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Emerging issues: towards sustainable and resilient societies: innovation and interconnectivity for social development

Note by the Secretariat***

Summary

Pursuant to Economic and Social Council resolution 2006/18, the programme of work of the Commission for Social Development has included the item "Emerging issues" since its 2007–2008 review and policy cycle. Under this agenda item, the Commission addresses current issues affecting social development that require urgent consideration or new cross-cutting issues in the context of evolving global development challenges. At its fifty-sixth session, under this item, the Commission will consider the question "Towards sustainable and resilient societies: innovation and interconnectivity for social development". The present note has been prepared to provide background information for the discussion of the topic.

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I. Introduction

1. The present note explores the role and impact of innovation and interconnectivity on social progress and development. It identifies emerging trends in innovation and interconnectivity and highlights the opportunities and challenges that those trends present in pursuing the objectives of the 2030 Agenda for Sustainable Development and the Sustainable Development Goals and in realizing the commitment of the Agenda to leave no one behind (see A/72/257). It also explores the role of social policy in ensuring that innovation, interconnectivity and inclusion interact effectively and that current and future technological advances serve to create inclusive and resilient societies.

II. Trends in innovation

A. Fourth industrial revolution

2. Historically, innovation and increased interconnectivity have played an important role in triggering social, economic and cultural transformations, especially at a global scale. Innovations in the use and development of broad categories of energy and technology, such as steam, electricity and information and communications technology (ICT), have heralded new forms of cultural, institutional and societal structures that are driving and being driven by shifts in production and consumption. In the first industrial revolution, in the late eighteenth century, water and steam power were used to mechanize production. In the second, in the early twentieth century, electric power was used to create mass production. In the mid-twentieth century, in the third industrial revolution, the digital revolution, electronics and information technology were used to automate production and digitize information. The world appears to be in the early stages of a fourth industrial revolution,[1] in which the lines between humanity and technology are being blurred through the use of ICT hardware, software, ancillary equipment and supporting services and the introduction of technology into almost every aspect of everyday life. The direction and scope of this fourth revolution remain mostly uncertain.

3. As with previous industrial paradigm shifts, the direction and impact of the fourth revolution depend on the role of the State and, more broadly, on the social, economic and regulatory policies that shape its development. The policy frameworks chosen will either increase the number of people who benefit from the technological innovation driving this paradigm shift across society or widen existing societal inequalities.

4. In the fourth revolution, advances in computing, communication, automation and digitization are creating a convergence of the physical world, digital information and the biological world, within and across national boundaries. Some of the technological advances and related innovations driving this convergence include the Internet of things, cloud computing, artificial intelligence, robotics and automation, virtual reality and augmented reality, three-dimensional (3D) printing, big data, social media, wearable technology, smart electrical grids, digital and biological fabrication, unmanned vehicles, remote sensing and imaging and blockchain technologies.

[1] World Economic Forum (2016), *The fourth industrial revolution: what it means, how to respond*. Available from www.weforum.org/agenda/2016/01/the-fourth-industrial-revolution-what-it-means-and-how-to-respond.

Together, these innovations are not only changing production and consumption patterns, they are also changing the way that human beings interact with the natural and built environment and how they communicate and interact.

5. These technologies and innovations are becoming a part of daily life, influencing people's choices, decisions and opinions and making their lives more interconnected. For example, social media had 2.41 billion users worldwide in 2017, and that number is continuing to grow, connecting people and facilitating the sharing of information, ideas, advice and support. The Internet of things links everything, including physical objects and people, to the Internet, enabling such innovations as the synchronization of traffic and services and the monitoring of air pollution. Cloud computing enables shared pools of computer networks, servers, storage applications and services and has untethered the storage and sharing of digital information from user hardware. Smart electrical grids have improved the efficiency and effectiveness of power supply, while 3D printing and other additive manufacturing technologies have transformed manufacturing, creating ways for ordinary citizens to manufacture items ranging from vehicle parts to prosthetic limbs for small-scale or personal use. Unmanned vehicles, such as drones, can now be used for surveillance, agricultural spraying or the delivery of vital medical or other supplies to remote areas, in harsh conditions or in emergencies. Blockchain technologies, decentralized and distributed digital ledgers that are used to record transactions across many computers, enable secure and participatory decision-making, as a community of users can control how the information records are amended and updated.

B. Infrastructure, transportation and energy

6. The growing interplay between digital, natural and built environments, spurred by emerging technological advances, has led to ongoing transformations in the development and use of physical infrastructure, transportation and logistics, energy and other utilities. Networked communication and collaboration technologies that control or manage core network assets, such as roads, railways, ports and energy systems, are a powerful and often disruptive source of innovation and renewal. While this leads to greater interconnectivity and interactions between the people who can afford to invest in such technologies, it may also exacerbate the disadvantages of those who cannot.

7. The use of technology in traditional or "hard" infrastructure (for example, embedding sensors in bridges and roads) is already enabling utility systems, especially those for electricity and gas, to improve operations and increase flexibility across a range of areas, from energy generation to customer relationship management. For example, by conservative estimates, smart meters and smart grids, digital productivity tools for employees and the automation of back-office processes significantly boost productivity. New technologies are also changing existing patterns of mobility and interaction, including how people live and work, spend their leisure time and learn, creating new, cheaper and more effective options for connecting.

