After COVID-19: Crises, Ethics, and Socio-Technical Change

***Abstract*—Crises like the COVID-19 pandemic accelerate social and technological changes and put new political and public demands on science, technology, and innovation systems. Their urgency clashes with the deliberate slowness of existing responsible innovation and technology ethics practices and processes, while many fast and ad-hoc changes and infrastructures brought about during a crisis become permanent fixtures. This special issue brings together work reflecting in different ways how COVID-19 as an exemplary crisis is creating new challenges for technology ethics. From epidemiological models to contact tracing, biometric recognition, and machine learning-based assisted diagnosis, the different articles show the quandaries of our increasingly datafied health systems.**

***Index Terms*—COVID-19, crisis, datafication, responsible innovation, responsible modelling, technology ethics.**

I. Introduction

As THE COVID-19 pandemic has shown, crises can catalyze socio-technical changes at a speed and scale otherwise thought impossible. They test and expose the fragility or resilience of our sociotechnical systems – from healthcare to financial markets, Internet connectivity, or the fabric of local communities. Their urgent peril can allow governments and other political actors to rapidly enact interventions thought impossible before, such as states across the globe rolling out lockdowns or digital contact tracing applications. Crises can accelerate technological trends like the virtualization of work, commerce, education, and communing, and dramatically reshape markets, threatening economic incumbents and creating new opportunities for innovation and profiteering alike. Thus, we have been seeing physical retailers and entertainment venues defaulting, while online retail and streaming companies thrived and stores, artists, and manufacturers desperately trialed new digitally enabled services and new forms of financing, production, and delivery. Technology companies and scientists have been rapidly developing new technologies to respond to the pandemic, from 3D-printing medical devices to data and AI-driven symptom tracking and immunity certification, while struggling to counter tides of unvetted, potentially harmful medical advice, opinion, and cures.

In parallel, ongoing crises like COVID-19 often dramatically reshape political and public demands on science. Standard forms of scientific inquiry, responsible innovation, and technology ethics emphasize slowness, deliberation, critique, long-term anticipation and preparedness, and systematic accumulation and vetting of evidence. In contrast, in periods of crisis, policy-makers and media publics desire concrete, real-time decision guidance and interventions from researchers. During the COVID-19 pandemic, this has led some researchers to suggest their own discipline may not be 'crisis-ready' [1]. It has generated new amounts of media and public attention for science. In a twist on Campbell's law [2], the more a quantitative social indicator (like intensive care bed occupation rates, R values, or population incidence rates) was used for political decision making, the more subject it became to media coverage and public debate. This new public attention to science sometimes took the form of select scientists becoming celebrity and public intellectuals, finding themselves subject to intense public scrutiny and attack, for which standard science communication playbooks have no script.

Beyond changing demands, COVID-19 also showed how crises produce strong internal and external forces driving change of science systems world-wide – from vast rapid-response funds to new digital infrastructures designed to accelerate information sharing and aggregation, to changes in publication cultures. Many of these, again, rubbed against prevailing norms, conceptions, and practices of rigor, peer review, and due diligence, and all of them exposed the various degrees of fragility and resilience of the science system itself.

Importantly, many of the dramatic and sudden adaptations to a crisis are bound to stay. "After 9/11" has become a marker for a new epoch of pervasive socio-technical regimes of surveillance that were considered exceptional and temporary when introduced [3]. Similarly, many of today's ad-hoc responses will become historical path dependencies for a new era "after COVID-19".

Catalyzing rapid change; reshaping demands on science, technology, and their regulation; locking in future socio-technical regimes: All these factors make it crucial for researchers and technologists to consider the societal impacts of new technologies and socio-technical changes that respond to COVID-19. But they also invite us to better understand how crises impact socio-technical change, and how we can develop forms of science and technology ethics and regulation that fit the needs and demands of crises. To this end, this special issue aims to bring together researchers from different disciplines exploring the intersections of technology, ethics, and COVID-19 as an exemplary crisis.

