Re-Building Sudan AFTER THE WAR

SCIENCE, TECHNOLOGY AND INNOVATION

OPEN ACCESS

DOI: 10.47556/B.SUDAN2025.17

CHAPTER 17

LITERATURE REVIEW

Artificial Intelligence as a Catalyst for Achieving the Sustainable Development Goals: Literature Review

Dr Muawya Ahmed Hussein
Assistant Professor, Department of Finance & Economics, Dhofar University
Salalah 211, PO Box 2509, Oman
Email: m_hussein@du.edu.om / muawyaccba@hotmail.com
ORCID: 0000-0002-5938-1026

Dr Hanaa Mahmoud Sid Ahmed
Assistant Professor, College of Economics and Business Administration
University of Technology and Applied Sciences
Salalah 211, PO Box 608, Oman
Email: hanaa@utas.edu.om
ORCID: 0000-0002-8275-9840

ABSTRACT

PURPOSE: This study aims to critically evaluate the role of artificial intelligence (AI) in advancing the United Nations Sustainable Development Goals (SDGs).

METHODOLOGY: The research adopts a structured expert elicitation approach, utilising a consensus-based inference process to assess AI's impact on all 17 SDGs and their associated targets.

FINDINGS: The findings reveal that AI positively contributes to 79% of the SDG targets (134 in total), mainly by overcoming development challenges through technology. However, AI also poses risks to 59 targets.

CONTRIBUTION: This study contributes to the emerging body of literature on AI and sustainable development by offering a comprehensive, target-level analysis of AI's influence on the SDGs. It integrates ethical, social, and regulatory considerations into developing AI technologies to ensure alignment with global sustainability objectives.

LIMITATIONS: Expert judgement's subjectivity and AI's evolving nature may limit analysis accuracy, requiring ongoing reassessment to address future uncertainties.

KEYWORDS: *Artificial Intelligence (AI); Sustainable Development Goals (SDGs); Expert Elicitation; Technology; Development Challenges; Ethics; Regulatory Considerations.*

CITATION: Hussein, M.A. and Sid Ahmed, H.M. (2025): Artificial Intelligence as a Catalyst for Achieving the Sustainable Development Goals: Literature Review. In Ahmed, A. (Ed.): *Re-Building Sudan from War to Sustainable Development*, Vol 1, pp. 279-291

RECEIVED: 8 May 2025 / **REVISED:** 12 June 2025 / **ACCEPTED:** 27 June 2025 / **PUBLISHED:** 1 December 2025

INTRODUCTION

Since the emergence of artificial intelligence (AI), both its theoretical foundation and technological capabilities have advanced significantly, with its application spreading across various sectors. In the early 21st century, AI gained substantial traction as machine learning techniques began to solve complex problems in both academia and industry. This growth was driven by new methodologies, the availability of powerful computing resources, and the accumulation of large datasets.

Given AI's rapid development and its increasing influence across multiple industries, there is a pressing need to evaluate its role in achieving the Sustainable Development Goals (SDGs). An expert consensus-based process has revealed that AI has the potential to contribute to the achievement of 134 SDG targets across various goals. However, it may also impede the progress of 59 targets. Despite these findings, existing research often overlooks key considerations. As AI evolves rapidly, it is crucial to have regulatory frameworks and oversight to ensure that AI technologies are aligned with sustainable development. Without proper safeguards, issues such as lack of transparency, safety concerns, and ethical dilemmas may arise.

AI's impact is far-reaching, influencing global productivity (Acemoglu and Restrepo, 2018), equality, inclusion (Adeli and Jiang, 2008), and environmental outcomes (Karnama *et al*., 2019), both in the short and long term (Bissio, 2018). While AI shows promise in advancing sustainable development (Bolukbasi *et al*., 2016), it also presents challenges that could undermine it (Brynjolfsson and McAfee, 2014). Current literature lacks a comprehensive study examining AI's impact across all SDGs, which is a notable research gap. This study addresses that gap by evaluating how AI might either support or hinder the achievement of the 17 SDGs and their 169 targets outlined in Agenda 2030 (Cockburn *et al*., 2018). The study's findings, which focus on SDGs (Courtland, 2018; Dalenberg, 2018; Dobbs *et al*., 2016), are derived from expert assessments and previous research, highlighting the nuanced role of AI in sustainable development. AI, defined here as any software technology with specific capabilities such as perception, decision-making, and pattern recognition, encompasses various subfields, including machine learning.

METHODOLOGY

This section describes the methodology used to derive the results presented in this study, which are detailed in Supplementary Data 1. The goal was to address the question: "Does published evidence exist indicating that artificial intelligence (AI) acts as an enabler or inhibitor for each of the 169 targets within the 17 Sustainable Development Goals (SDGs)?"