8. Technology innovation in the transport sector has led to major public investment in intelligent and integrated transport systems and logistics (for example, intelligent streets and digital railways), as well as smart and user-centred mobility services for cars and buses (for example, ride-hailing applications and car-sharing), highly efficient pricing and payment systems that substantially reduce overall costs, high levels of automation and improvements to safety and security.

9. These innovations in transport systems are driven by, and are driving, public and private partnerships. Specific transformative technologies include autonomous (self-driving) and connected vehicles, electric drivetrains and efficient multi-modal networks that integrate different transport modes within a specific region and ensure seamless interconnections with other areas. Also significant is the use of new lightweight, strong and environmentally friendly materials, with an emphasis on the recycling and reuse of local scrap material feedstocks, and production using additive manufacturing technologies, including 3D printing.

10. New sources of energy are transforming markets, industrial operations and society at large. The energy landscape is changing rapidly as new, more cost-effective technologies are developed, renewable energy sources are more widely available, gains are made in energy efficiency and small-scale distributed generation and storage systems become more prevalent. The roles of the various stakeholders are also shifting, with individual homeowners and communities able to generate power, including by installing rooftop solar panels and setting up community solar projects.

C. Food and agriculture

11. ICT and related innovations are transforming the food and agriculture sector through the empowerment of small-scale farmers, the reduction of food waste, the development of food traceability systems, the smart allocation of resources, progress in climate-resilient agriculture and the creation of resilient crops. New hydroponics and aquaponics techniques can be used to grow organic food with minimal use of water or other resources and without taking up valuable land, for example, in former factory buildings or underground. It was estimated that the global hydroponic farming industry was worth $21.4 billion in 2015, with its value projected to grow at 7 per cent per year.[2] The expanding global population (an extra 3 billion people are projected by 2050, with over 80 per cent living in urban centres)[3] and demand for more and better food with minimal environmental impact could prompt a rapid acceleration in the growth of the industry as much of the world's arable land is already being used.

D. Shifting approaches to innovation

12. Growing interconnectivity and access to information and production have led to transformations in the very nature of innovation. In recent decades, new notions of open innovation have emerged. In a departure from traditional top-down innovation for technology and business development, open innovation involves the systematic encouragement and exploration of a wide range of internal and external sources for innovative opportunities across all sectors.

13. One example of open innovation is the "bottom of the pyramid" approach, which focuses on understanding and realizing the potential of the 4 billion people who make up the world's poorest and largest population group. These individuals constitute huge and rapidly growing markets for goods and services and potential partners and innovators for new business models that benefit companies and communities globally and locally. This has generated reverse innovation, also known as "trickle-up" innovation, which originates in developing countries and spreads to the developed

[2] See https://bigpictureeducation.com/hydroponics-and-future-farming.

[3] United Nations (2014), *World urbanization prospects: 2014 revision*.

world. An example of this model is the mobile money application M-Pesa, which was originally developed in Kenya and is now being rolled out globally.

14. Another category of open innovation, frugal innovation, attempts to reduce to a minimum the cost and the complexity of products and production processes, often by using unconventional distribution channels, with the implicit purpose of making the benefits of those products available to everyone. Focusing on creativity in resource-poor contexts, frugal innovation aims to provide affordable access to high-quality goods and services. This creates livelihood opportunities for disadvantaged and marginalized populations, primarily those at the base of the pyramid, on a long-term sustainable basis through significant outreach.[4]

15. Social innovation aims to meet a social need, in collaboration with and through the empowerment of the beneficiary, harnessing societal opportunities, transforming social mechanisms and social relations, leading to social change. For instance, in 2013, the European Commission launched a social investment package, "Towards social investment for growth and cohesion",[5] to support the implementation of the Europe 2020 strategy. The package provides a policy framework for redirecting the policies of Member States, where needed, towards social investment throughout the life cycle, with a view to ensuring adequate, sustainable budgets for social policies and their effective use by the Government and the private sector.

16. In addition, the "quadruple helix" approach has emerged, based on the idea that innovation is the outcome of an interactive process involving different actors, each contributing through knowledge-sharing and transfer. Traditionally, these actors were universities, industry and Government, with the inclusion of civil society as an additional actor. Nature has been proposed as a fifth source of innovation to form a "quintuple helix",[6] incorporating ecological and environmental value. Successful innovations often incorporate natural systems in areas such as ecosystem development, the recycling and reuse of assets, the development of circular societies and economies and the development of learning systems through co-creation and the full utilization of human and natural assets.

III. Benefits and opportunities created by technological advances, innovation and growing interconnectivity

17. Recent waves of innovation and new technologies have brought numerous benefits and opportunities for the advancement of social progress. They have improved access to education, health care and other public goods and services, increased productivity and enhanced people's living standards and well-being. ICTs have linked individuals to global, regional and local knowledge resources and information, facilitated the exchange of ideas, experiences and innovative solutions and contributed to making societies more open, inclusive, participatory, prosperous and cohesive. Technological innovations have also facilitated the development of personalized medicine and education, the provision of support to vulnerable

[4] Mashelka, R.A. (2014), *Inclusive innovation*, The Global Research Alliance. Available from www.theglobalresearchalliance.org/index.php/inclusive-innovation.

