OPCW Technical Secretariat

S/2444/2025
17 September 2025
ENGLISH only

NOTE BY THE TECHNICAL SECRETARIAT

WORKSHOP ON ARTIFICIAL INTELLIGENCE AND CHEMICAL SAFETY AND SECURITY MANAGEMENT: OUTCOMES AND KEY FINDINGS

INTRODUCTION

1. The Technical Secretariat of the OPCW (the Secretariat) and China co-organised a workshop on artificial intelligence (AI) and chemical safety and security management from 17 to 20 June 2025 in Shanghai, China. The theme of the AI workshop was "AI for Good and for All: Enhancing the Role of Artificial Intelligence in the Implementation of the Chemical Weapons Convention". The workshop explored both the opportunities and risks associated with AI in the context of chemical safety and security and the implementation of the Chemical Weapons Convention (the Convention).

BACKGROUND

2. The rapid advancement of AI is reshaping the scientific and industrial landscape, including in the field of chemistry. AI is enhancing the efficiency of chemical synthesis and forensics, toxicity prediction, and risk assessment, driving the digital transformation of the chemical industry, and increasing the potential for enhanced verification capabilities by enabling adaptive approaches to detect and deter chemical weapons proliferation. These developments present opportunities to promote the objectives of the Convention. At the same time, concerns over the misuse of AI, such as for the development of new toxic substances, threats to chemical facility operations through cyberattacks, and the malicious use of automated weapon systems, pose new security risks.

3. The development of AI as an enabling technology has been monitored by the OPCW through the Scientific Advisory Board (SAB) for more than a decade. Recently, with the increasingly widespread adoption of AI technology, the SAB has broadened its focus to include applications in related fields, such as biotechnology and drones. In parallel, the Secretariat has placed an increasing emphasis on AI to better understand its potential implications for the work of the Organisation, as well as to identify opportunities for its integration into OPCW workflows. A number of activities have been undertaken—and continue to be pursued—in support of these efforts.

4. In April 2024, the Director-General convened an initial meeting of experts to deepen understanding of AI and its impact on the chemical sciences, as well as science and technology more broadly. Shortly thereafter, in June, the Director-General delivered the keynote address at the "Artificial Intelligence and Weapons of Mass Destruction" conference in Berlin, Germany, organised by the German Federal Foreign

Office. Subsequently, the Secretariat launched the OPCW AI Research Challenge,[1] focusing on identifying approaches to leverage AI to benefit the work of the Organisation. These initial discussions, initiatives, and scoping efforts culminated in the pioneering "Global Conference on the Role of Artificial Intelligence in Advancing the Implementation of the Chemical Weapons Convention", co-hosted by Morocco and the Secretariat in October 2024 in Rabat. The Global Conference explored the opportunities and risks that the technology poses to the Convention and the work of the OPCW. It highlighted the importance of ensuring that the benefits of AI are accessible to all regions, as well as the need to harness its potential to strengthen the capabilities of developing States Parties in implementing the Convention. Building on the momentum of these events, the SAB Temporary Working Group (TWG) on AI was established and began its mandate on 1 January 2025. The work of the TWG will provide a solid foundation for States Parties to consider the decisions that need to be made to keep pace with this technology and ensure that both the OPCW and the Convention remain fit for purpose. In addition, in recognition of the growing need to ensure the safe and responsible use of AI within the framework of the Convention, the Secretariat launched a pilot capacity-building project focusing on the various applications of AI in chemical safety and security management.

Workshop on Artificial Intelligence and Chemical Safety and Security Management

5. The workshop, co-organised with China, aimed to raise awareness among States Parties about the transformative impact that AI is having on the chemical domain and the implementation of the Convention. Its primary objectives were to promote responsible innovation, foster international cooperation, and contribute to the safe, ethical, and peaceful use of AI technologies in the field of chemistry for the benefit of all States Parties. The workshop sessions covered four key areas, namely:

   (a) the development of AI technologies and emerging models of AI governance;

   (b) the impact of AI on chemistry and chemical research;

   (c) the transformation of the chemical industry through AI-driven innovations that enhance production efficiency and safety practices; and

   (d) the opportunities and challenges AI presents for the implementation of the Convention.

6. The workshop also addressed cross-cutting issues, including the potential misuse of advanced technologies for malicious activities.

PROCEEDINGS AND KEY FINDINGS

7. A total of 39 participants from 28 States Parties participated in the four-day workshop, which included 13 presentations, two site visits, and a group discussion. Twelve experts from industry and scientific, academic, and research institutions, in addition to the United Nations, shared their experience and expertise with the participants.

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1 See S/2301/2024 (dated 4 July 2024).

