasized by the Statistical Commission,[24] is vital, particularly for low-income States. This enhances resilience and aligns with the equitable world envisaged in the Goals.

33. Public data systems offer extensive, granular data aiding in trend prediction and policy modification.[25] Data-centric approaches can uncover emerging policy issues, including gender mainstreaming. By identifying and addressing gender disparities, data help ensure equal opportunities, but their effectiveness hinges on responsible and impactful use.

[19] Plekhanov D et al., 2023.

[20] World Economic Forum, 2022, *State of a Quantum Computing: Building a Quantum Economy*. Cologny/Geneva, Switzerland.

[21] Opoku, D-GJ, Perera S, Osei-Kyei R and Rashidi M, 2021, Digital twin application in the construction industry: A literature review, *Journal of Building Engineering*, 40:102726.

[22] Organisation for Economic Co-operation and Development (OECD), 2018, The digitalisation of science and innovation policy, in *OECD Science, Technology and Innovation Outlook 2018: Adapting to Technological and Societal Disruption*, OECD Publishing, Paris.

[23] Contributions from the Governments of Brazil, the United Republic of Tanzania and the United States of America, and the United Nations Economic and Social Commission for Asia and the Pacific.

[24] See https://unstats.un.org/sdgs/hlg/Hangzhou-Declaration/.

[25] OECD, 2020b, OECD case study of Norway's digital science and innovation policy and governance landscape, Paris.

E. Data analytics to combat climate change

34. Climate change is a critical threat, and data-driven innovations are key in both contributing to and solving it.[26] Data-centred approaches go beyond optimizing resource use, playing a crucial role in enhancing environmental management and governance. The value of data lies in the ability, through that data, to navigate the complex interplay of ecological, social and economic factors in climate change. Tackling climate change requires data-centred approaches for understanding patterns, predicting outcomes, and shaping comprehensive policies. Data also aid in enforcing environmental regulations, ensuring accountability and prompting timely corrective actions to prevent further damage.

35. Data-centred approaches aid in effectively implementing nature-based solutions, such as reforestation, by providing insights into the best vegetation for carbon sequestration and the impacts of climate change on ecosystems. Space technologies also provide vital data to monitor and assess the interconnected crises of climate change, biodiversity loss, and pollution, offering information that guides mitigation and adaptation strategies.[27]

36. The value of data in combating climate change lies in the capacity of data to enable more informed and comprehensive environmental governance. This understanding helps formulate proactive actions, anticipating and addressing environmental challenges early on. Through these data-centred approaches, organizations significantly contribute to global climate change mitigation, amplifying efforts in the collective fight against climate change.

F. Data for urban development and disaster management

37. More sustainable urban development can be enabled by the innovative use of data, forecasting demographic changes, optimizing traffic and transport systems and enhancing urban environmental sustainability. Data can also help identify and address socioeconomic disparities, fostering equitable urban growth. Urban data collection is expanding, with sources, such as social media, mobile data and satellite imagery, improving decision-making. Earth observation data are particularly vital, assessing vulnerabilities in infrastructure planning, especially in areas prone to natural disasters.[28] These data also inform climate modelling and risk assessments.

38. Building on the foundation of data-driven approaches, crowdsourcing is emerging as a key method in urban planning.[29] It invites public participation and democratizes the process of data collection. This method helps uncover gaps in the understanding of the Sustainable Development Goals and can lead to the formulation of new objectives. Platforms that leverage crowdsourced data provide real-time insights into urban issues, fostering community involvement in planning and development. This approach enhances urban accessibility and inclusivity, addressing challenges highlighted by diverse community groups.

39. Data analytics play a crucial role in disaster relief and mitigation efforts. During natural disasters, analytical tools can provide essential insights that are vital for effective response strategies. Additionally, post-disaster, data analytics aid in assessing damage, coordinating recovery efforts and planning for future disaster resilience.

40. In summary, data-driven innovations are reshaping urban planning, fostering community engagement, resource optimization and improving disaster management. This marks a promising shift towards more liveable, sustainable and resilient urban and rural areas.

[26] E/RES/2021/10.

[27] Contribution from the United Nations Office for Outer Space Affairs.

[28] Contribution from the Group on Earth Observations.

[29] Crooks A et al., 2015, Crowdsourcing urban form and function, *International Journal of Geographical Information Science*, 29(5):720–741.