[5] See http://ec.europa.eu/social/main.jsp?langId=en&catId=1044&newsId=1807&furtherNews=yes.

[6] Carayannis, E. G., Barth, T. D., and Campbell, D. F. (2012), "The quintuple helix innovation model: global warming as a challenge and driver for innovation", Journal of Innovation and Entrepreneurship. Available from www.innovation-entrepreneurship.com/content/1/1/2.

populations, the prediction and management of shocks and disasters, greater social and political inclusion, improved sanitation, the issuing of proof of identity and reduced environmental toxicity through better monitoring.

18. Similarly, the recent development of infrastructure networks has connected regions, countries, cities, communities and people. This has enhanced productivity, boosted aggregate demand and expanded markets and facilitated the movement of people, the transfer of technology and the diffusion of knowledge. Physical, virtual and social integration have been promoted as a result. Such networks have also contributed to job creation and improvements in the quantity and quality of jobs, food security and nutrition, thus lifting millions of people out of poverty.

A. Cross-societal transformation

1. The knowledge society, knowledge distribution and knowledge transfer

19. The simultaneous growth of the Internet, mobile telephony and digital technologies have revolutionized the role of knowledge in societies, as they serve as powerful tools to create new knowledge and values, disseminate information and knowledge and connect people, organizations, sectors and places. Such technologies are driving the transformation from information societies, in which the amount and availability of information and the speed of its transmission have increased, to knowledge societies in which people have the capabilities not only to acquire information but also to transform it into knowledge and understanding.[7]

20. The transition to a knowledge society calls for enhanced capacity to co-produce and co-create new information and knowledge. Not only is a broad range of sources of information and knowledge required, but also diversity in the way that people think and learn, adapt and transform.[8] Indigenous and local knowledge systems that have been empirically tested, applied and validated by indigenous peoples and local communities over years can close knowledge and technology gaps. If revitalized through appropriate technologies, they can also provide solutions to societal problems and promote innovation.

2. Enhancing productivity and the creation of jobs in new areas

21. Technological advances and innovation continue to drive increased productivity, job creation and economic growth.[9] While estimates of the percentage of jobs at risk of being automated vary widely, depending considerably on the methodology used, it is predicted that between 10 per cent and more than 80 per cent of all jobs worldwide will be lost to robots in the coming years.[10] However, new jobs will also be created. It is predicted that 65 per cent of children entering primary school today will ultimately work in completely new job types that do not yet exist. For example, about 2 million jobs will be created in fields relating to computing, mathematics,

[7] See United Nations Educational, Scientific and Cultural Organization (2005), UNESCO World Report, *Towards knowledge societies*.

[8] Scientific Advisory Board of the Secretary-General of the United Nations (2016), "Indigenous and Local Knowledge(s) and Science(s) for Sustainable Development". Available from http://unesdoc.unesco.org/images/0024/002461/246104E.pdf.

[9] For further information, see United Nations, *Frontier issues: artificial intelligence and development*. Available from www.un.org/development/desa/publications/video/frontier-issues-artificial-intelligence-and-development.

[10] Davenport T. and Kirby J. (2016), *Only humans need apply: winners and losers in the age of smart machines*, HarperCollins, London.

architecture and engineering.[11] Furthermore, in the future, data analysts and specialized sales representatives will be needed in practically every industry owing to technical innovation and increasingly diversified customers and their preferences. Computers and robots may take over tasks, but rarely are they able to do all elements of a job. The changes are therefore expected to be more closely related to augmentation (computers and humans working collaboratively) than automation. For example, evidence shows that tasks are carried out more quickly and to a higher level of quality when people work with machines.[12] As artificial intelligence systems, robotics and cognitive tools are becoming more sophisticated, many institutions are re-examining or reinventing their job profiles, organization of work and future growth strategies by creating an enabling environment for an enhanced workforce.

22. It is also clear that, although machines are starting to outperform people in solving complex but highly specialized tasks using known rules, as in chess and the game of "go", people are much better at understanding and making decisions requiring knowledge across a range of tasks. People need to develop a hybrid skill set that integrates knowledge of advanced digital technology, digital business and creative innovation skills. More niche digital up-skilling is required, specific to various industries, such as education, health, law, banking and marketing. By absorbing the routine aspects of work, machines can release people for more creative work-related tasks or community-based activities better suited to humans. For example, Amazon increased its workforce from about 100,000 to 350,000 between 2014 and 2016, while simultaneously increasing its number of warehouse robots from 1,400 to 45,000.[13]

B. Sector-specific and context-specific applications

1. Urban development and smart cities

23. Technologies have led to the creation of "smart cities", which use ICT to provide, interconnect and improve the efficiency and effectiveness of basic urban infrastructure and human settlements. "Smart citizens" are empowered to pursue innovative solutions and social innovations to improve their living conditions and social interactions and enhance social cohesion. One example is Fab Cities, a global project to develop locally productive and globally connected and self-sufficient cities.[14] This new urban model seeks to transform and shape cities, shifting how they source and use materials, from a "Products in trash out" model to a "Data in data out" approach (a city's imports and exports in the form of data, including information, knowledge, design and code), thus enabling more production and recycling within the city and meeting local needs through local inventiveness so that citizens and cities are empowered to take ownership of their sustainable future.

