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VFSF | Vienna Food Safety Forum 2025

The Potential of Digitalization

Background Paper | 10 - 12 June, 2025 | Vienna, Austria

Disclaimer: *This background paper was prepared by Ms. Madeleine Smith, Senior Food Safety Expert, UNIDO and Mr. Gabor Molnar, Industrial Development Officer, UNIDO. It went through technical review by Ms. Marlynne Hopper, Acting Head of the Standards and Trade Development Facility (STDF) and Mr. Glen Edmunds, Director of Export Standards Branch, Department of Agriculture, Forestry and Fisheries, Australia. The background paper aims at introducing the main topics of the Vienna Food Safety Forum 2025.*

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CONTENTS

ACRONYMS

AI	Artificial Intelligence
ASEAN	Association of Southeast Asian Nations
B2G	Business to Government
CA	Competent Authority
CCFICS	Codex Committee on Food Import and Export Inspection and Certification Systems
Codex	Codex Alimentarius Commission
COVID-19	Severe acute respiratory syndrome corona virus 2 (SARS-CoV-2)
EC	European Commission
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
FBO	Food-Business Operator
US FDA	United States Food and Drug Administration
UK FSA	United Kingdom Food Standards Agency
G2G	Government to Government
GeNS	Generic ePhyto National System
ICT	Information and Communication Technology
IoT	Internet of Things - digital overlay of information over the physical world
LA	Local Authority
ML	Machine Learning
NCA	National Competent Authority
POA	Products of Animal Origin
QR	Quick Response Code
RFID	Radio Frequency Identification
SME	Small and Medium Size Businesses
SPS	Sanitary and Phytosanitary
STDF	Standards and Trade Development Facility
SW	Single Window
TRACES	TRAde Control and Expert System European Commission
UN/ CEFACT	United Nations Centre for Trade Facilitation and Electronic Business
UNIDO	United Nations Industrial Development Organization
VFSF	Vienna Food Safety Forum
vTPA	Voluntary Third-Party Assurance
WCO	World Customs Organization
WHO	World Health Organization
WTO	World Trade Organization
XML	Extensible Mark-up Language

INTRODUCTION

The Vienna Food Safety Forum (VFSF) provides a platform for food safety stakeholders from the public and private sectors and from academia to exchange experiences on the digital transformation of food safety practices. The objectives of the forum are:

1. To share best practice using case studies and lessons learned by entities at the forefront of digital transformation
2. To identify aspects of digital transformation that need to be developed or explored to improve existing practices and to expand participation.

The third VFSF will take place in June 2025 in Vienna. It follows previous successful VFSF editions in 2015 & 2022. In 2022, presentations and discussions covered the use of

1. Voluntary third-party assurance (vTPA) and data sharing
2. Remote inspection and audit
3. Electronic Certification
4. Data Driven Decision Making

This paper identifies and analyses key developments in the use of digital solutions, building on the VFSF 2022, as well as topics for further consideration and discussion in the Vienna Food Safety Forum 2025.

DATA SHARING

Participants in the VFSF 2022 discussed various aspects and examples of data sharing based on the use of data generated by voluntary third-party assurance (vTPA) programmes[1] and broader information exchange between industry and regulators. Although the national control system and a vTPA programme are separate systems, many regulatory authorities recognize the high standards that can be achieved through vTPA and consider outputs of these systems when assessing regulatory compliance. Typically, this would affect the risk rating of the business and, consequently, result in a lower frequency of delivery of official controls. Where cost recovery is practiced there can also be a financial benefit for the business. The process is often referred to as 'earned recognition'. Several case studies were presented at the 2022 VFSF where earned recognition has been used to the mutual benefit of the regulator and food business operator.

Existing situation

The approach behind Codex Principles and Guidelines for the Assessment and Use of Voluntary Third-party Assurance (vTPA) Programmes (CXG 93-2021) showcases a new way of collaboration between competent authorities and food safety service providers. The structured exchange of information among stakeholders involved in food safety also offers new avenues for improved outcomes. These include improved risk profiling of the food and feed sector enabling optimized use of public resources. The Standards and Trade Development Facility (STDF) has funded three regional pilot initiatives (West Africa, East Africa, and Latin America) which resulted in additional tools for regulators to apply the vTPA approach.