G. Data-driven innovations for health care and health research

41. Data innovations can drive a digital health-care revolution, enhancing individual care and fuelling medical research. They enable precision medicine, offering personalized treatments, streamline health-care governance for cost optimization and contribute to medical research breakthroughs.[30] Data-driven management identifies inefficiencies in health-care processes, improving patient safety and treatment reliability by reducing errors and standardizing procedures.[31]

42. Advanced digital technologies can analyse complex data and identify patterns beyond human cognition, aiding in health-care advancements. Algorithms can simultaneously consider multiple variables and outcomes, essential for making informed decisions. Advanced imaging techniques enable early disease detection, including tumours, diabetes complications and heart issues. Early identification of diseases, such as cancer detected through the mix of nuclear medicine and data-enabled approaches, improves treatment outcomes and reduces mortality. Integrating data with health care leads to proactive interventions and personalized patient care.

43. Technological advancements ranging from artificial intelligence to quantum computing can significantly enhance pharmacogenetics techniques by providing sophisticated tools for analysing and interpreting genetic data.[32] Pharmacogenetics focuses on understanding how genetic variations influence individual responses to drugs. With rapid and accurate genetic data analysis, health-care providers can tailor drug therapies to individual genetic profiles, increasing treatment efficacy and reducing adverse drug reactions.

44. Institutions can use artificial intelligence to analyse genomic data from oncology patients, creating a continuous data loop from patient identification to treatment and outcome monitoring. Rapid genome sequencing can identify genetic markers for diseases, aiding early detection and targeted treatment development for conditions such as Alzheimer's and Parkinson's disease.[33]

III. Challenges of data for development

A. Addressing the foundational challenges of data

45. Benefiting from data is not easy. It necessitates the fulfilment of several prerequisites that encompass a range of areas, from the quality of data, to data management and security. Foremost, countries must ensure that the available data are of high quality. The adage "garbage in, garbage out" applies here: without high-quality data, any derived insights or decision-making would be flawed or, at worst, detrimental. It is not enough for data to just be plentiful – it must be accurate, complete, timely, relevant and consistent.

46. Alongside data quality, the interoperability of data across different technological systems is of paramount importance. As the world grows increasingly interconnected, different systems, applications and devices must be able to exchange and make use of data effortlessly. Ensuring such interoperability allows for seamless communication and integration, eliminating potential data silos that could hinder comprehensive analysis and interpretation.

[30] Contributions from the Governments of Peru and the Philippines.

[31] UNCTAD, 2022b, *Entrepreneurship and Innovation in the New Health Economy* (United Nations publication, Geneva).

[32] Fedorov A and Gelfand M, 2021, Towards practical applications in quantum computational biology. *Nature Computational Science*, 1(2):114–119.

[33] Marx V, 2021, Biology begins to tangle with quantum computing, *Nature Methods*, 18(7):715–719.

47. Furthermore, the necessary technological infrastructure must be available. This infrastructure forms the foundation on which data can be collected, stored, processed and accessed. Without this, the entire data life cycle could be compromised, preventing countries from maximizing the value of data.

48. Yet, having access to high-quality, interoperable data housed on sound infrastructure is not enough. Countries must also possess the necessary capabilities and skills to extract insights from data. This means investing in the development of data literacy, analytical skills and technical expertise among their workforce. Only then can countries turn raw data into actionable insights and informed decisions.

49. Equally important is the establishment of robust data privacy measures. The trust of citizens can be fortified by maintaining transparency in data practices[34] and by actively working to minimize organizational resistance against data-centred approaches. In an era where data misuse and breaches are prevalent, it is crucial for countries to earn their citizens' trust by demonstrating and fulfilling commitment to ethical, responsible data practices.

50. The necessity for data safety and security cannot be overstated. With the rise of cyber threats, countries must have robust mechanisms in place to protect their data assets. This includes measures to prevent unauthorized access, detect potential threats, respond to incidents and recover from attacks or data loss.

51. Finally, there is the provision of necessary funding for data infrastructures and data management. Managing data effectively is a complex task that requires substantial investment. Countries need to secure funding for everything from constructing and maintaining the infrastructure, to the tools and personnel necessary for data management, to the training and development programmes that build data skills.

52. All these elements intertwine to form a comprehensive framework for countries to truly benefit from data. Only when these prerequisites are met can countries hope to fully harness the power of data in driving decision-making, innovation and overall societal progress.