24. Another driver of socioecological transition is green growth technologies. The European nature-based solutions programme for inclusive urban regeneration[15] recognizes nature as a part of viable solutions and uses its services in a smart,

[11] World Economic Forum (2016), *The future of jobs: employment, skills and workforce strategy for the fourth industrial revolution*, Geneva, Switzerland.

[12] McAfee A. and Brynjolfsson E. (2017), *Machine platform crowd: harnessing our digital future*, W.W. Norton & Company, New York.

[13] O'Reilly T. (2017), *WTF? What's the future and why it's up to us*, HarperCollins Publishers.

[14] Further information available from http://fab.city/about/.

[15] See http://ec.europa.eu/research/participants/portal/desktop/en/opportunities/h2020/topics/scc-02-2016-2017.html.

engineered way. For example, using concrete and other construction materials that can "breathe" and "self-heal" prolongs the life of buildings and reduces their environmental impact. Similarly, roads and pavements can report traffic and pedestrian flows, while also generating electricity from those flows. Nature-based solutions, by reshaping the built environment, can enhance the physical and ecological environment, while ensuring greater resilience to natural disasters and conserving resources. Those solutions also improve the social well-being of citizens by creating more inclusive and engaged communities.[16] They also promoted improved mental and physical health and quality of life for citizens, reduce urban violence and decrease social tensions through better social cohesion, particularly for the most vulnerable groups, such as children, older persons and people living in poverty.

2. Public sector

25. ICT has had a dramatic impact on public services and their delivery via websites and online portals, mobile and smart phones, social media and kiosks located in public spaces. Such service delivery is more cost-effective than traditional modes, gives users greater access, convenience, availability, and time and cost savings and allows for the provision of completely new types of services.[17] ICT can also complement existing public service delivery methods. Especially in developing countries and in rural and remote areas, where non-digital service delivery channels remain important, adding a digital channel or using satellite broadcasting and multi-channel learning services through mobile Internet centres, for example, can significantly improve access to existing services and provide locally relevant content in local languages.

26. ICT solutions can handle and analyse large amounts of data using standardized, routine and rules-based processes and streamline administrative transactions, thereby reducing overall transaction costs and increasing process efficiency. Staff and resources can thus be redeployed away from routine transactions to analytical functions and face-to-face engagement with users. Finally, ICT has emerged as a key tool for capacity-building by providing learning and training opportunities for public servants. Furthermore, the potential of artificial intelligence in areas such as policy integration, health, crime prevention and civil registration could be further explored. For example, India digitized its civil registration system, using biometric information to enrol residents.[18]

IV. Potential challenges to social development

A. Exacerbating inequalities

27. New technologies have lowered barriers for many people and continue to level the playing field. However, there is also a potential risk that technological developments might contribute to intensifying existing inequalities, as in the case of rising wage inequality in many countries. Moreover, gaps in access to new innovations and technology will create further inequalities between those who have

[16] See, for example, Pengcheng Xiang, Yiming Wang and Qing Deng (2017), *Inclusive nature-based solutions for urban regeneration in a natural disaster vulnerability context: a case study of Chongqing, China*. Chongqing University, China.

[17] Millard, J. (2015), *Open governance systems: doing more with more*, Government Information Quarterly. Available from http://doi.org/10.1016/j.giq.2015.08.003.

[18] Population and Development Review, vol. 43, issue 1 (2017), *Identify systems and civil registration in Asia*. Available from http://onlinelibrary.wiley.com/doi/10.1111/padr.12040/full.

access and those who do not, just as uneven access to infrastructure, including roads, ports and energy, creates pockets of poverty and poor communities. Already, substantial divides in Internet access persist between urban and rural areas and between men and women.

28. A digital divide has emerged among and within countries, with significant differences in access to various basic technologies. [19] Developing countries, particularly the least developed countries, lag significantly in fixed line telecommunications. While they are catching up in terms of mobile access, they remain far behind in mobile broadband access. They also lag significantly in household access to a computer and the Internet and individual access to the Internet. In addition, there is a significant correlation between national income per capita and the provision of services for vulnerable groups, highlighting a difference between countries in using ICT to support vulnerable groups. Disparities between urban and rural areas and between core economic centres and remote locations also exist in the availability of ICT infrastructure and access to ICT.