Emerging issues

In the past 25 years the role of vTPA has expanded and evolved in response to need and opportunity. Industry may also opt for a second-party audit of its suppliers, through an audit aligned with the requirements of the regulator. This can be less resource-intensive than vTPA and still inform the delivery of official controls. Not only does the company gain substantial information about its suppliers' conformity level but the uniformity of the audits undertaken can result in fewer audits/assessments overall.

1 A voluntary third-party assurance (vTPA) programme or scheme is a non- government programme in which business participation is not mandated. The advantage of a voluntary Third-Party Assurance scheme (variously known as vTPA, voluntary Third-Party Certification scheme or voluntary Third-Party Certification programme) is that a business can demonstrate conformity with a particular standard. The use of voluntary certification is widespread, especially in the food industry.

Agreement between competent authorities and industry on sharing generated data can lead to better informed regulatory decision-making in terms of risk profiling. Improved sharing of data among stakeholders will require commonly agreed data frameworks and the willingness of the industry to provide data to competent authorities. Nevertheless, data sharing might also require the consideration of some prerequisites which can ensure data security, privacy, and integrity.

There now exist a number of challenges which impact upon the value of the programmes for businesses, regulators and consumers. These include issues of varied terminology, consistency, clarity, access and equity, credibility and oversight. Although there are various benchmarking initiatives in place already, these are either sectorial or theme-specific and have developed in an *ad hoc* manner in response to particular challenges or opportunities. There is no single global best-practice governance framework to drive integrity and consistency across these existing benchmarking platforms which could address existing challenges and enhance the value of the process. The first steps to set up such a global governance framework were taken at a three-day UNIDO-organized Dialogue on Certification held in Vienna in June 2024.

REMOTE AUDIT AND INSPECTION

During the COVID lockdowns competent authorities and the food industry were unable to conduct the traditional face to face activities that evaluated food business compliance with food safety requirements. Consequently, many stakeholders used remote practices and technology to deliver their obligations, including food safety regulators (official controls), food certification auditors (third-party audits), and associations/buyers (second-party auditors). Information and Communication Technology solutions were also deployed to conduct remote audits in regulatory frameworks where regulators assessed each other's food control systems or elements thereof.

Existing situation

A survey was carried out by UNIDO and STDF collected lessons learned and best practices in the delivery of remote inspection and audit in SPS measures. From the responses a five-step process was collated which described the way remote inspections and audits could be conducted. In general, participants in the survey were in favour of continuing to use remote practices in a targeted manner, even when COVID restrictions had been lifted. Remote audit and inspection were considered to be useful as part of a hybrid model but should not completely replace traditional on site inspections and audits.

The results of the survey were presented and discussed at the VFSF 2022 along with several case studies describing the successful use of remote practices by both the industry and regulators.

Emerging issues

Follow up research to determine the continued use of remote practices needs to be carried out globally to determine whether remote practices remain part of regulatory settings.

The participants in the 2022 survey also identified two main issues that required attention in the development of remote practices. The first issue was that of connectivity, including internet access and the compatibility of technology.

The second issue was a lack of internationally agreed guidelines. At the time of the VFSF 2022, the Codex Committee on Food Import and Export Inspection and Certification Systems (CCFICS) had already started to develop guidelines for remote practices and Principles and guidelines on the use of remote audit and inspection in regulatory frameworks (CXG 102-2023) were adopted in late 2023. Following on from this document, some organizations are developing regional or local guidelines/codes of practice to assist in the use of remote practices[2]. Presenting ongoing practices and providing a regional approach to put in practice the relevant Codex guidelines can accelerate its adoption.

2 For example, an STDF project to pilot test new approaches in the ASEAN region will be launched in 2025. Link to the project: https://standardsfacility.org/PG-782

PAPERLESS EXCHANGE OF CERTIFICATES

The use of electronic format (paperless) in international trade has become increasingly popular and is considered to have many advantages. Suggested benefits include increased efficiency, speed of information transfer including pre-notification of product, improved security and reduction in fraud. There is also streamlined archive storage and better ease of access to information for authorized participants (Stokes 2017, Lazaro *et al* 2021, Ryan *et al* 2023). The use of electronic data exchange is supported by international organizations such as the World Trade Organization (WTO) and World Customs Organization (WCO) as a way to streamline and enhance international trade, being more sustainable and potentially reducing the cost of non-tariff measures (UN ESCAP 2023).