To answer this, we implemented a consensus-based expert elicitation process, guided by prior research on SDG interlinkages (Courtland, 2018; Dalenberg, 2018; Butler *et al*., 2015; Morgan, 2014). The authors, a group of academics from various disciplines such as engineering, natural and social sciences, participated as experts in this process. These experts conducted a literature review to support the connections between AI and specific SDG targets. Acceptable sources included peer-reviewed chapters on real-world applications, controlled studies, reports from accredited organisations such as the United Nations, and commercial-stage applications. Sources not considered valid included speculative data, non-peer-reviewed real-world applications, media reports, and informal sources.

Each SDG target was assigned to one or more lead contributors, with additional contributors in some cases, as listed in Supplementary Data 1. Lead contributors performed initial research on the targets, while additional contributors conducted the primary analysis. A single relevant study sufficed to establish a linkage between AI and a target, although multiple references were typically provided. After analysis, reviewers not involved in the initial research evaluated the work and provided critical feedback, ensuring a robust final analysis. Discussions between lead contributors and reviewers refined the results.

Once consensus was reached on the evaluation, we analysed the data, determining how many targets AI enabled or inhibited, calculating the percentage of targets with positive or negative AI impacts for each SDG (Francescato, 2018; Fuso Nerini *et al*., 2017). We also grouped the SDGs into society, economy, and environment categories. The results for each group are illustrated in Figures 1, 2, and 3, summarising the overall impact.

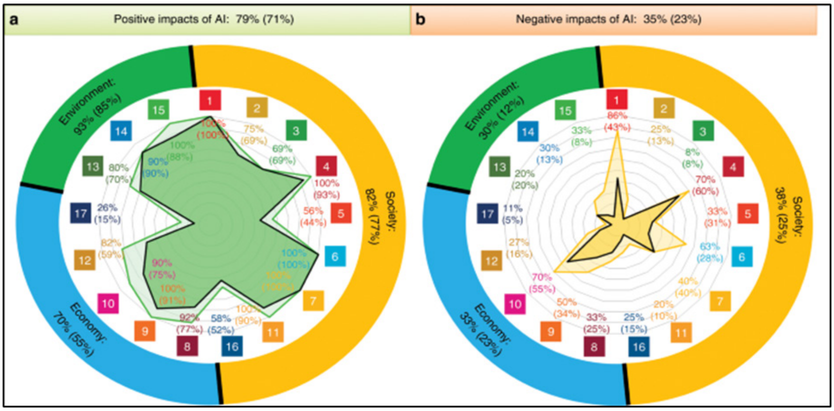

Figure 1: Summary of the Positive and Negative Impact of AI on the Various SDGs
Source: http://creativecommons.org/licenses/by/4.0/ (Vinuesa *et al*., 2020)

Figure 1 presents documented evidence on how AI can either support or hinder progress towards each of the SDGs. The numbered squares indicate specific SDGs, with percentages above showing the overall share of targets potentially influenced by AI. Inner circle percentages reflect AI's impact within individual SDGs. The outer circle summarises findings across three key areas: society, economy, and environment. Shaded inner areas and bracketed values highlight outcomes when considering the type of evidence used in the analysis.

Documented Links between AI and the Sustainable Development Goals

Our review of the evidence suggests that AI has the potential to support 134 targets (79%) across all SDGs, primarily by offering technological improvements that can address current limitations. However, 59 targets (35%) could be negatively impacted by AI advancements. To better understand these effects, we categorised the SDGs into three groups based on the pillars of sustainable development: society, economy, and environment (Francescato, 2018; Fuso Nerini *et al*., 2017). This classification enables us to outline the key areas where AI might have an impact. Additionally, a weighted analysis of the evidence, considering the relevance of each reference, was conducted to assess how AI correlates with the percentage of goals evaluated. The findings are summarised in Figure 2, with further discussion on the societal, economic, and environmental groups, accompanied by specific examples. In summary, AI is seen as a positive force for 79% of SDG targets, although it may negatively affect 35% of them.

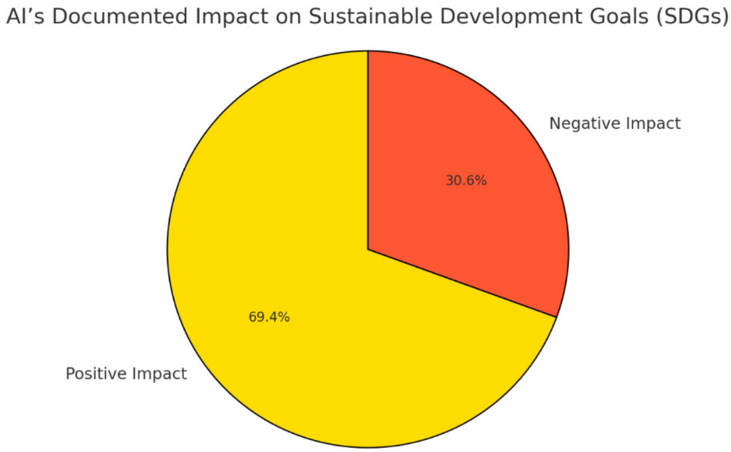

Figure 2: AI's Documented Impact on Sustainable Development Goals (SDGs)
Source: Constructed by author