29. The digital divide goes beyond connectivity and capability. The inequalities in access to and use of ICT can further exacerbate existing inequalities in other dimensions, such as inequalities in income and in access to education, health services, productive assets, markets and decent jobs. It is therefore critical to close digital gaps, including through enhanced public investment in infrastructure and through innovative and comprehensive ICT-enabled public service delivery, especially in developing countries. Many valuable lessons can be drawn from how countries have used ICT, alongside more traditional delivery channels, to improve public service delivery.[20]

B. Work and the workplace

30. The nature of work, the workplace and the workforce are undergoing significant change, as technological advances in such areas as artificial intelligence, machine learning, robotics, nanotechnology, 3D printing, genetics, biotechnology and smart systems are increasingly interconnected, building on and amplifying one another. Recent research suggests that just as these new technologies bring immense opportunities, they could potentially disrupt labour markets and exacerbate income inequality, as robots and artificial intelligence may replace humans on a large scale, resulting in mass unemployment or underemployment in the near term.

31. In high-income countries, artificial intelligence and automation are also replacing middle-skilled work (simple, repetitive jobs, such as machine operators and office clerks); however, jobs that require complex cognitive skills remain a challenge for automation. This points to the need for workers to continuously improve the quality and relevance of their skills. To understand better the current and future skills mismatches in different country contexts, the International Labour Organization (ILO) launched the Global Product on Jobs and Skills Mismatch and convened an international conference on the subject in May 2017.

32. Artificial intelligence and robotics can threaten not only work itself but also the quality and remuneration of work. Rapid advances in artificial intelligence capabilities will enable the automation of some tasks that have long required human

[19] International Telecommunication Union (ITU) (2016), *Measuring the information society report*, Geneva Switzerland.

[20] United Nations, E-Government survey, 2014 and 2016.

labour, potentially disrupting current livelihoods on a large scale. In the coming years, artificial intelligence will radically transform not only the future of work, but also the way in which economies function. Whether artificial intelligence leads to unemployment and increases in inequality over the long run depends not only on the technology itself but also on the institutions and policies that are in place. The issues related to artificial intelligence require a series of global dialogues with multiple and diverse stakeholders to understand the accelerating capabilities of artificial intelligence from all angles and their broad implications, both positive and negative, for societies.

33. Much of the promise of artificial intelligence remains to be realized, but the trends that are expected would have significant impacts on welfare, jobs and the organization of work. The more transactional a job is, the more likely that it will be automated, as automation is fundamentally the substitution of capital for labour. A "race to the bottom" may create a growing "precariat", an emerging global class with no financial security, job stability or prospects of career progression. Precarious work is much more prevalent among women and young people.[21] This situation, coupled with the fact that traditionally much of the work that women carry out is unpaid, for example in the home, highlights gender-based differences in employment that require a policy response.

34. The pace of change and how concentrated the losses are in specific occupations also affect the intensity of the challenge in the world of work. Even if new jobs are created quickly enough to replace those lost, the transition from one job to another still often entails loss of income for affected workers and an increase in structural unemployment. Furthermore, increased labour productivity by using artificial intelligence may not automatically translate into wage increases for workers, but increase the profits of companies, including stock values, which will further concentrate economic gains in the hands of a very few and leave many behind. These issues require urgent policy action as Governments must shoulder the social and fiscal costs of long-term unemployment and job insecurity.

C. Complex roles of technology

35. While advances in technology have created great opportunities across sectors, it is difficult for society and Governments to respond effectively to the rapid change. Typically, Governments and regulators react to changes, as the majority of technical innovation occurs in the private sector. This prompts the question of what technology companies are accountable for and to whom. For example, the deregulation of financial markets in the run-up to the financial crisis of 2007-2008, combined with instantaneous digital financial transactions that enabled the fast spread of the crisis globally, led to the global recession that the world economy is still struggling to overcome.

36. The rise of digital connectivity also raises increased cybersecurity concerns, for example with the hacking of critical infrastructure, such as electricity and transport networks, and the security, ownership and use of the massive amount of personal data that are created and shared.[22] While social media has had a positive impact on the

[21] McDowell, L. (2016), *Migrant women's voices: talking about life and work in the UK since 1945*, Bloomsbury Press, London.

[22] 2030Vision (2017), *Uniting to deliver technology for the global goals*. Available from https://2030vision.com/assets/pdf/ARM_2030VisionReport.pdf.

lives of many people, the misuse of social media, such as trolling and bullying online, has also had a negative impact.

37. The role of ICT in political participation is complex. Although "fake news" and "fact-free" discourse, including political discourse, are not new, enabled by ICT, their significance has grown. The democratic and mind-broadening potential of the web has also come under scrutiny, as more people access only material that they choose to follow. They increasingly ignore or are excluded from other content, leading to filter bubbles: search engines use sophisticated algorithms to adapt to users and present them only with content that matches their preferences.

38. While there are numerous examples where technical advances have been driven by social needs, such as the Linux free open-source operating system for computers and the M-Pesa mobile telephone money transfer application in Kenya, most technical advances are market-driven and aim to increase profits rather than serve the public good. Much new ICT is designed to extract market value from individuals and communities. The neutrality of technology is, therefore, not straightforward, and there is scope for policy to promote the greater public good.

V. Role of social policy

39. In a world that is increasingly interconnected and technologically enhanced, social policy has a critical role to play in harnessing advancements for social progress to ensure that all people, in particular vulnerable groups and communities, have equitable access to and benefit from technological advances, while addressing the negative impacts and mitigating potential risks that undermine people's livelihoods and well-being. Social policy should assist people in becoming better equipped to cope with societal changes and facilitate their active participation in creating a more inclusive, accessible, sustainable, resilient and innovative society for all.