B. Digital divides

53. The benefits of the data economy are not automatic or evenly distributed, often exacerbating inequalities and deepening data divides, particularly impacting lower-income countries. This has favoured certain groups or regions, leaving others, especially developing countries, struggling for equitable participation in the global data economy.[35] The high value of data has led to competitive, sometimes unsustainable practices, widening disparities in data access and control.

54. Developing countries, in particular the least developed countries, often lack infrastructure, such as high-speed Internet and data analysis capabilities, limiting their potential in data-intensive technologies. This situation risks relegating these countries to mere data consumers without the capacity to harness the value of data. Despite increased Internet access, millions of people remain offline, particularly in marginalized communities.[36] Even among those with access, limited connectivity and high costs of Internet and devices hinder full engagement in the data economy. Additionally, the lack of culturally appropriate digital content and services, along with digital literacy gaps, exacerbate inequalities.

55. The least developed countries face challenges in participating in global data markets and governance due to power dynamics and barriers to entry. Building the necessary institutional and regulatory frameworks for data trust, such as data protection and privacy laws, is resource-intensive and often challenging for these countries.

[34] Contribution from the Government of Japan.
[35] Contributions from the Governments of the Gambia and South Africa and ITU.
[36] UNCTAD, 2022a.

56. The lack of comprehensive data to measure the progress of the Sustainable Development Goals underscores the need for better data sources. Addressing these challenges requires collaboration at multiple levels, including investing in infrastructure, promoting digital literacy and empowering developing countries, in particular the least developed countries, in global data policymaking.

C. Market competition and fair play in the data economy

57. The current business landscape is dominated by a few large platform companies controlling vast amounts of data, raising concerns about market power and potential discriminatory practices.[37] Their influence can skew wealth distribution, obstruct local value creation and disadvantage smaller entities and new market entrants. Risks include abusive use of personal data for price setting and biased search engine results.[38]

58. Algorithms used by companies for pricing can lead to implicit price collusion, harming consumer welfare. This highlights the need for robust regulatory frameworks to promote competition, prevent anti-competitive behaviour and protect against data-based discrimination.[39] Regulations should include antitrust policies, scrutiny of mergers in data-driven industries and data privacy and protection measures.

59. Beyond these immediate concerns, the significant concentration of power within a few entities brings forth pressing questions of accountability, the transparency of operations, and the overarching question of how democratic control can be asserted over data and artificial-intelligence systems, especially given the profound influence they have on daily life.

D. Ethical implications of modern data practices

60. Data-driven approaches can impact human rights, ranging from freedom of expression to the right to work.[40] Ethical guidelines are essential in data practices, particularly when legal compliance does not address moral, cultural and societal concerns, which can lead to adverse outcomes for individuals or groups.

61. Cultural sensitivity in data ethics is vital in a diverse global community, as ethical norms vary across cultures. This requires careful handling of data to respect cultural beliefs and values. Additionally, societal aspects of data ethics must consider the potential impacts of data practices on different social groups. This underlines the need for a comprehensive data ethics framework that integrates moral, cultural and societal factors with legal compliance.

62. The extensive data processing by artificial-intelligence systems raises significant privacy concerns. Data sharing and usage can have unintended negative effects, such as exploiting shared data to infringe on the privacy of others who have not consented. Advances in data analytics, blurring the lines between personal and non-personal data, challenge traditional regulatory methods based solely on a static definition of “personal data”.[41]

63. Artificial-intelligence biases related to gender, race and socioeconomic factors can adversely affect disadvantaged individuals.[42] These biases can influence life-altering decisions, such as employment and legal outcomes, yet affected individuals often lack recourse. Algorithmic bias can exacerbate socioeconomic disparities, particularly for

[37] Ibid.

[38] Adams T, 2017, Surge pricing comes to the supermarket, *The Guardian*, 4 June.

[39] Contributions from the Governments of Latvia, Portugal and the Russian Federation.

[40] Zou J and Schiebinger L, 2018, AI can be sexist and racist – It’s time to make it fair, *Nature*, 559(7714):324–326.

[41] OECD, 2019, *Enhancing Access to and Sharing of Data: Reconciling Risks and Benefits for Data Re-use across Societies*, OECD Publishing, Paris.

[42] UNESCO, 2021, *UNESCO Science Report: the Race Against Time for Smarter Development*, UNESCO Publishing, Paris.

groups with limited digital access. Decision-making based on social interactions can amplify discriminatory effects.