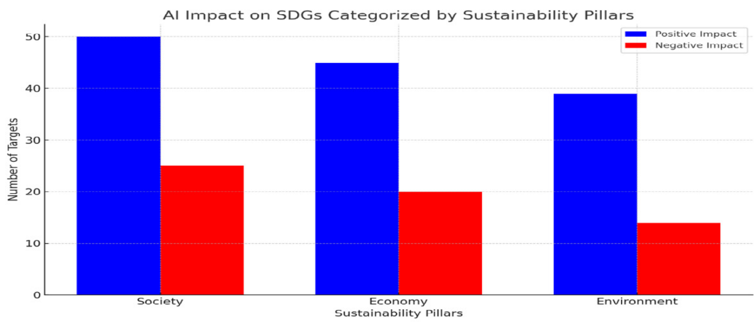

Figure 3: Summary of AI impact on SDGs categorised Sustainability Pillars
Source: Constructed by author

ARTIFICIAL INTELLIGENCE (AI) AND ITS POTENTIAL IMPACT ON SOCIETAL OUTCOMES

Artificial Intelligence (AI) and its potential impact on societal outcomes have become increasingly significant in achieving global goals. A large portion of goals within the societal group (82%) can benefit from AI-driven technologies, as shown by their positive influence on various Sustainable Development Goals (SDGs) (Fuso Nerini *et al*., 2018; Fuso Nerini *et al*., 2019a). For instance, AI can play a crucial role in SDG 1, which focuses on eradicating poverty, SDG 4 on providing quality education, SDG 6 concerning clean water and sanitation, SDG 7 about affordable and clean energy, and SDG 11 on sustainable cities. AI has the potential to enhance the delivery of essential services such as food, health, water, and energy. It can also support the transition to low-carbon systems by promoting circular economies and smart cities that use resources more efficiently (Fuso Nerini *et al*., 2018; Fuso Nerini *et al*., 2019a).

AI facilitates the development of sustainable cities through technologies such as autonomous electric vehicles and smart appliances that help optimise electricity demand, and contributes to SDGs 7, 11, and 13, which addresses climate action. Additionally, AI can help integrate renewable energy sources such as solar and wind into the grid by optimising the use of smart grids that balance electricity demand during varying daylight and wind conditions. While most goals benefit from AI advancements, some, particularly in the community sector (38% of goals), could be negatively impacted, which warrants careful consideration.

The main concerns regarding AI's negative impact relate to its implementation in countries with diverse values and cultural contexts. Advanced AI technologies require large computational resources and data centres that consume vast amounts of energy and contribute to carbon emissions (Fuso Nerini *et al*., 2019b). For example, applications such as Bitcoin require electricity comparable to that of entire countries (Helbing, 2015), negatively affecting SDG 7 (Affordable and Clean Energy) and SDG 13 (Climate Action). Projections suggest that by 2030, Information and Communication Technology (ICT) could account for 20% of global electricity demand, up from just 1% today, highlighting the urgent need for green ICT solutions. Improved cooling systems, greater energy efficiency, and renewable energy in data centres are crucial to mitigate these concerns (Helbing and Pournaras, 2015).

Furthermore, incorporating human knowledge into AI models can significantly reduce energy consumption, as human brains are much more energy efficient than the computational resources required to train AI systems. Using models informed by human knowledge, such as physics-based deep learning, reduces the need for data-intensive training, helping to lower overall energy consumption (Helbing *et al*., 2019).

Despite AI's potential to advance Agenda 2030, it also poses challenges that could exacerbate inequalities, hindering progress towards SDGs 1 (Poverty Eradication), 4 (Quality Education), and 5 (Gender Equality). AI can assist in identifying poverty areas using satellite imagery, but it may also create barriers by raising qualification requirements for jobs, further entrenching existing social inequalities. Additionally, AI technologies are often shaped by the values and needs of the countries that develop them, and when deployed without ethical scrutiny or democratic oversight, they can perpetuate nationalism, discrimination, and social divisions (IEA, 2017).

A concerning example of AI misuse is the development of citizen scores; these monitor social behaviour and pose threats to privacy and human rights. A lack of transparency and public awareness about how data are used and their impact on individuals' lives is a significant problem (Jean *et al*., 2016; Jones, 2018). AI's uneven distribution also exacerbates disparities, such as small farmers lacking access to advanced AI-powered agricultural tools, hindering progress on SDG 2 (Zero Hunger) (Nagano, 2018; Nagler *et al*., 2019). Finally, there is insufficient research on the gendered implications of AI technologies. AI-driven systems, such as intelligent algorithms and image recognition, may inadvertently perpetuate biases, particularly against women and minority groups, thereby undermining gender equality (SDG 5) (Norouzzadeh *et al*., 2018; NSF, 2018).