Moving from the use of paper for certification to exchange of information in electronic format requires considerable adaptation and development. It is likely to be very costly and can be complicated to implement. A country deciding to use electronic certification and paperless trade needs to have:

1. Government commitment to the use of electronic certification and an existing robust control system that meets international standards. An appropriate institutional structure must also exist. Where more than one competent authority is involved in control of the product, roles, responsibility and lines of communication should be clearly established. Official controls must be correctly delivered through the food chain, including good traceability. There must be appropriate databases, where needed, to support the certification process. Legislation must permit the use of electronic certification and enable the delivery of official controls.

2. The technological capability to exchange electronic certification. This requires appropriate equipment and software for interoperability as well as the trained personnel to develop, use and maintain the system. Systems need to use Extensible Markup Language (XML), standardized message structure and exchange protocols with harmonized codes.

Existing situation

The fifth UN Global Survey on Digital and Sustainable Trade Facilitation reports that the average implementation rate of cross-border paperless trade measures stands at approximately 47%. This has increased by 8% since the 2021 survey (UN ESCAP 2023). Yet there are wide variations globally. Historically the exchange of electronic certification has developed through a series of bilateral agreements between trading partners, which is often costly, especially for developing countries. The STDF-funded ePhyto project provided an alternative approach, based on the creation of a global hub for the exchange of ePhyto certificates. Learning from this experience, countries in Latin America and the Caribbean are piloting a regional approach to exchange eVet certificates under a new STDF project.

The extent and type of measures also vary. Nearly all respondents to the 2023 UN Global Survey had internet access, 90% for customs and 85% for other control authorities. The correct legal framework for the use of electronic

transactions was also widespread, with 82.8% of respondents having initiated the process, and some 37% reporting full implementation. The ability for cross border electronic exchange of certificates of origin was the least implemented measure reported, with only 5.5% reporting full implementation. Responses were similar for electronic exchange of customs declarations and sanitary and phytosanitary certificates, highlighting that more efforts are needed to address remaining challenges in these areas (for full results see page 32 fig 20 of ESCAP 2023 https://www.untfsurvey.org/report).

Australia and New Zealand are active participants in the use of paperless cross border trade (UN ESCAP 2023), as is the People's Republic of China. The Netherlands was an early adopter, and Chile has been steadily developing the exchange of electronic certification with various trading partners (Ryan *et al* 2023). ASEAN countries are also developing cross border paperless trade through the development of the ASEAN single window which allows direct exchange of data between ASEAN members and other regional partners (Benjelloun *et al* 2012). The United Nations Economic and Social Commission for Asia and the Pacific (UN ESCAP) has developed a framework agreement on Facilitation of Cross-border Paperless Trade in Asia and the Pacific. The agreement provides advice and guidance on matters associated with electronic certification such as electronic business standards, interoperability and technical standards, mutual recognition and legal issues. It also highlights areas associated with the development of single windows for use in B2G transactions and the interface with other single windows for G2G communication.

For trade in plants and plant products, countries can use the IPPC ePhyto solution which was developed through an STDF project. The IPPC ePhyto solution uses a hub and web-based system (GeNS). The GeNS allows countries to send, produce and receive ePhyto certificates without first developing their own system. The process uses a standard certificate, data elements and message structure to provide the same information as found in a paper certificate.

TRACES is a multilateral online platform run by the European Commission that covers SPS certification and border clearance for animals, animal products, plants, and food and feed of non-animal origin, allowing products to enter European markets. It has offered electronic certification for both EU and non-EU country

authorities since 2019.

The TRACES and IPPC hub are connected allowing transfer of ePhyto certificates to EU member states.

Emerging Issues

Cross border trade requires harmonization between partners with mutual recognition of controls. In order to participate, some countries may need to modernize or upgrade food control systems and implement new measures to meet SPS standards. This can occur at varying rates (Lazaro *et al* 2021) and will impact the development of electronic data transfer opportunities.

The use of paperless trade is more widespread for plants and plant products than for other commodities such as food of animal origin (Ryan *et al* 2023). Cross border trade in products of animal origin (POA) is challenging. There are likely to be multiple authorities involved, for example, veterinarians are involved in animal health control while other competent authority officials may be responsible for food of animal origin. The international standards and regulatory frameworks can be complex for POA and the risks to human health from animal disease must be managed.

The development of many independent bilateral agreements has resulted in differing data requirements according to the agreement. There is also variation in the certificate models in use, especially for trade in products of animal origin, as there is not currently a globally accepted standardized sanitary certificate (Ryan *et al* 2023).

Harmonization of international sanitary certificates would facilitate the increased use of eCertification. This should cover the information required and how it is to be presented (Ryan *et al* 2023). Ideally a single internationally accepted model certificate for POA could be developed.