8. The programme was designed to highlight the development of AI technology in the chemical sciences and the evolving global governance landscape via expert presentations, using as examples best practices and regulatory approaches in China. The discussions delved into the practical applications of AI in chemical research and industry, emphasising opportunities for improving safety and operational standards. Finally, the workshop explored how AI can be harnessed to strengthen chemical security management, prevent the illicit transfer of chemicals, and facilitate international cooperation essential to the effective implementation of the Convention.

AI governance

9. The presentations under the theme of AI governance provided an overview of current AI technologies, different stages of their progression over the last couple of years, and associated governance challenges. National, regional, and global AI governance efforts are aimed at minimising the risks associated with AI development while not hampering technological progress. Associated sessions highlighted the need for a coherent approach to governance that balances innovation and societal safeguards. China's prevailing AI governance system was presented as a case study, with insights into how regulatory frameworks can shape responsible AI deployment at municipal and national levels. The rate and speed of AI development requires a public policy approach that is broad, much more agile, and responsive to the ongoing interconnected developments. The ensuing discussions under this theme reflected concerns over different governance approaches to AI, the handling of data privacy, the risks of AI malfunction, and the widening technology divide.

AI in chemical research

10. The presentations under the theme of AI in chemical research underscored the transformative potential of AI in accelerating scientific discovery. This includes insight into how AI developments can facilitate the automation of laboratories, create smart controls, and process large sets of data. Large language models can be used in the prediction and analysis of chemical reactions and synthesis pathways, in particular via the analysis of associated spectroscopic data. AI can assist in laboratory experiments by supporting real-time decision-making and automation of operational tasks, thereby enhancing the efficiency and accuracy of experimental workflows. A range of current AI applications in chemical research were presented, with examples of its use in retrosynthesis, prediction of unknown properties, molecular design, and automated chemical laboratories. To provide a practical view, the role of AI in transforming the pharmaceutical industry was showcased, with examples of how AI can augment drug discovery as well as assist in clinical studies. The presentations were accompanied by a demonstration of an online AI tool that can chart synthetic pathways of known and unknown chemical compounds.

AI in chemical industry

11. This theme explored the potential for the integration of AI across various work streams of the chemical industry, from research and development, to production optimisation, to administrative and customer service functions. While there are some immediate benefits, such as in areas of research and development, the full extent of the impact of AI on chemical industry has yet to be seen. The digital transformation of chemical

industry will require more time because of the industry's inherent complexity. Ongoing and future efforts will likely include the integration of AI into the safety, surveillance, and security measures at industrial facilities. One expert showcased AI-assisted robots equipped with sensors that are able to conduct round-the-clock inspection and monitoring duties at industry sites, replacing humans or complementing their work in dangerous operations. The discussions emphasised that digitalisation is not a one-size-fits-all strategy to improve productivity in the industry, and there is a need for a bottom-up approach to digital transformation and addressing concerns about human job security.

AI in chemical security and counterterrorism

12. This cross-cutting theme highlighted the increasingly easier access by malicious actors to emerging technologies, which has lowered the threshold of the dual use of chemicals. Available AI tools for drug discovery could also be used to create toxic chemicals or facilitate the advanced design of proteins and biotoxins, leading to increased concerns about misuse by non-State actors. These threats require robust global cooperation for building norms and regulatory frameworks. The United Nations Global Counter-Terrorism Strategy was cited as an example of a framework that provides strategies for prevention, incident response, international coordination, and capacity building to counter terrorist and non-State entities.

Convention implementation and international cooperation

13. A final round-table discussion focused on the responsible use of AI in support of the implementation of the Convention. Participants explored three key areas, namely: the challenges posed by AI to the non-proliferation of chemical weapons; the application of AI in regulating scheduled chemicals and enhancing chemical safety and security; and the leveraging of AI to promote capacity building across States Parties, especially those with developing or emerging economies. In addressing these themes, participants discussed the potential impact of AI on verification and inspection processes, recommending that the OPCW consider incorporating AI into its functions. The importance of developing and updating AI-related guidelines aligned with the Convention was also emphasised. Furthermore, the discussions highlighted the need for a harmonised approach to support chemical safety and security management efforts. To ensure equitable implementation of the Convention, participants proposed various strategies for using AI tools to facilitate knowledge transfer, skills development, and effective communication across diverse national contexts.

14. In addition, participants exchanged views on national priorities, capacity building, and the role of AI in supporting the Convention. While AI offers tools to reduce hazards and prevent incidents, addressing the risks of misuse requires cooperation and a collective response. The participants underscored the need for the OPCW to engage at the intersection of AI and the implementation of the Convention. They highlighted the Organisation's potential role in promoting the responsible and ethical use of AI among States Parties by providing technical information and capacity building. The participants called for inclusive cooperation to bridge the increasing technological divide and increased access to AI technologies in general.