ARTIFICIAL INTELLIGENCE AND ECONOMIC OUTCOMES

Artificial Intelligence (AI) has the potential to positively influence the achievement of various SDGs in the economic sector, offering technological advantages that can improve productivity. AI benefits 42 targets (70%) of the SDGs, but it also has negative effects on 20 targets (33%). While some studies, such as those of Acemoglu and Restrepo (2018), emphasise AI's productivity gains, concerns remain about its contribution to inequality (Nunes and Jannach, 2017; Raissi *et al*., 2017; Saam and Harrer, 1999; Seo *et al*., 2015). As markets increasingly rely on data analysis, the unequal access to resources between high-income and low- and middle-income countries could worsen economic disparities (SRC, 2017; Tegmark, 2017) impacting SDGs 8 (Decent Work and Economic Growth), 9 (Industry, Innovation, and Infrastructure), and 10 (Reduced Inequalities).

Brynjolfsson and McAfee (2014) argue that AI may deepen inequality within nations by replacing low-skill jobs with those requiring higher qualifications, favouring the educated. For instance, in the US, wages for graduates have risen by 25%, while wages for high school dropouts have dropped by nearly 30%. Automation also shifts income from labour to investors. Despite similar revenues, tech companies such as Google and Apple employ far fewer workers and have much higher market values than traditional automakers (UNGA, 2015; UCOSOC, 2019; Wegren, 2018).

While AI offers potential solutions to inequality by identifying sources of disparity, its use in human behaviour predictions risks reinforcing biases. Discriminatory practices, such as biased online job ads, highlight the need for better data preparation and more equitable AI algorithms. Although AI shows promise in addressing inequality, careful implementation is crucial to avoid exacerbating existing challenges.

ARTIFICIAL INTELLIGENCE AND ENVIRONMENTAL OUTCOMES

The final set of SDGs focuses on environmental sustainability, comprising goals related to climate action, marine life, and terrestrial ecosystems (SDGs 13, 14, and 15). In this context, AI plays a pivotal role in enabling progress, with 25 identified goals (93%) benefiting from AI's capabilities. Its strength lies in analysing vast, interconnected datasets to foster collective actions aimed at environmental preservation (Fuso Nerini *et al*., 2018; WEF, 2018a; Vinuesa *et al*., 2016).

For SDG 13 on climate action, AI advancements contribute to a deeper understanding of climate change and the modelling of its future effects. Additionally, AI aids in enhancing low-carbon energy systems by promoting the integration of renewable energy and improving energy efficiency, crucial elements for tackling climate change. AI also supports the overall health of ecosystems.

In line with SDG 14.1, which seeks to reduce marine pollution, AI proves valuable by deploying algorithms that automatically detect oil spills. Similarly, for SDG 15.3, addressing desertification and land restoration, AI techniques such as neural networks can analyse satellite imagery to monitor vegetation changes and identify desertification patterns over large areas. These technologies provide critical data for planning and managing environmental recovery.

However, AI's potential to support SDG 13 is tempered by concerns about its high energy consumption, particularly if powered by non-renewable sources. Furthermore, while AI aids biodiversity conservation, there is a risk that increased access to ecosystem data could lead to resource overexploitation, although this issue remains under-researched. These challenges will be explored in future discussions of AI's environmental impact (Keramitsoglou *et al*., 2006; Mohamadi *et al*., 2016; Kwok, 2019).

ASSESSMENT OF COLLECTED EVIDENCE ON INTERLINKAGES

A more in-depth examination of the collected data is illustrated in Figure 1 (further explained in the Methodology section). In practice, each link was evaluated by weighing the applicability and relevance of each reference to assess a particular link, which could also help uncover research gaps. Although the method for calculating evidence has a minor effect on positive outcomes (with a decrease from 79% to 71% in positively impacted goals), we see a more considerable decline in negative impacts (from 35% to 23%). This decline could stem from the fact that AI research often uses quantitative methods, which can create a bias towards positive results. Notably, there are variations across different fields such as community, economy, and environment. In the community sector, the weighted evidence shows a 5% decrease in positive goals and a 13% decrease in negative goals. Specifically, weighting evidence related to negative impacts on SDG 1 (No Poverty) and SDG 6 (Clean Water and Sanitation) leads to reductions of 43 and 35 percentage points, respectively.

In the economic sector, positive impacts decreased by 15 percentage points, while negative impacts dropped by 10 percentage points. This difference may be linked to studies on job displacement caused by AI, which address pressing policy concerns. In the environmental sector, the positive impacts decrease slightly by 8 points, while negative impacts exhibit the most significant drop (18 points), suggesting that while some negative effects of AI are possible, the evidence is not strong, making it a potential area for further investigation. The overall findings indicate that the existing research lacks analysis tailored to specific AI-related issues, highlighting several research gaps that need to be addressed, as discussed in the following section.

RESEARCH GAPS ON THE ROLE OF ARTIFICIAL INTELLIGENCE IN SUSTAINABLE DEVELOPMENT

Significant research gaps remain regarding the role of artificial intelligence (AI) in advancing the SDGs. As AI is increasingly integrated into critical sectors, from autonomous transport systems (De Fauw *et al*., 2018), to healthcare diagnostics (De Fauw *et al*., 2018), and smart energy infrastructure (Fuso Nerini *et al*., 2018), the urgency to invest in AI safety research grows. These systems must be robust and secure to avoid failures or cyberattacks (Russell *et al*., 2015). A crucial area of research is understanding catastrophic risks associated with systemic AI malfunctions, especially as emphasised by concerns raised in the financial sector by the World Economic Forum (WEF, 2018b).