64. Left unchecked, data practices could worsen socioeconomic disparities and disadvantage marginalized groups in the data economy. Addressing these issues is critical for establishing a fair and inclusive digital future.

E. Negative effects of data on sustainability transitions

65. The utilization of data brings numerous benefits, such as improved efficiency and economic growth, yet it also presents significant environmental challenges.[43] To achieve sustainable technological advancement, it is imperative to strike a balance between technological progress, economic growth and environmental protection. This balance is challenged by several factors, including the rebound effects, high energy consumption, resource-intensive manufacturing of digital devices and issues in electronic waste management.[44]

66. A paradox arises in data-driven efficiency. While it can reduce production costs and increases efficiency, it can also lead to increased overall consumption. As products and services become cheaper and more accessible, consumer demand may rise, potentially resulting in greater total energy and resource use.

67. Another major concern is the energy consumption of data centres, which are essential for processing and storing data. These facilities consume substantial amounts of energy, mainly for powering servers, operating cooling systems and maintaining infrastructure. This high energy usage contributes to greenhouse gas emissions, underlining the environmental impact of digital technologies.[45]

68. The extraction of minerals, such as lithium and cobalt, crucial for battery production, also poses significant environmental issues. Mining practices lead to ecosystem damage, water pollution and human rights concerns, further complicating the environmental footprint of digital technologies.[46] Moreover, the increasing volume of electronic waste, generated by devices, such as smartphones and computers, presents considerable environmental and health risks. This issue is exacerbated in most developing countries, where a large proportion of that waste is dumped.[47]

69. To effectively tackle environmental challenges posed by data-enabled technologies, a comprehensive and integrated approach is required. This approach should encompass policies that integrate sustainable development and climate action, focus on enhancing the energy efficiency of digital technologies and encourage collaboration across different sectors. Such a holistic strategy is vital for ensuring that the benefits of technological progress do not come at the cost of environmental sustainability.

[43] Plekhanov D et al., 2023.

[44] UNCTAD, forthcoming, *Digital Economy Report 2024*; UNCTAD, 2023.

[45] Mora C et al., 2019, Bitcoin emissions alone could push global warming above 2° C, *Nature Climate Change*, 8:931–933.

[46] Kara S, 2023, *Cobalt Red: How the Blood of the Congo Powers Our Lives*, St. Martin's Press, New York; OECD, 2022, Environmental impact of digital assets: Crypto-asset mining and distributed ledger technology consensus mechanisms, OECD Business and Finance Policy Papers, No. 16, OECD Publishing, Paris.

[47] Nižetić S, Šolić P, Gonzalez-De D and Patrono L, 2020, Internet of things: Opportunities, issues and challenges towards a smart and sustainable future, *Journal of Cleaner Production*, 274:122877; United Nations Environment Programme and United Nations Institute for Training and Research, 2023, *The 2050 West Asian E-waste Outlook*, Nairobi and Bonn.

IV. Data governance

A. Global perspectives and paradigm shifts in data governance

70. Approaches to data governance vary significantly among the major global players – China, the United States and the European Union – each reflecting distinct societal values.[48] The United States model favours private sector control, viewing data as a competitive business asset. The China model leans towards State-centric governance, while the European Union prioritizes individual data control, emphasizing personal data protection. These diverse models highlight the importance of cultural and political contexts in data governance but also raise concerns about potential fragmentation in global data governance, particularly with differing regulations impacting cross-border data flow and Internet operations.

71. For developing countries, in particular the least developed countries, which often have limited representation in global data governance discussions, such fragmentation creates challenges in adhering to varying standards. Developing countries, in particular, risk being trapped in choices affecting their economic relations. It is critical that they gain a stronger voice in international forums for more inclusive data governance frameworks.

72. Data collection, storage and use impact privacy, freedom of expression and non-discrimination, with obvious ethical implications. Data governance must therefore take a holistic approach, safeguarding stakeholders' interests and recognizing the multidimensional nature of data. Global recognition by all relevant stakeholders that some data can be a common good, implies an approach that extends beyond individual control, emphasizing the role of social contracts. While data can both generate private profits and contribute to social development, it is crucial to distinguish between different types of data. Not all data can be treated as a common good. For instance, commercial data such as that found in contracts and invoices require distinct handling. Therefore, the governance framework should be tailored to respect the varied data typologies, ensuring that stakeholders' interests are safeguarded. This approach involves recognizing the unique value and sensitivity of different data types, from those that serve the public interest to those that are integral to private commercial transactions.[49] In doing so, balanced data governance frameworks can contribute effectively to addressing global challenges, while maintaining the integrity of private and commercial data.

