“ENABLING SUSTAINABLE AI”

Research Paper

Frank Soans, SSBM, Geneva, Switzerland, frank@ssbm.ch

Dr. Anna Provodnikova, SSBM (anna@ssbm.ch)

Dr. Bojan Kostandinovic, SSBM (bojan@ssbm.ch)

“Abstract”

Deep tech and the world of AI have been rapidly changing the market share and is one of the most focused industries. While opportunities are great, the pit falls maybe likewise. One key element in avoiding pit falls is the need to develop AI with a sustainable approach or building Sustainable AI. AI is dependent on human intelligence and would undergo similar learning cycles to that of humans such as learning, unlearning, and new learning as part of its machine learning ability. This cycle would ensure it is relevant based on new data and information that is made available, discovered or generated, be it by humans, nature, industry or by AI itself. It would also need an active supply chain, one that is sustainable to ensure appropriate learning and refresh to ensure the improvement continues. The processes applied from design to decline would be key in creating Sustainable AI. To ensure this process is viable and sustainable, principles like design thinking and systems thinking maybe critical right from the design process, through the steps carried out in the AI build and its continued maintenance to ensure a more humane and wholistic development of AI. This design approach needs to be profitable, inclusive and circular to ensure stakeholder objectives, human social factors, economic requirements and environmental impacts are addressed.

Keywords: Sustainability, AI, Machine Learning, Artificial Intelligence, environmental, societal, economy, design, Sustainable AI.

1 Introduction

AI has been rapidly growing and influencing multiple aspects of our lives. Many industries are adopting AI, be it in the automobile sector, consumer goods, media, agriculture and the list goes on. AI seems to be everywhere. Given the ease in availability of data, IoT, device capability and flexibility of digital solutions, AI companies have been mushrooming, not just from industries and garages, but from desktops, laptops and even mobile devices.

Digital and AI have been defining Industry 4.0. However, given we are already phasing into the 5th Industrial Revolution, an Industrial revolution defined around Sustainability, we need to be conscious of the impact of the created solutions. Developers and designers need to be cognizant of its impact on humankind, society, the economy, the environment, and even AI. Given the incredible growth in AI, requirements for sustainable growth may be overlooked.

There is critical need to ensure a sustainable approach in AI development. This would be across its development lifecycle and around the supply chain that encompasses it. Using a sustainable approach

will not just control the negative impact of AI but potentially enable a more positive impact on the environment, society, and economy.

2 Literature review

2.1 The world of AI

We are living in one of the most exciting phases imaginable – it is not just the change, but the intensity and pace of change. According to R Rajagopal and Provodnikova (2023) we are seeing the rise of a mélange of technologies like never before – IoT, Edge computing, 3D printing, AI, Machine Learning, Gen AI, Advanced biology, wearables just to name a few. The relevance of these technologies in our everyday use is so wide that we may not even fully appreciate how much it has permeated our lives.

According to Schank (1987) development of AI has two main goals, to build an intelligent machine, and find out the nature of intelligence. However, there is little agreement on what AI should be or should not be. He further goes on to define what are in his list of intelligent capability, which is communication, internal knowledge and world knowledge, intentionality, and creativity.

Today there are multiple types of AI, not just traditional AI, predictive AI and conversational AI but also Generative AI (Microsoft, 2025). According to Deloitte other iterations on AI are autonomous, Gen AI agents or Agentic AI (Loucks et al., 2024). Adoption of AI is going to be the single most important factor for an organization to forge ahead in the game.

2.2 Growth of AI

According to Anthes (2017) the term Artificial Intelligence was first coined by John McCarthy, Marvin Minsky, Claude Shannon, and Nathaniel Rochester in 1955, where they said that every aspect of learning and any other feature of intelligence in principle can be simulated by a machine. Further, he goes on to share that in 1997, IBM's Deep Blue Supercomputer was able to defeat Gary Kasparov at chess. In 2016, Google's DeepMind was able to defeat a Go professional (Anthes, 2017).

According to MIT, in the year 2014 a machine learning architecture known as Generative Adversarial Network was proposed by researchers from the university of Montreal (Zewe, 2023). In 2017, Google introduced the transformer architecture which formed large language models the backbone of Generative AI solutions such as ChatGPT. In November 2022, chat GPT a generative AI solution was released which provided human like responses.