Many studies highlight the potential of AI in enabling SDG targets, but much of this research is limited to prototype testing, small datasets, or laboratory environments (Gandhi *et al*., 2017; Esteva *et al*., 2017; Cao *et al*., 2014), limiting its applicability in real-world contexts. Given the evolving nature of society and technological landscapes, a mismatch can arise between AI's design assumptions and actual implementation environments. Moreover, few studies address how resilient societies are to AI-driven changes, indicating a need for new methodologies that assess AI impacts ethically, efficiently, and sustainably before scaling up. Combined human-machine analysis methods are also recommended to identify causes of AI failures and ensure accountability (Nushi *et al*., 2018).

Despite the growing literature on AI's benefits for SDGs, there is a risk of publication bias favouring positive outcomes. This is especially noticeable in environmental SDGs, for instance, algorithms may suggest optimal marine conservation zones, yet overlook long-term social impacts such as equity (Beyer *et al*., 2016). Furthermore, profit-driven priorities may lead to underfunding AI projects aimed at less commercially lucrative SDGs, contributing to inequality (Whittaker *et al*., 2018). This highlights the necessity of assessing the societal, legal, ethical, and environmental impacts of AI technologies.

Current AI research often focuses on predictive analytics, such as extreme weather forecasting or criminal behaviour prediction. However, governments face barriers in adopting such tools, including cybersecurity risks and privacy concerns that intersect with fundamental human rights . Overcoming these barriers is essential to ensure AI technologies are practical, ethical, and unbiased in public governance.

Finally, the distribution of AI applications is skewed towards wealthier nations where AI research is concentrated. In contrast, low-income regions see limited AI integration into SDG strategies. When technologies are not tailored to local needs, they risk widening inequalities. Therefore, AI solutions should be developed with cultural and regional awareness, ensuring they are equitable and context appropriate.

TOWARDS SUSTAINABLE AI

Artificial intelligence (AI) holds the potential to generate immense wealth, but this prosperity may disproportionately benefit already privileged, educated populations, while others may face job displacement and worsening inequality. Globally, disparities in access to education and computing infrastructure risk amplifying these inequalities. Additionally, biases in training data may reinforce and magnify existing societal prejudices, increasing discrimination. Another concern is the manipulation of public opinion through AI-generated propaganda, or "big nudging", where autonomous AI agents use vast datasets to promote political or commercial agendas via social media, contributing to polarisation (Petit, 2018).

Although current studies dispute the idea that technology alone determines the spread of misinformation (Petit, 2018), the long-term societal impacts of AI remain under-studied due to limited research methodologies. A new approach is needed, one that encourages collaboration and curbs the misuse of AI for controlling public behaviour. Finance 4.0 is one such proposed model (ECOSOC, 2019), envisioning a multi-currency system that supports the circular economy and societal values. Central to this is "informational self-determination" that allows individuals to control how their data is used (Scholz *et al*., 2018).

The data-hungry nature of AI algorithms also raises privacy concerns, especially in sensitive domains such as healthcare. While extensive personal health data can support advanced diagnostic tools, issues of data ownership and privacy must be addressed through strong policy frameworks (Panch *et al*., 2019). These concerns feed into debates over the legal status of AI and robots, prompting fears of emerging technological authoritarianism (Ramirez *et al*., 2014; Solaiman, 2017).

This situation stems from an imbalance between technological growth and the capacity of individuals, governments, and the environment to adapt. Current regulatory systems lag behind AI advancements, lacking the legal infrastructure needed to guide sustainable development. To reverse this, it is vital to create informed legislation that aligns AI with public and environmental well-being. Regulatory foresight, deep understanding of AI implications, must come before regulatory action to avoid ineffective or harmful policies.

LIMITATIONS OF THE STUDY

The analysis presented reflects the authors' viewpoint, acknowledging that some literature on the impact of AI on specific SDG targets may have been overlooked, or that no evidence has been published yet regarding these connections. The methods employed aimed to reduce subjectivity, with multiple authors evaluating the effects of AI on each SDG target. Several studies were reviewed for each linkage, and discussions among a subset of authors led to a consensus on their nature. The study primarily focuses on the SDGs that offer a comprehensive framework for sustainable development, surpassing the Millennium Development Goals by addressing human rights, social sustainability, environmental outcomes, and economic development. However, the SDGs represent a political compromise and may not fully capture all complex dynamics and interlinkages. As such, the SDGs should be considered alongside other international agreements, such as the United Nations Universal Declaration of Human Rights, to ensure a more holistic approach to global sustainability.