73. Private contracts often reflect the dynamics of market power where a handful of large technology firms from a small group of countries usually have a privileged position. In the absence of proper governance frameworks, these firms can dictate the terms of service, privacy policies and other regulations pertaining to data handling. Often, individuals must either agree to the terms set by these firms or opt out of using the technological solution altogether. This "take-it-or-leave-it" approach undermines the principle of informed consent and individual autonomy in data management.[50] For any right to have genuine meaning, it should empower the individual with the agency to exercise it, thoughtfully, and without undue constraints.

74. Avoiding major divergence between approaches to data governance is crucial for enabling worldwide data-sharing, avoiding fragmentation and compliance challenges and harnessing the development potential of data and addressing global challenges, such as climate change. Data flows are now central to trade agreements, yet trade policy alone cannot fully address the complexity of data, potentially neglecting privacy and security.[51] This underscores the need for international data sharing agreements and standards. The fast development of artificial intelligence as a data-dependent technology with deeply transformative effects at the global level makes it even more critical to develop adequate

[48] UNCTAD, 2021.

[49] Ibid.

[50] Ibid.; World Bank, 2021, World Development Report 2021: Data for Better Lives, Washington, D.C.

[51] World Customs Organization and World Trade Organization, 2022, *WCO/WTO Study Report on Disruptive Technologies*.

answers to international governance questions, including in terms of multilateralism, ensuring that all countries are involved in the process and in terms of multidisciplinary approaches, to ensure that all the dimensions of data governance (ethical, developmental, environmental, gender, safety and security) are addressed.

75. UNESCO, ITU, OECD and the Group of Seven have developed guidelines aimed at ensuring that the development of artificial intelligence is ethical, transparent, and beneficial to society. Building on these efforts, the high-level advisory body on artificial intelligence,[52] housed within the Office of the Secretary-General's Envoy on Technology, promotes a globally inclusive approach to harness artificial intelligence for the benefit of humanity. In the context of these developments and considering the 20-year review of the World Summit on the Information Society and negotiations for a global digital compact, effective and equitable data governance becomes foundational. It is essential for fostering a technological environment that is people-centric, inclusive and development-oriented.

76. Effective data governance requires innovative, strategies, blending top–down and bottom–up approaches. Governance should be multilayered, with a global coordinating system ensuring coherence. Developing countries' involvement is vital for inclusive, relevant standards and policies. Building on the contributions of the High-level Advisory Board on Effective Multilateralism[53] and considering the broader context that may be defined by the outcomes of the global digital compact at the intergovernmental level, the Commission on Science and Technology for Development provides an optimal forum to engage in a holistic, multi-stakeholder dialogue about the fundamental principles of global, inclusive framework for data governance under the United Nations.

B. The need for a balanced approach to effective data governance

77. Data governance must be flexible enough to effectively navigate the rapidly evolving data landscape. Solely relying on command-and-control, top–down regulatory mandates may not be practical or effective given the complexity and unpredictability of technological advancements.[54] These mandates are not always likely to address the nuanced and specific needs of different data-enabled technologies across various industrial sectors. A hybrid approach in data governance may combine both hard law and soft law mechanisms. "Hard law" refers to legally binding regulations that are enforceable through formal legal mechanisms, whereas "soft law" encompasses non-binding guidelines, principles, and practices that influence behaviour but are not always legally enforceable.[55]

78. This combination of hard and soft law mechanisms allows for more nuanced and context-specific handling of data-related issues, recognizing that different sectors and technologies may require varied governance strategies. In managing data, stakeholders need to strike a balance between risk avoidance and the promotion of healthy competition and business innovation. A pre-emptive, precautionary approach to data governance may not always be well-suited to address potential future risks, which are constantly evolving with the emergence of new data-enabled applications.

79. Proactive hard law measures implemented before potential issues or harms occur should be mainly reserved for situations where a trial-and-error approach is unacceptable due to high risks. In other scenarios, an overly risk-averse stance may lead to prematurely judging data-enabled innovations as guilty until proven innocent. Ex ante regulations during the development stages of data-enabled technologies involve risks for innovation

[52] See https://www.un.org/en/ai-advisory-body.