Even where regional or international frameworks exist (e.g. UN ESCAP framework) there is still a need for bilateral discussions to establish mutual recognition, typically requiring Memoranda of Understanding (MOU) or other agreements.

The existing ICT in some countries may not be suitable for e-certification and paperless trade. Upgrading/replacing outdated systems is costly and time consuming. It requires planning and clear objectives with specialist expertise and training to ensure compatibility and suitability for purpose.

The development of Single Windows that are comprehensive, i.e. offer access to all or most government agencies, for B2G communication is still challenging (Tsen 2011). There will be added difficulties if they are to be connected with authorities in other countries as a portal for paperless cross border trade.

DIGITAL TRACEABILITY

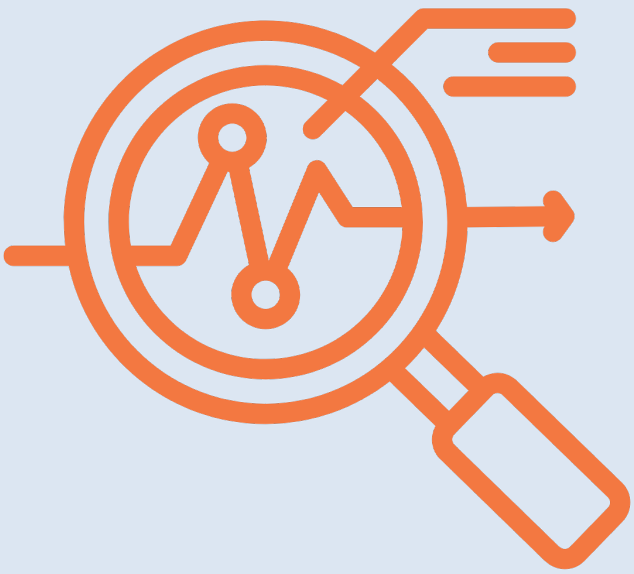
When a product is identified as non-compliant it is essential that it is removed from the market. This requires good traceability to ensure all suspect food, including any ingredients or components, are identified, recalled as needed and subjected to the appropriate control. Traceability is the ability to accurately follow a food through its journey from origin (primary production) to consumption. A traceability system needs to be able to identify the food in an appropriate way and systematically record the movements of the food in an accessible, accurate and incorruptible manner throughout the food chain. Typically, Food Business Operators are expected to have records detailing from whom they acquired all products/ingredients and to whom the products are sold – one step forward, one step back, but the manner of this recording is not usually specified. Using this framework to trace product back through a complex food chain can be difficult and is always time consuming. When there is an urgent need to identify all possible sources or batches of a food the inherent delays, variability and incompatibility between business data recording systems and possible errors in or loss of data can result in serious negative impact on human health and on businesses.

Some of these traceability challenges can be addressed by digital solutions. SMEs require solutions which are easily accessible and simple to use as some such businesses may lack the capacity or capability for complex technological solutions. It must also be cost effective to accommodate often narrow profit margins. Basing a traceability system on existing ICT can be effective.

Existing situation

An example of digital traceability which uses existing technology and is suitable for SMEs is CamTrace. It is being successfully piloted in Cambodia for the fish value chain. The system offers real time tracking through the food chain using an application available from the App store or Google play. Batches are identified using a QR code and it can be used on a mobile device or computer. Businesses input relevant information, and a detailed traceability report is generated. The report can be downloaded as a pdf file if required. The system can accommodate simple operations as well as more complex processes. The development objective is to link all stakeholders in a value chain providing full traceability from origin to final consumer. There is also interest in the use of decentralized data-sharing systems in the form of blockchain, as a way to address traceability issues in complex food supply chains. Blockchain is a digital system or ledger which records transactions. Originally developed for currency transactions, it has developed into a process which can record other data. Data entries or 'blocks' are connected into a sequence or 'chain'. Data can be logged in real time and stored electronically. The data base is decentralized, transparent and secure. All participants can access the information but not alter it. The process can provide full traceability data to all participants, quickly and accurately. Product traceability can be enabled by the use of smart tags such as RFID or QR codes with global positioning.

Blockchain technology could also be used to improve food safety in the food chain if the data inputs align with relevant standards. Safety and



quality metrics can be measured using sensors or other relevant techniques (Internet of Things). The types of data needed will depend on the product, process and objectives. Loss of control is recorded and can trigger warnings to allow swift remedial action.