II. In This Special Issue

When we planned this special issue early in 2020, COVID-19 was just starting. We knew that it would trigger many sociotechnical changes, but the scale surprised everyone. Many of us got ill and suffered through the recovery, many

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lost people they loved to COVID-19. But many also sought opportunities for positive change and are still finding some silver linings in the pandemic. Some of these are amongst the 19 research groups who submitted a paper to our special issue (of which we accepted 7).

Apart from vaccines, arguably few other scientific outputs impacted people's lives during the COVID-19 pandemic as much and were as hotly publicly debated as epidemiological models. As Nabavi [A1] shows in their review article, the failures and uses of epidemiological COVID-19 models showcased many issues long discussed in science and technology studies, often resulting in 'evidence-making' for policies while hiding their inherent uncertainties and foreclosing broader public debate. In response, Nabavi articulates a research agenda for *responsible modelling*, unpacking science-policy interactions, how to engage publics in modelling work, its uncertainty and boundary parameters, create more integrative modelling approaches – and unpacking what 'responsible' can mean beyond a vague appeal to public good.

Most submissions focused on legal and ethical ramifications of new regimes of large-scale data collection, data transfer, and automated, data-based decision-making put in place during COVID-19. Thus, Rizou et al. [A2] highlight and work through privacy law impacts of new large-scale cross-border data flows under the European General Data Protection Regulation (GDPR), particularly health data being exchanged between researchers and potentially used for automated decision-making.

In a similar vein, Allahabadi et al. [A3] applied the general European Union's High-Level Expert Group's (EU HLEG) guidelines for trustworthy AI to evaluate the trustworthiness of a concrete multiregional AI system in Italy developed to help radiologists assess the degree of lung compromise in COVID-19 patients. Limited time and resource to properly deploy, validate clinical efficacy, and ensure privacy, transparency, and stakeholder involvement were but some trustworthiness issues they found exacerbated by the pandemic. The team concluded that the Z-Inspection method they used may hold value for similar ethics-based assessment of AI systems.

Where Zicari and colleagues studied trustworthiness, Hohma et al. [A4] explored another important ethical principle involved in a technology widely deployed and discussed during COVID-19, namely the user-perceived fairness of contact tracing apps. Using an online vignette study, they tested which contact tracing and machine learning (ML)-based decision-making system regarding self-isolation people perceived as fairer: one featuring high individualisation (requiring more individual data to make personalised recommendations), or one featuring low individualisation (requiring less data and treating everyone sorted into the self-isolation category equally). People viewed the highly individualized version as fairer, and fairness correlated with an overall positive evaluation of the system.

Next to studies focusing legal and ethical principles, a second set of submissions explored socio-technical challenges and possible solutions that arose with COVID-19 and are likely to stay with us. One such challenge has been the rise of misinformation spread on social media by groups undermining governments' public health approaches and campaigns, from the use of masks to vaccination. Technology companies and governments have struggled to find ethical approaches to moderate these misinformation campaigns that are effective and safeguard free public debate. One promising starting point is the fact that disinformation campaigns often originate with a very small number of actors, inviting social media monitoring. Along these lines, Sufi et al. [A5] developed and tested ethical techniques for identifying and tracking Anti-Vax and Pro-Vax groups across Twitter in 2021.

Another socio-technical challenge likely to re-emerge under future pandemics is that public health measures like face masks or avoiding touching public surfaces can interfere with increasingly widespread biometric systems working on face, fingerprint, or voice recognition. Gomez-Barrero et al. [A6] reviewed the literature concerning these challenges, which finds face and fingerprint recognition most affected by the pandemic. They outline emerging technologies (such as touchless fingerprint recognition) that are worthwhile intensified work in preparation for the next pandemic.