40. By pursuing the right policy and institutional options, innovation and interconnectivity can be leveraged for social progress, making it possible to achieve, for example, a combination of higher wages and better leisure opportunities, enabled by artificial intelligence and robotics, for a wide range of workers. Analysis to support evidence-based policymaking will be an important step in this direction. ILO established a high-level Global Commission on the Future of Work,[23] which will undertake an in-depth examination of the future of work that can provide the analytical basis for social and economic policies that promote social justice in the twenty-first century. Some Governments have commissioned in-depth analyses on the consequences for employment of some technologies, in particular artificial intelligence.[24]

[23] See www.ilo.org/global/about-the-ilo/multimedia/video/institutional-videos/WCMS_570704/lang--en/index.htm.

[24] See Executive Office of the President (2016), *Artificial intelligence, automation, and the economy*, available from https://www.whitehouse.gov/sites/whitehouse.gov/files/images/EMBARGOED%20AI%20Economy%20Report.pdf; and Executive Office of the President, National Science and Technology Council Committee on Technology (2016), *Preparing for the future of artificial intelligence*, available from https://obamawhitehouse.archives.gov/sites/default/files/whitehouse_files/microsites/ostp/NSTC/preparing_for_the_future_of_ai.pdf.

A. Investment in infrastructure for equitable access

41. In today's world of rapid technological change, access to innovations and being connected have become important factors in ensuring equality of opportunity. Disparities among and within countries in access to traditional and physical infrastructures, as well as in interconnectivity, have contributed to inequalities in many dimensions. The digital divide reinforces poverty and inequality owing in part to a lack of investment in connectivity to expand access to innovations driven by ICT.

42. Investment in infrastructure for equitable access is therefore critical for reducing inequalities among and within countries. In this context, the mobilization of domestic resources and increasing external flows to low-income, especially the least developed countries, from both private and official sources, form an integral part of socioeconomic policies aimed at the implementation of the 2030 Agenda in all countries. With regard to international cooperation, the One Belt, One Road initiative of China, which addresses infrastructure development, has the potential to accelerate interconnectivity and more inclusive socioeconomic development in many countries.

B. Investment in education and lifelong learning

43. In the coming years, knowledge, especially tacit or experiential knowledge, creativity and interpersonal and cognitive skills will become increasingly crucial as the world moves towards knowledge societies. These skills are unique to humans and not easily replaced by machines or technologies. Investment in education for all, which has historically been proved an effective means to promote social mobility and reduce inequality, is even more important today.

44. Current education systems and curricula, however, do not address the wide skills gap that comes with rapid technological change. It is possible that the skills and competences acquired just a few years ago may become obsolete or instantly obtainable through the Internet or artificial intelligence. The current approach to education therefore needs to be re-examined and fundamentally transformed, so that people of all ages and backgrounds can acquire a mix of skills to cope with the rapid pace of technological and societal changes.

45. New types of education and training models providing updated and relevant content and methods of delivery facilitated by ICT, and focusing on science, technology, engineering and mathematics (STEM) education are needed. In addition to academic competencies, a wide range of skills are required to better respond to market demands. Such skills include digital literacy, interpersonal skills, communication, teamwork and critical thinking, as well as complex reasoning and creative thinking to filter, analyse and extract meaning from the vast amounts of information.[25] It is important for young people to gain solid ethics and values that place people at the centre of development. In addition, lifelong learning and adaptive skills retraining should be promoted for people of all ages, as the shelf life of employees' existing skill sets is ever shorter owing to technological changes across industries and regions. These new demands on education add to the urgent need for greater investment in the education sector.

[25] Rebecca Winthrop and Eileen McGivney (2016), *Skills for a changing world: advancing quality learning for vibrant societies*, Center for Universal Education at Brookings. Available from: www.brookings.edu/wp-content/uploads/2016/05/Brookings_Skills-for-a-Changing-World_Advancing-Quality-Learning-for-Vibrant-Societies-3.pdf.

C. Social protection

46. With rapid technological advances in an increasing interconnected world, changes have been seen in the causes of job loss, the duration of periods of unemployment, the prevalence of underemployment and the use of non-standard contracts. The effects have been different on workers of varied skill levels, as well as on different population groups by gender, age, disability, income, social status and location of residence. Winners and losers are being created as unemployment and job insecurity increase.

47. Social protection systems have proven to be effective in mitigating risks and protecting people from falling into poverty. The need for social protection for all is ever greater given that advancements in technology, including ICT, automation, artificial intelligence and robotics are changing the world of work. However, the current societal transition is threatening the well-established social protection systems in many countries with advanced economies because of demographic change, job losses or job insecurities caused by automation and the changing nature of work, with an increase in more flexible jobs outside the standard employment contract model. Employers are moving away from traditional employment models and social protection contributions. In some cases, severely underfunded State social systems are at a breaking point.[26] Existing social protection systems should be modernized to safeguard those who are negatively affected, either temporarily or permanently, by rapid technological change. Countries that are currently building national social protection systems could take opportunities to avoid these pitfalls, including by promoting a life-cycle approach to streamline existing social welfare schemes and programmes that are fragmented or overlapping, while identifying innovative and sustainable sources of funding.