[53] See https://www.un.org/sg/en/content/sg/note-correspondents/2022-03-18/note-correspondents-secretary-general%E2%80%99s-high-level-advisory-board-effective-multilateralism-comprises-12-eminent-current-or-former-global-leaders-officials.

[54] UNCTAD, 2020, *Fifteen Years Since the World Summit on the Information Society* (United Nations publication, Sales No. E.20.II.D.12, Geneva).
OECD, 2023, Emerging technology governance: Towards an anticipatory framework, in *OECD Science, Technology and Innovation Outlook 2023: Enabling Transitions in Times of Disruption*, OECD Publishing, Paris.

[55] UNCTAD, 2021.

and market concentration, whose costs should be considered. This may also result in investment concentration in jurisdictions with lower risk aversion. Large firms and market incumbents, who possess the necessary resources, knowledge and networks to manage the burdens of regulatory compliance, are likely to emerge as winners in such a regulatory environment.

80. Given that legal frameworks often struggle to keep pace with technological advancements and regulators may lack the necessary technical expertise, bottom–up approaches can offer an alternative or a complement to traditional top–down rulemaking. This bottom–up strategy would rely on soft law mechanisms, such as social norms, good practices, third-party accreditation, whistleblower systems and voluntary codes of conduct and commitments. These methods are flexible and can be customized to address the specific challenges and opportunities posed by data.

81. However, soft law mechanisms are not without drawbacks. A significant concern is the phenomenon of "ethics washing", where companies' claims of ethical self-governance lack transparency and substance. This issue has been compounded by several high-profile governance failures in the technology industry.[56] Incidents involving the misuse of personal data, emissions test cheating and deceptive marketing of unverified technologies have all contributed to growing mistrust. These examples highlight the limitations and challenges of applying soft law for data governance, underscoring the need for a balanced and effective regulatory framework.

82. Effective data governance may therefore require strategically blending soft and hard law mechanisms, leveraging their strengths while mitigating their individual shortcomings. To enhance the efficacy and trustworthiness of soft law in data governance, it is essential to move beyond merely principles-based approaches, developing mechanisms for implementation of those principles and ensuring accountability.

83. Excluding any stakeholder group can diminish the overall efficacy of data governance. Civil society, businesses, academia, non-governmental organizations and technical communities should be involved in the development and implementation of robust data governance structures. An often overlooked but vital group is youth, whose perspectives are crucial in shaping data governance frameworks that consider the needs of future generations.

84. Data governance should find a balance between risk avoidance and the promotion of innovation.

85. To advance data governance for development, consistent with the imperatives of multilateralism, multi-stakeholder approach and multidisciplinary consideration of data, seven principles are proposed:

- *Foundation in human rights*. Data governance should be consistent with the Universal Declaration of Human Rights, upholding human rights in all aspects of data management and use.
- *Treating data in context*. As products of socio-technological systems, data are neither objective nor neutral. They reflect pre-existing social relations and technological limitations, making this context essential for ensuring the ethical design of data-based decisions.
- *Balancing risks and innovation*. It is crucial for data governance to balance risk aversion with innovation promotion. This involves recognizing and addressing risks inherent in data management, while simultaneously supporting and not unduly hindering data-driven innovations.
- *Empowering people*. To empower individuals, it is essential to enhance data skills and capabilities and provide access to data infrastructures and effective tools for data management, while protecting indigenous knowledge. These efforts should enable

[56] See https://www.un.org/en/chronicle/article/government-policy-internet-must-be-rights-based-and-user-centred; *The Lancet*, 2022, Theranos and the scientific community: At the bleeding edge, vol. 399:211.

people to make informed decisions about their data and fully benefit from technological progress.

- *Multilayered approach in data governance*. Data governance should strike a balance between hard (legally binding) and soft law (guidelines and practices) mechanisms. This multilayered approach leverages the strengths of each, providing a robust yet flexible framework that can adapt to the evolving data landscape.
- *Multi-stakeholder inclusivity*. Effective data governance requires a multi-stakeholder approach. This includes engaging policymakers, businesses, academia, non-governmental organizations, technical communities, civil society and other relevant groups. Excluding any stakeholder group can compromise the effectiveness and fairness of data governance.
- *Inclusion of youth for future orientation:* Finally, data governance should proactively incorporate youth perspectives. This helps in designing forward-looking, people-centred, inclusive and development-oriented information society. Inclusion of youth ensures that data governance is aligned with the aspirations and needs of future generations.