REFERENCES

Acemoglu, D. and Restrepo, P. (2018): Artificial Intelligence, Automation, and Work. *NBER Working Paper No. 24196*. National Bureau of Economic Research. Available at: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3101994

Adeli, H. and Jiang, X. (2008): *Intelligent Infrastructure: Neural Networks, Wavelets, and Chaos Theory for Intelligent Transportation Systems and Smart Structures*. Boca Raton: CRC Press.

Beyer, H.L., Dujardin, Y., Watts, M.E. and Possingham, H.P. (2016): Solving conservation planning problems with integer linear programming. *Ecological Modelling*, Vol. 328, pp.14-22.

Bissio, R. (2018): Vector of hope, source of fear. In *Spotlight on Sustainable Development 2018: Exploring new Policy Pathways* (pp.77-86). Report by the Civil Society Reflection Group on the 2030 Agenda for Sustainable Development. Available at: https://www.2030spotlight.org/sites/default/files/spot2018/Spotlight_2018_web.pdf. 167pp.

Bolukbasi, T., Chang, K.-W., Zou, J., Saligrama, V. and Kalai, A. (2016): Man is to computer programmer as woman is to homemaker? Debiasing word embeddings. *Advances in Neural Information Processing Systems*, Vol. 29, pp.4349-4357.

Brynjolfsson, E. and McAfee, A. (2014): *The Second Machine Age: Work, Progress, and Prosperity in a Time of Brilliant Technologies*. New York: W. W. Norton & Company.

Butler, A.J., Thomas, M.K. and Pintar, K.D.M. (2015): Systematic review of expert elicitation methods as a tool for source attribution of enteric illness. *Foodborne Pathogens and Disease*, Vol. 12, No. 5, pp.367-382.

Cao, Y., Li, Y., Coleman, S., Belatreche, A. and McGinnity, T.M. (2014): Detecting price manipulation in the financial market. In *2014 IEEE Conference on Computational Intelligence for Financial Engineering & Economics (CIFEr) (pp.77-84)*. Available at: https://doi.org/10.1109/cifer.2014.6924057.

Cockburn, I., Henderson, R. and Stern, S. (2018): The Impact of Artificial Intelligence on Innovation. *NBER Working Paper No. 24449*. National Bureau of Economic Research. Available at: https://doi.org/10.3386/w24449 :contentReference[oaicite:29]{index=29}

Courtland, R. (2018): Bias detectives: the researchers striving to make algorithms fair. *Nature*, Vol. 558, No. 7710, pp.357-360.

Dalenberg, D.J. (2018): Preventing discrimination in the automated targeting of job advertisements. *Computer Law & Security Review*, Vol. 34, No. 3, pp.615-627.

De Fauw, J., Ledsam, J.R., Romera-Paredes, B., Nikolov, S., Tomasev, N., Blackwell, S., Askham, H., Glorot, X., O'Donoghue, B., Visentin, D. and Van Den Driessche, G. (2018): Clinically applicable deep learning for diagnosis and referral in retinal disease. *Nature Medicine*, Vol. 24, No. 9, pp.1342-1350.

Dobbs, R., Madgavkar, A., Manyika, J., Woetzel, J., Bughin, J., Labaye, E. and Kashyap, P. (2016): *Poorer Than Their Parents? Flat or Falling Incomes in Advanced Economies*. McKinsey Global Institute.

Esteva, A., Kuprel, B., Novoa, R.A., Ko, J., Swetter, S.M., Blau, H.M. and Thrun, S. (2017): Corrigendum: dermatologist-level classification of skin cancer with deep neural networks. *Nature*, Vol. 546, No. 7660, p.686.

Francescato, D. (2018): Globalization, artificial intelligence, social networks and political polarization: new challenges for community psychologists. *Community Psychology in Global Perspective*, Vol. 4, No. 1, pp.20-41.

Fuso Nerini, F., Hughes, N., Cozzi, L., Cosgrave, E., Howells, M., Sovacool, B. and Milligan, B. (2018): Shore up support for climate action using SDGs. *Nature*, Vol. 557, No. 7703, p.31. Available at: https://doi.org/10.1038/d41586-018-05007-1

Fuso Nerini, F., Sovacool, B., Hughes, N., Cozzi, L., Cosgrave, E., Howells, M., Tavoni, M., Tomei, J., Zerriffi, H. and Milligan, B. (2019a): Connecting climate action with other Sustainable Development Goals. *Nature Sustainability*, Vol. 2, No. 8, pp.674-680. Available at: https://doi.org/10.1038/s41893-019-0334-y

Fuso Nerini, F., Slob, A., Ericsdotter Engström, R. and Trutnevyte, E (2019b): A research and innovation agenda for zero-emission European cities. *Sustainability*, Vol. 11, No. 6, p.1692. Available at: https://doi.org/10.3390/su11061692

Fuso Nerini, F., Tomei, J., To, L.S., Bisaga, I., Parikh, P., Black, M., Borrion, A., Spataru, C., Castán Broto, V., Anandarajah, G. and Milligan, B. (2017): Mapping synergies and trade-offs between energy and the Sustainable Development Goals. *Nature Energy*, Vol. 3, No. 1, pp.10-15. Available at: https://doi.org/10.1038/s41560-017-0036-5

Gandhi, N., Armstrong, L.J. and Nandawadekar, M. (2017): Application of data mining techniques for predicting rice crop yield in semi-arid climatic zone of India. In *2017 IEEE Technological Innovations in ICT for Agriculture and Rural Development (TIAR) (pp.116-120)*. Available at: https://doi.org/10.1109/tiar.2017.8273697.