48. In connection with this rethinking of social protection and coupled with the concern that in the future artificial intelligence and robots may replace workers in certain functions, the concept of a universal basic income has emerged. A universal basic income is a regular unconditional payment, sufficient for a basic but comfortable living, made to all adults regardless of their background or labour market status. A universal basic income is currently being trialled in countries such as Canada, Finland, the Netherlands and Spain, with mixed results. The value and effectiveness of a universal basic income are under evaluation. ILO has also been examining this approach; however, at this nascent stage, a wide variety of proposals are under consideration.[27]

D. Human-centred and ethical policies

49. In today's workplace, there is increasing insecurity regarding the relationship between people and advanced technology. How are human values, ethics and well-being protected and promoted in such a context? What are the philosophical implications of blurring the boundaries between the physical, biological and digital sphere? Policies are needed to enable humans to transparently assess a system's incentives and to influence its direction or debate its alteration. An ethical dimension needs to be introduced in the exploitation, for example, of big data and biotechnologies, as well as in examining the tensions between a citizen's right to

[26] World Economic Forum, *Global Risks Report 2017*.

[27] ILO (2017), Global Commission on the Future of Work, available from http://www.ilo.org/global/topics/future-of-work/WCMS_569528/lang--en/index.htm.

privacy and improved security systems through routine surveillance and image analysis.

50. Current attempts to embed such ethical considerations at all stages of research and innovation need to be monitored, developed and coordinated internationally. In the European Human Brain Project, for example, there is an embedded ethics and society programme, which applies the principles of responsible research and innovation.[28] The idea behind this is to engage with external stakeholders early and to foster a process of reflection throughout the different stages of research and technology development with a view to creating mutual responsiveness between researchers, institutions, policymakers and civil society. A responsible research and innovation approach has been adopted by a number of European national funding bodies, in addition to the European Commission, and serves as an example of encouraging public debate on the acceptability, desirability and sustainability of current and emerging technologies.

E. Public-private partnerships for social development

51. As recognized in the 2030 Agenda for Sustainable Development, an enhanced global partnership is needed to ensure the realization of the Sustainable Development Goals for all. This need for partnership is paramount if technological innovation and interconnectivity are to be harnessed to benefit all to promote social progress. Given that the majority, if not all, innovations are owned privately, collaboration is needed between the Government, the private sector and civil society to bring together their specific competencies and assets, in order to balance public interests and private profits. Such partnerships should aim to ensure that the needs, rights and privacy of the public — the users — are protected in an open and transparent manner. In this context, policies on ICT and other infrastructure should be directly embedded into broader national or regional sustainable development policies and plans to meet the public service needs of people with diverse backgrounds.

52. As an outcome of the Tunis phase of the World Summit on the Information Society, held in 2005, the multi-stakeholder Internet Governance Forum was established in 2006 to facilitate open and inclusive dialogue on public policy related to key elements of Internet governance, for example, the sustainability, robustness, security, stability and development of the Internet. At its 2017 session, to be held in Geneva from 18 to 21 December, the Forum will focus on the theme “Shape your digital future”.[29]

53. Legal and regulatory frameworks need to be conducive to the new social and business models emerging in the context of new technological innovations. With forward-looking regulatory and legal frameworks, social innovation, co-creation and the collaborative and sharing economy can provide significant potential benefits and new sources of value creation. Guidelines should be created to ensure accountability, transparency and privacy and mitigate the dangers of undermining the economic, social, community and individual benefits through exploitation, loss of rights or reduced quality of services.

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[28] European Commission (2012), *Responsible research and innovation — Europe’s ability to respond to societal challenges*; European Commission (2013), *Options for strengthening responsible research and innovation*; and Stilgoe and others (2013), *Developing a framework for responsible innovation*.

[29] See www.intgovforum.org.

54. In addition, all segments of society — policymakers, regulators, business leaders, researchers and civil society — should be involved in developing the framework needed to promote the ethical development of artificial intelligence and safeguard against potential abuses. Some steps have been taken in this regard. The Group of 20 (G-20) and Group of Seven (G-7) have undertaken studies on digital transformation, including the impact of artificial intelligence. The Organization for Economic Cooperation and Development held a conference on "AI: intelligent machines, smart policies" in October 2017 to inform its future work and to initiate a broad engagement with the policy, research, academic and public sectors. Similarly, the World Economic Forum convened its annual Global Future Councils event, to be held in Dubai, United Arab Emirates, in November 2017, on the theme "Towards a shared narrative about the future".

55. To harness science, technology and innovation to achieve the Sustainable Development Goals, a Technology Facilitation Mechanism [30] was launched, consisting of three components: (a) an inter-agency task team on science, technology and innovation for the Sustainable Development Goals; (b) a collaborative multi-stakeholder forum on science, technology and innovation for the Sustainable Development Goals; and (c) an online platform as a gateway for information on existing science, technology and innovation initiatives, mechanisms and programmes. The outcome of the forum held in 2017 (see E/HLPF/2017/4) highlights, among other actions, the need to build science, technology and innovation capacity in every country, including by strengthening science advisory ecosystems and policy frameworks.