15. The presentations were complemented by site visits to the Shanghai Chemical Industry Park and the University of Shanghai, during which participants had the opportunity to observe the application of AI technologies in different disciplines.

16. A proceedings document of the workshop, compiling the slides presented, summaries of the sessions, the final round-table discussion, and statements delivered will be made available on the OPCW Catalyst platform.

MAIN OUTCOMES

17. The workshop helped foster international cooperation through the exchange of expertise, site-visits by participants, the sharing of practical experience, and policy discussions on the use of AI in chemical research and its industrial applications. There were three principal outcomes.

18. First, the workshop enhanced the knowledge of participating States Parties at different levels of the AI spectrum—particularly those from developing and transitioning economies—on AI trends. It helped build an understanding of potential opportunities and associated risks, enabling them to participate more effectively in ongoing policy discussions both within their own governments and at the international level.

19. Second, the workshop examined linkages between technological advancements and the work of the OPCW on the peaceful uses of chemistry and international cooperation. This confirmed the growing interest among States Parties to deepen their understanding of the role of AI in the area of chemical safety and security management, which should be a priority area for future AI-related capacity-building efforts.

20. Finally, as the first AI-focused capacity-building programme offered by the Secretariat to States Parties, the workshop has paved the way for future capacity-building efforts in response to the growing interest in better understanding AI and its potential uses and misuses in the context of the Convention.

THE WAY FORWARD AND OTHER ONGOING EFFORTS

21. With the overall aim of providing specialised and technical capacity-building assistance to support States Parties' efforts to meet their obligations under the Convention, and recognising the growing importance of AI, the Secretariat will continue to explore options to support States Parties by incorporating relevant AI elements into the capacity-building programmes offered by its International Cooperation and Assistance Division (ICA).

22. A specialised module on the applications of AI and its potential for the peaceful uses of chemistry will be integrated into relevant ICA programmes. In addition, building on the AI workshop, the Secretariat will continue to deliver an annual capacity-building programme dedicated to AI. This annual event will serve as a flagship capacity-building platform for States Parties with developing and transitioning economies to raise their understanding and awareness of the impact of AI, facilitate the exchange of best practices in the application of AI in the context of peaceful uses of chemistry, highlight emerging technological developments, and provide updates on discussions related to AI governance, with a focus on assisting States Parties in enhancing chemical safety and security management.

23. In the area of assistance and protection, depending on the facilities and resources available, the Secretariat will endeavour to incorporate AI-assisted virtual reality and virtual simulations technologies into its capacity-building programmes for first responders and hospitals. Furthermore, the potential use of drone and AI technology will be explored for chemical emergency response training, particularly in the areas of detection, analysis, and decontamination operations.

24. To support national implementation of the Convention, the Secretariat is examining the use of AI to review national draft legislation against initial measures. To keep abreast of the AI-related trends and challenges that chemical industry faces in the context of the implementation of the Convention, a dedicated session will be included in future annual meetings of representatives of the chemical industry and National Authorities.

25. In implementing these efforts, the Secretariat is paying particular attention to ensuring that African States Parties are kept informed and benefit from ongoing initiatives, by exploring relevant activities under Africa Programme through a region-specific approach.

26. Capacity building linked with emerging technologies and AI will form a central part of the Secretariat's overall strategy to address AI. States Parties need to prepare to address the challenges and impacts that AI may pose in relation to the Convention. Considering the rapid developments and need to support States Parties, it will be imperative for the Secretariat to regularly conduct AI-focused workshops in parallel with the other ongoing capacity-building work. In this regard, the Secretariat will continue to actively monitor the evolving landscape of AI to better understand and harness its transformative potential. With more understanding on the impact of AI on the implementation of the Convention, these capacity-building efforts will be progressively refined and strengthened.

27. Alongside these efforts, the SAB TWG on AI is continuing its review of current capabilities and technology adoption, addressing various questions posed by the Director-General. Upon completion of its mandate at the end of 2025, the TWG will submit a comprehensive report containing advice and recommendations to the SAB. Regarding the AI Research Challenge, the four projects selected by the technical evaluation team are designed to enhance the capabilities of the OPCW in the fields of chemical identification and forensics. Once completed, these projects will demonstrate the technical feasibility of applying AI to the work of the Organisation, and will inform the future direction of the Secretariat's efforts in international cooperation.

28. In conclusion, rapid progress is being made each day in the field of AI. The Secretariat remains committed to deepening its own understanding of how AI can support the implementation of the Convention, both for its own work and in support of the capacity-building efforts of the States Parties to implement Convention. To achieve these imperatives, the Secretariat would welcome contributions from interested States Parties to further its capacity-building efforts in AI.

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