It appears that blockchain technology is being implemented for specific value chains where the benefits are worth the cost of implementation and the required quality of data is available for input (Collart and Canales 2022). It could be a major challenge for small and medium-sized enterprises to use blockchain as a technology.

Emerging Issues

With the acceptance of digital traceability, the number of technological solution providers and various initiatives has been increasing. This has created issues related to interoperability. It is particularly problematic in large-scale solutions, such as blockchains, but can also be evident in some systems developed for smaller food business operators.

Digital solutions to traceability problems need all parties in the value chain to participate.

1. Some Food Business Operators may lack understanding of the technology or be unable to participate technically.

2. The initial costs of implementation may be high, especially for large scale solutions such as blockchain. Food Business Operators, especially SMEs, may be reluctant or unable to invest, creating a technical barrier to trade.

3. The size, extent and complexity of the food chain creates a challenge for scalability as the computational resource needed for large scale solutions such as blockchain would be immense. According to Pearson *et al (2019)* and Duan *et al (2020)* this could be a significant technical challenge.

It has been suggested that Blockchain technology may be especially useful for products at risk of adulteration or substitution, but for which end-product authenticity tests are limited. Reports of Halal products which have been contaminated or adulterated (Fuseini, 2017) have led to concerns about authenticity of some Halal products (Tan *et al* 2022). While some types of adulteration such as species substitution can be identified in the final product using analytical techniques, there is no test to confirm correct slaughter methods or appropriate handling. Consumers of Halal products must rely on Halal certification and food chain integrity to confirm the product meets these requirements. Using blockchain technology for the production of Halal products could reduce the opportunities for fraudulent activities (Tan *et al* 2022) and improve transparency (Hew *et al* 2020, Duan *et al* 2020). Consumers could be given access to the full chain data (e.g. using a QR code on the final product packaging), helping to improve trust in the process.

ARTIFICIAL INTELLIGENCE

The Oxford English Dictionary defines artificial Intelligence (AI) as *"...computer systems able to perform tasks normally requiring human intelligence"*.

Machine Learning is a type of AI in which a computer is 'trained' using large data sets to extract 'features' and identify relationships between features. The model can be used to determine patterns, trends or correlations and produce a decision or prediction accordingly (Anon 2025). Deep Learning is a subsection of Machine Learning where the computer appears to learn (rather than being 'trained') from the data. Deep Learning comprises complex model structuring and artificial neural networks with interconnected layers which can be used for advanced applications like image recognition (Anon 2025).

Existing situation

Primary production

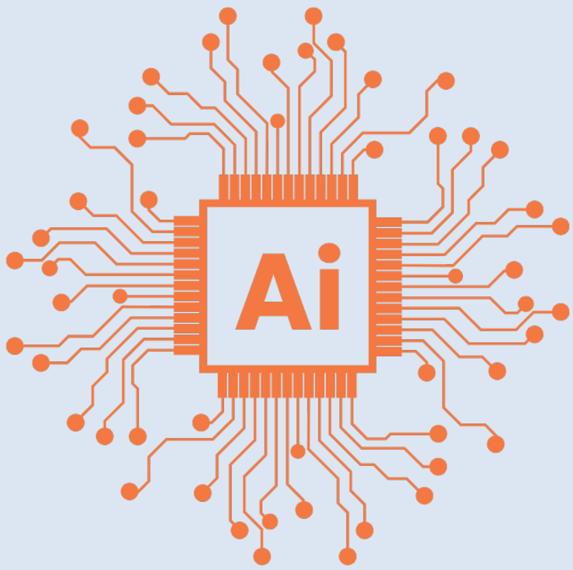
Machine learning has been used to optimize agricultural practices through the development of precision agriculture. A review article by Benos *et al* (2021) report the application of Machine Learning in crop, soil, water and livestock management. Rai *et al* (2023) review the use of Deep Learning integrated with ground and aerial technologies for site specific weed control. Inputs vary according to the model but can include images or data from ICT such as soil sensors and other data sources. Satellites and unmanned ground and aerial vehicles have also been used to collect information. Some of the limitations described in the literature include the availability of good quality data with which to train the models and practical limitations related to the on-farm use of sensors and other equipment (Benos *et al* 2021). Singh (2018) describes a scalable low-cost solution for crop disease identification which enables use through a mobile phone application. It has been tested successfully for several plant diseases.