Helbing, D. (2015): *The Automation of Society is Next: How to Survive the Digital Revolution; Version 1.0*. North Charleston: CreateSpace.

Helbing, D. and Pournaras, E. (2015): Society: build digital democracy. *Nature*, Vol. 527, No. 7576, pp.33-34.

Helbing, D., Frey, B.S., Gigerenzer, G., Hafen, E., Hagner, M., Hofstetter, Y., van den Hoven, J., Zicari, R.V. and Zwitter, A. (2019): Towards Digital Enlightenment. In Helbing, D. (Ed.): *Towards Digital Enlightenment: Essays on the dark and light sides of the digital revolution* (pp.73-98). Cham: Springer International Publishing. Available at: https://doi.org/10.1007/978-3-319-90869-4_7

International Energy Agency (IEA) (2017): *Digitalization & Energy*. Paris: International Energy Agency. Available at: https://www.iea.org/reports/digitalisation-and-energy

Jean, N., Burke, M., Xie, M., Alampay Davis, W.M., Lobell, D.B. and Ermon, S. (2016): Combining satellite imagery and machine learning to predict poverty. *Science*, Vol. 353, No. 6301, pp.790-794.

Jones, N. (2018): How to stop data centres from gobbling up the world's electricity. *Nature*, Vol. 561, 7722, pp.163-166.

Karnama, A., Haghighi, E.B. and Vinuesa, R. (2019): Organic data centers: A sustainable solution for computing facilities. *Results in Engineering*, Vol. 4, p.100063.

Keramitsoglou, I., Cartalis, C. and Kiranoudis, C.T. (2006): Automatic identification of oil spills on satellite images. *Environmental Modelling & Software*, Vol. 21, No. 5, pp.640-652.

Kwok, R. (2019): AI empowers conservation biology. *Nature*, Vol. 567, No. 7746, pp.133-134.

Mohamadi, A., Heidarizadi, Z. and Nourollahi, H. (2016): Assessing the desertification trend using neural network classification and object-oriented techniques. *Journal of Faculty of Forestry Istanbul University*, Vol. 66, No. 2, pp.683-690.

Morgan, M.G. (2014): Use (and abuse) of expert elicitation in support of decision making for public policy. *Proceedings of the National Academy of Sciences*, Vol. 111, No. 20, pp.7176-7184.

Nagano, A. (2018): Economic growth and automation risks in developing countries due to the transition toward digital modernity. In *Proceedings of the 11th International Conference on Theory and Practice of Electronic Governance (ICEGOV '18)* (pp.42-50). Available at: https://doi.org/10.1145/3209415.3209442

Nagler, J., van den Hoven, J. and Helbing, D. (2019): An Extension of Asimov's Robotics Laws. In Helbing, D. (Ed.): *Towards Digital Enlightenment: Essays on the dark and light sides of the digital revolution* (pp.41-46). Cham: Springer International Publishing. Available at: https://doi.org/10.1007/978-3-319-90869-4_5

National Science Foundation (NSF) (2018): *Women and Minorities in the S&E Workforce*. Arlington: National Science Foundation. Available at: https://www.nsf.gov/statistics/2018/nsb20181/report/sections/science-and-engineering-labor-force/women-and-minorities-in-the-s-e-workforce

Norouzzadeh, M.S., Nguyen, A., Kosmala, M., Swanson, A., Palmer, M.S., Packer, C. and Clune, J. (2018): Automatically identifying, counting, and describing wild animals in camera-trap images with deep learning. *Proceedings of the National Academy of Sciences*, Vol. 115, No. 25, pp.e5716-e5725.

Nunes, I. and Jannach, D. (2017): A systematic review and taxonomy of explanations in decision support and recommender systems. *User Modeling and User-Adapted Interaction*, Vol. 27, pp.393-444.

Nushi, B., Kamar, E. and Horvitz, E. (2018): Towards accountable AI: hybrid human-machine analyses for characterizing system failure. In *Proceedings of the AAAI Conference on Human Computation and Crowdsourcing* (Vol. 6, pp.126-135).

Panch, T., Mattie, H. and Celi, L.A. (2019): The "inconvenient truth" about AI in healthcare. *NPJ Digital Medicine*, Vol. 2, No. 1, p.77.

Petit, M. (2018): Towards a critique of algorithmic reason. A state-of-the-art review of artificial intelligence, its influence on politics and its regulation. *Quaderns del CAC*, Vol. 44.