VI. Conclusion and recommendations

56. The present note contains a comprehensive, but not exhaustive overview of trends in innovation, technological advances and interconnectivity, identifying related opportunities and challenges for social development. It has explored the potential role of social policies to ensure that the benefits of technology are shared equitably, while protecting people from potential risks. Tackling the complex task of mitigating the negative effects and maximizing the potential opportunities of technology and innovation requires comprehensive, coherent and integrated policies that promote coordinated action across sectors. This holistic, "whole of society" approach is crucial to protect those who may be left behind and requires action at global and national levels. In this regard, policymakers may wish to consider a number of possible actions.

A. Global level

57. At the global level, policymakers may wish to:

(a) Raise awareness, using data and analysis, of the benefits and potential risks that technology and innovation bring to society. Facilitate global platforms, mechanisms and policy coordination to leverage innovation and interconnectivity for social progress at the international and national levels, and address potential negative consequences, particularly, socioeconomic inequalities, as well as the regional disparities to which technology, infrastructure and interconnectivity often give rise;

[30] See https://sustainabledevelopment.un.org/tfm#forum.

(b) Promote proactive and human-centred ethical policies to enhance accountability, transparency and privacy at all stages of research and innovation in order to protect people from potential risks;

(c) Encourage the development of research and innovation policies as a means of early identification of potential consequences of new technologies. In doing so, incorporate civil society perspectives (civil society organizations, the private sector, academia and scientific institutions) at all stages of the research and innovation life cycle, from agenda-setting to user-testing;

(d) Support and promote international cooperation in technology and innovation for inclusive development in all countries, especially in the least developed countries. The Technology Facilitation Mechanism represents a concrete step towards this end.

B. National level

58. At the national level, policymakers may wish to:

(a) Undertake a proactive national high-quality infrastructure development programme (for example, improve Internet, mobile and broadband coverage) and ensure adequate funding for more general initiatives, such as promoting digital literacy, by creating appropriate incentives, awareness, reward systems and supporting providers and users to support the effective use of technology and interconnectivity for development;

(b) Recognizing the critical role of the private sector, promote public-private partnerships in technology innovation, infrastructure development and maximizing interconnectivity for all. Guide the private sector to move from short-term shareholder value towards shared value to bring benefits to society as a whole, which has become increasingly essential for businesses' profits and survival. In this regard, developing legal and regulatory frameworks and ethical standards is of particular importance so as to encourage the new social innovation and business models, while also mitigating the adverse effects of such technological advances on the well-being of the community and individuals, especially that of low-wage and low-skilled workers, people living in poverty and other disadvantaged social groups;

(c) In the light of anticipated future job losses and job degradation owing to new technology and automation, focus on strengthening social protection systems, labour force up-skilling and innovation systems that augment and improve the quantity and quality of employment;

(d) Promote new and innovative forms of education, skills development and knowledge acquisition to meet the growing challenges of knowledge societies and the knowledge economy, including lifelong and life-wide learning, blended learning, personalized, self-directed and independent learning, as well as crowd and collaborative learning;

(e) Promote youth employment, especially for countries with high youth unemployment and underemployment and rapid population growth, by improving infrastructure and lowering business costs to raise labour demand, as well as upgrading the technological and entrepreneurial skills of young people;

(f) Focus on green growth policies and technologies that promote quality of life and well-being, which is critical to enable socioecological transition, through a shift towards renewable, decentralized electricity generation. Promote the use of

modern science and technology in agricultural production to increase profitability and rural standards of living;

(g) Support grass-roots innovations by working with the poorest and most deprived segments of the population and focusing on their rights and human dignity. Strengthen civil society by supporting non-governmental institutions, such as organizations and community groups, to build the knowledge society and promote social innovation. In this context, putting in place enabling mechanisms for those at the “bottom of the pyramid” in order to foster greater inclusion of disadvantaged population groups is a concrete action area;

(h) Undertake effective and participatory monitoring and evaluation of programmes and their outcomes to ensure policy coherence, effectiveness and adequate outreach to beneficiaries.

59. To discuss and elaborate on the suggestions contained in the present note, the Commission may wish to focus on the following questions in its deliberation on the emerging issues at its fifty-sixth session:

(a) How can the international community ensure that all people, in particular vulnerable social groups and communities, enjoy the benefits of innovation, technology and interconnectivity? What actions can be taken to address existing inequalities in access to technology and innovation?

(b) What can be done to support international cooperation to promote innovation and interconnectivity for the achievement of the Sustainable Development Goals in all countries for all people?

(c) How can Member States and the international community address the disruptive effects of technological innovation on work and the economy, such as the potential negative impact of technological advances on employment and job security? Are women and men affected differently by technological advances?

(d) What can be done to ensure that technological advances serve to further social progress and sustainable development for all? What guidance can the Commission provide to the private sector and civil society so that the adoption and enhancement of technology contribute to the greater public good?