Evaluation of Risk

The ability to identify relationships and trends in large data sets means that Machine Learning can be used to evaluate risk, target interventions and highlight patterns of non-compliance.

Competent Authorities collect and analyze a wide range of data, including food testing and other non-compliance data, which can result in border rejections, alerts, recalls and food borne illness notifications. Machine Learning models can be designed to extract and aggregate information, classify data, identify relationships, correlations and trends which regulators can then use to target the delivery of food controls.

For example, historical sampling data can be used to predict the likelihood that a food has compliance issues and control would be required. The United States Food & Drug Administration (US FDA) has used such data to develop Machine Learning models which support their sampling plan for imported foods. The UK Food Standards Agency (FSA) has developed a short-term horizon scanning model which uses inputs such as food alerts and other relevant real time data to identify potential food hazards. These can then be addressed preventatively. The FSA also uses Machine Learning to refine their risk



categorization tool which is applied to imported products of animal origin (FAO 2025).

Robots

AI can be used in the software of intelligent robots which use acquired data to improve or alter performance.

Examples of successful use of AI in robotics include:

1. The Summer Berry Company uses robots to harvest ripe berries, collect information and, if necessary, spray the growing plants. https://summerberry.co.uk/innovation/. The Tortuga webpage also shows this technology https://medium.com/@tortugaagtech/essential-robotics-ff03db7b59aa.
2. Ocado is an online grocery retailer which has developed a sophisticated automated warehouse system to pick and pack groceries. Using a 'hive' system of storage, 'swarms' of robots move around to assemble customer orders (Pettit *et al* 2022). AI is also used to optimize the loading of vehicles https://www.ocadogroup.com/solutions/our-technology and https://youtu.be/hnDtW32Ctgk .

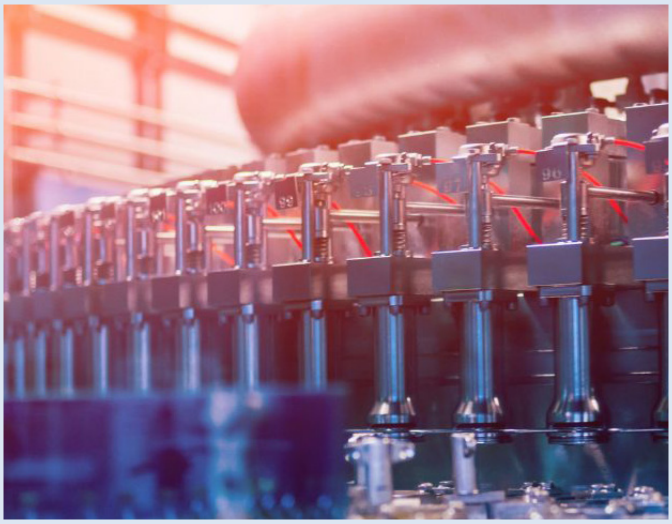
Issues

Some of the challenges for the development and use of Machine Learning relate to Data, for example:

1. Quality of data: All models require large sets of suitable data for development testing and training.
2. Data requirements: The data needs to be representative, accurate, unbiased, accessible and in a usable format.
3. Sources of data: Mechanisms are needed to allow data sharing and combination of multiple databases
4. Ownership of data: All data will have a creator. Intellectual property rights and copyright can apply and require consent.
5. Confidentiality and protection: Data sets may contain personal or private information which needs to be protected.
6. Governance of Data: Governance is the authority over and control of data and is somewhat problematic.
7. Human-AI relation: Ultimate decision remains with people and therefore they should be able to assess the recommendations and information received from the used AI.
8. There may also be difficulty in creating robots which can adapt to unexpected situations in real world environments (Anon 2025).

Accuracy of Output

In Speaking about Frontier AI[3], Anon (2023) states '…they [frontier models] produce regular errors and cannot check their own work.' The outputs from Machine Learning models which use historic data to support predictive capability or target interventions can be tested against actual situations and evaluated. Where AI is being used to create content or to enlarge databases (e.g. LLM) the risks of inaccurate or incorrect results are higher. Anon (2025) declares that outputs should not be treated as factually correct information but as a 'statistically informed guess'. Probabilistic models such as LLM and Generative AI have the potential to create hallucinations – responses which seem plausible but are factually incorrect. See, for example, https://www.bbc.co.uk/news/articles/cx2j15r1g09o



3 The authors define Frontier AI as: highly capable general-purpose AI models that can perform a wide variety of tasks and match or exceed the capabilities present in today's most advanced models.

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