Raissi, M., Perdikaris, P. and Karniadakis, G.E. (2017): Physics informed deep learning (part I): data-driven solutions of nonlinear partial differential equations. *arXiv preprint*, arXiv:1711.10561.

Ramirez, E., Brill, J., Ohlhausen, M.K., Wright, J.D. and McSweeny, T. (2014): *Data Brokers: A Call for Transparency and Accountability*. Federal Trade Commission. Available at: https://www.ftc.gov/system/files/documents/reports/data-brokers-call-transparency-accountability-report-federal-trade-commission-may-2014/140527databrokerreport.pdf

Russell, S., Dewey, D. and Tegmark, M. (2015): Research priorities for robust and beneficial artificial intelligence. *AI Magazine*, Vol. 34, No. 4, pp.105-114.

Saam, N.J. and Harrer, A. (1999): Simulating norms, social inequality, and functional change in artificial societies. *Journal of Artificial Societies and Social Simulation*, Vol. 2, No. 1, p.2.

Scholz, R., Bartelsman, E.J., Diefenbach, S., Franke, L., Grunwald, A., Helbing, D., Hill, R., Hilty, L., Höjer, M., Klauser, S. and Montag, C. (2018): Unintended side effects of the digital transition: European scientists' messages from a proposition-based expert round table. *Sustainability*, Vol. 10, No. 6, p.2001.

Seo, Y., Kim, S., Kisi, O. and Singh, V.P. (2015): Daily water level forecasting using wavelet decomposition and artificial intelligence techniques. *Journal of Hydrology*, Vol. 520, pp.224-243.

Solaiman, S.M. (2017): Legal personality of robots, corporations, idols and chimpanzees: a quest for legitimacy. *Artificial Intelligence and Law*, Vol. 25, pp.155-179.

Stockholm Resilience Centre (SRC) (2017): *Stockholm Resilience Centre's Contribution to the 2016 Swedish 2030 Agenda HLPF Report*. Stockholm: Stockholm University.

Tegmark, M. (2017): *Life 3.0: Being Human in the Age of Artificial Intelligence*. New York: Random House Audio Publishing Group.

UN General Assembly (2015): Transforming our world: the 2030 Agenda for Sustainable Development. *Resolution A/RES/70/1*, Vol. 25, pp.1-35.

United Nations Economic and Social Council (ECOSOC) (2019): *Special edition: progress towards the Sustainable Development Goals*. Special Report of the Secretary-General. New York: United Nations Economic and Social Council. Available at: https://docs.un.org/en/E/2019/68

Vinuesa, R., Azizpour, H., Leite, I., Balaam, M., Dignum, V., Domisch, S., Felländer, A., Langhans, S.D., Tegmark, M. and Fuso Nerini, F. (2020): The role of artificial intelligence in achieving the Sustainable Development Goals. *Nature Communications*, Vol. 11, No. 1, p.233. Available at: https://doi.org/10.1038/s41467-019-14108-y

Vinuesa, R., Luna, M. and Cachafeiro, H. (2016): Simulations and experiments of heat loss from a parabolic trough absorber tube over a range of pressures and gas compositions in the vacuum chamber. *Journal of Renewable and Sustainable Energy*, Vol. 8, No. 2.

Wegren, S.K. (2018): The "left behind": smallholders in contemporary Russian agriculture. *Journal of Agrarian Change*, Vol. 18, No. 4, pp.913-925.

Whittaker, M., Crawford, K., Dobbe, R., Fried, G., Kaziunas, E., Mathur, V., Myers West, S., Richardson, R., Schultz, J. and Schwartz, O. (2018): *AI Now Report 2018*. AI Now Institute. Available at: https://ainowinstitute.org/wp-content/uploads/2023/04/AI_Now_2018_Report.pdf 62pp.

World Economic Forum (WEF) (2018a): *Fourth Industrial Revolution for the Earth Series: Harnessing Artificial Intelligence for the Earth*. World Economic Forum.

World Economic Forum (WEF) (2018b): *The New Physics of Financial Services – How Artificial Intelligence is Transforming the Financial Ecosystem*. World Economic Forum.

BIOGRAPHY

Dr Muawya Ahmed Hussein received a PhD in Economics (2018). He is an assistant professor of Economics in the Department of Finance and Economics at Dhofar University, Oman. His research interests include economic development, environmental economics, economics of education, and financial economics. Dr Hussein has published many papers in reputable journals, which were indexed in Web of Science and Scopus. He has also served as a reviewer for many well-reputed journals and conferences. He was the chair of the Department of Accounting and Finance at Dhofar University. Moreover, he was appointed as the Convener of the Master of Management programme 2019-2022.

Dr Hanaa Mahmoud Sid Ahmed earned her PhD in Economics (2006). She is currently an assistant professor in the College of Economics and Business Administration at the University of Technology and Applied Sciences in Oman. Her research interests include economic development and environmental economics. Dr Sid Ahmed has published numerous papers in reputable journals indexed in Scopus. Additionally, she has served as a reviewer for various respected conferences and has contributed as a reviewer for several well-regarded journals. She was head of the research department in the college until 2018.