V. Suggestions for consideration

86. Governments and all relevant stakeholders should undertake measures that include enhancing data literacy, strengthening domestic capacities for data analysis and management, and establishing fair data sharing agreements at the international level. Robust approaches for cross-border data sharing and global data governance are essential to effectively combat global challenges, such as climate change and pandemics. These initiatives should aim to create an environment where data flows benefit all parties involved and contribute genuinely to sustainable development. This requires a concerted effort from Governments, international organizations, the private sector, academia, technical communities and civil society.

87. The governance of data and data-enabled technologies should be consistent with the Universal Declaration of Human Rights. In this context, the principle of inseparability of human rights is crucial: all human rights are interdependent, indivisible and equally important. In practical terms, this means that any action or policy related to data and technology should be evaluated not only for its immediate impact but also for its broader implications on human rights.

88. The pursuit of economic development, driven by data-enabled technologies, must not come at the expense of ethical considerations. As businesses and Governments leverage data for economic gains, it is essential that this is done in a manner that respects individual privacy rights and data protection. This includes ethical data collection practices, informed consent and robust data security measures.

89. Empowering people with data literacy and the tools to manage their digital footprint is key to enabling them to make informed decisions about their data. This empowerment is essential for fostering a sense of agency and control over personal information. It also means ensuring that choosing to opt out of data collection does not result in significant disadvantages or exclusion from essential services. Such protective measures are critical to prevent people from being compelled into making decisions that go against their interests or rights, thereby maintaining fairness and equity in the digital domain.

90. Overall, addressing inequality in data capabilities is about creating a digital environment and universal and meaningful connectivity where everyone has the opportunity and means to make informed choices about their data, without being subjected to coercive or exploitative practices. This approach is fundamental to ensuring that the future is inclusive and equitable, allowing everyone to participate and benefit on an equal footing.

91. The responsibility of upholding the balance between the ethical, policy and economic and business considerations falls on all stakeholders involved in the governance of data and digital technologies. This includes Governments, which should enact and enforce laws that protect human rights in the digital realm; businesses, particularly technology companies, which need to ensure their practices are ethically aligned with human rights principles; and academia, civil society, youth and technical communities, which play a crucial role in informing governance principles, advocating for and monitoring compliance with these principles.

92. Multilateralism is essential for meaningful data governance. Leveraging existing international processes, such as the World Summit on the Information Society and the global digital compact, multi-stakeholder cooperation can play a crucial role in managing data in a way that respects human rights and addresses challenges posed by digital and data divides.

93. Member States may wish to consider the following suggestions:

(a) Prioritize the education and training of their citizens and public servants in data literacy. A population skilled in understanding, analysing and interpreting data can more effectively engage in civic activities and drive innovation.

(b) Engage the public in decision-making processes related to data governance. Public consultations, town hall meetings, and open forums can provide valuable insights and foster trust.

(c) Regularly audit data practices to ensure adherence to standards, protocols and ethical considerations. External, third-party audits can provide unbiased insights into the effectiveness and integrity of data management practices.

(d) Allocate resources and funding for research in emerging data technologies, ensuring that nations do not miss out on the developmental potential of data-driven innovations.

(e) Modernize data governance regulations, through a balanced combination of hard law and soft law mechanisms, and ensure that all stakeholder groups are active and empowered participants in data governance.

(f) Address the concentration of infrastructural power in data markets through national and international policy mechanisms.

(g) Formulate comprehensive policies that ensure data’s safety, its ethical use and robust cybersecurity.

94. The international community may wish to consider the following suggestions:

(a) Eliminate all barriers that prevent free and open access to taxpayer-funded scientific knowledge, which is essential for achieving the Sustainable Development Goals. Given the inadequacy of current frameworks for open access to research findings and scientific data, humanity is not fully equipped to utilize research data and science in combating climate change and achieving the Goals.

(b) Reduce the technological disparity experienced by developing nations. It is essential to enhance and reinvigorate the Technology Facilitation Mechanism, for technology and skill transfers.

(c) Strengthen the institutional and human capacities of national statistical and data systems in developing countries, as well as other data producers and users, through investment, funding, training, partnerships and technical cooperation.

(d) Consider establishing a dedicated working group within the Commission on Science and Technology for Development that would engage in a holistic, multi-stakeholder dialogue on the fundamental principles of global, inclusive framework for data governance under the auspices of the United Nations.