Amongst the most affected area of daily life were traveling and mobility. In the past, people might have chosen travel routes based on cost or time; today, we be more sensitive to health risks of each possible route. This motivated Pilato et al. [A7] to study new approaches to orienteering, or itinerary planning, using social sensing. Using a large-scale open dataset, they created a modular social sensing system for personalized itinerary planning, taking into account how crowded places are.

III. Conclusion

If there is one watchword connecting the different contributions in this issue, it is data – how it informs policy (via epidemiological models) and medical decision-making (in self-isolation guidance or medical diagnostics), flows across borders, can support health-conscious navigation or misinformation monitoring, but also how public health measures may limit access to and reliability of the very data they so often, today, rely upon. Data dashboards of infection cases and deaths like that of the Johns Hopkins Coronavirus Resource Center were the earliest and possibly most ubiquitous imagery of the pandemic. But as each of the pieces collected in this issue demonstrate, underneath that imagery, COVID-19 also showcased and accelerated the datafication of health [4], [5], [6]. And we hope they contribute to the much-needed broader debate about the political and ethical ramifications of this datafication, and how to responsibly prepare our datafied health systems for future pandemics.

Appendix: Related Articles

[A1] E. Nabavi, "Computing and modeling after COVID-19: More responsible, less technical," *IEEE Trans. Technol. Soc.*, vol. 3, no. 4, pp. 252–261, Dec. 2022.

[A2] S. Rizou, E. Alexandropoulou-Egyptiadou, and K. E. Psannis, "Covid-19 impacts in the new technological era: Cross-border privacy issues with emphasis on AI," *IEEE Trans. Technol. Soc.*, vol. 3, no. 4, pp. 262–271, Dec. 2022.

[A3] H. Allahabadi et al., "Assessing trustworthy AI in times of COVID-19. Deep learning for predicting a multiregional score conveying the degree of lung compromise in COVID-19 patients," *IEEE Trans. Technol. Soc.*, vol. 3, no. 4, pp. 272–289, Dec. 2022.

[A4] E. Hohma, R. Burnell, C. C. Corrigan, and C. Luetge, "Individuality and fairness in public health surveillance technology: A survey of user perceptions in contact tracing apps," *IEEE Trans. Technol. Soc.*, vol. 3, no. 4, pp. 300–306, Dec. 2022.
[A5] F. K. Sufi, I. Razzak, and I. Khalil, "Tracking anti-vax social movement using AI-based social media monitoring," *IEEE Trans. Technol. Soc.*, vol. 3, no. 4, pp. 290–299, Dec. 2022.
[A6] M. Gomez-Barrero et al., "Biometrics in the era of COVID-19: Challenges and opportunities," *IEEE Trans. Technol. Soc.*, vol. 3, no. 4, pp. 307–322, Dec. 2022.
[A7] G. Pilato, F. Persia, M. Ge, and D. DAuria, "Social sensing for personalized orienteering mediating the need for sociality and the risk of COVID-19," *IEEE Trans. Technol. Soc.*, vol. 3, no. 4, pp. 323–332, Dec. 2022.

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[2] M. Poku, "Campbell's law: Implications for health care," *J. Health Services Res. Policy*, vol. 21, no. 2, pp. 137–139, 2015, doi: 10.1177/135581961559377.
[3] D. Lyon, *Surveillance After September 11*. London, U.K.: Polity Press, 2003.
[4] S. Flensburg and S. Lomborg, "Datafication research: Mapping the field for a future agenda," *New Media Soc.*, to be published, doi: 10.1177/14614448211046616.
[5] K. Hoeyer, S. Bauer, and M. Pickersgill, "Datafication and accountability in public health: Introduction to a special issue," *Soc. Stud. Sci.*, vol. 49, no. 4, pp. 459–475, 2019, doi: 10.1177/0306312719860202.
[6] M. Ruckenstein and N. Dow Schüll, "The datafication of health," *Ann. Rev. Anthropol.*, vol. 46, Oct. 2017, pp. 261–278, doi: 10.1146/annurev-anthro-102116-041244.

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