The pace of growth has also increased, McKinsey mentions about the speed with which Gen AI is developing (Chui et al., 2023). A timeline of its progress perhaps represents this best:

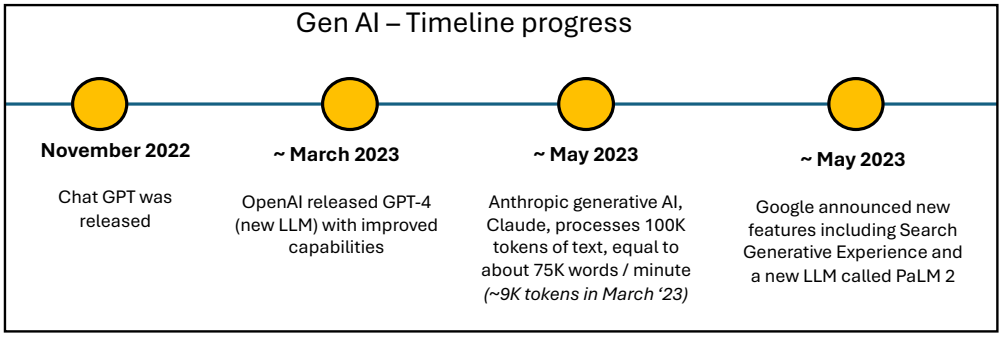

Figure 2.1. Timeline progress of Gen AI based on McKinsey report (Source: Chui et al., 2023)

This shows the speed and pace of change is unprecedented, and this is only going to increase with the passage of time.

Gen AI capabilities have evolved rapidly over the past two years.

Illustrative capabilities of gen AI platforms from select frontier labs, nonexhaustive

	2022–23[1]	Jan 2025[2]
Anthropic	Claude	Claude 3.5
	• Not multimodal (text only) • Limited contextual understanding (difficulty with complex conversations) • No tool usage	• Multimodal (text, audio, and images) • Enhanced contextual understanding and coherence during long interactions • Experimental computer usage capability for some users
Google Gemini	Google Bard	Gemini 2.0 Flash
	• Not multimodal (text only) • Fair reasoning • Limited contextual understanding (difficulty with complex conversations) • Limited real-time data integration • Low personalization (limited adaptability)	• Multimodal (text, audio, and images) • Advanced reasoning (capable of multistep problem-solving and nuanced analysis) • Enhanced contextual understanding (maintains coherence in long dialogues) • Real-time data integration (from Google Search) • Advanced personalization (user context)
Meta	Llama 1	Llama 3.3
	• Not multimodal (text only) • Fair reasoning • Limited contextual understanding (difficulty with complex conversations) • No API access	• Text-based (earlier versions were multimodal, LLaMa 3.2) • Advanced reasoning (capable of multistep problem-solving and nuanced analysis) • Enhanced contextual understanding (maintains coherence in long dialogues) • API access (tools for model and agent development)
Microsoft	Phi-1	Phi-4
	• Not multimodal (text only) • Fair reasoning (ie, limited to coding tasks) • Focused training (smaller, coding-focused data set)	• Multimodal (text, audio, and images) • Advanced reasoning (capable of multistep problem-solving and nuanced analysis) • Comprehensive training (diverse data)
OpenAI	GPT-3.5	OpenAI o1
	• Not multimodal (text only) • Fair reasoning ability (eg, scored high on SAT, but bottom 10% on bar examination) • Limited contextual understanding (difficulty with coherence in complex conversations) • Standard API access (for text generation)	• Multimodal (text and images) • Advanced reasoning (eg, top 10% on bar examination) • Enhanced contextual understanding (maintains coherence in long dialogues) • Advanced API access (supports multimodal inputs)

Note: Exhibit is not intended as an evaluation or comparison but as an illustration of the rapid progress in capabilities.
[1]Initial models released between Mar 2022 and Mar 2023.
[2]Latest models released between Nov and Dec 2024.
Source: Company websites and press releases; McKinsey analysis

Figure 2.2. Evolution of Gen AI capabilities (Source: Mayer et al., 2025)

2.3 Impact of AI

The impact of AI on our everyday life is significant. It is changing the way we live, work, even eat and sleep. Sometimes it also changes and defines our relationships. According to Forbes, most people experience AI from morning to night, from opening their mobile phone, to recommendations on their social media page, to checking spellings, to entertainment recommendations and many more (Marr, 2019).

According to Kinzler (2023), AI can influence us through various means:

- AI in Healthcare: Telemedicine, AI driven diagnostics, Predictive analytics, Drug discovery, personalized medicine.
- AI in Entertainment: AI recommendations, AI generated content, Enhanced gaming experiences, Virtual Assistants

- AI in Transportation: Navigation, Autonomous Vehicles, Public Transport Optimization, Safety Enhancements, Emission monitoring, Smart City and Mobility
- AI in Personal Devices: Predictive text, Smart cameras and Photography, Health and fitness tracking

To summarize, we experience some form of AI in our lives without us even realizing it. It has become so embedded into our daily lives that the absence of it may be felt very strongly. Given this ever-growing influence on us, it is imperative these systems are reliable and work seamlessly to enhance our daily lives and not complicate it.

2.4 AI and economy

The impact of AI on the economy too would be significant. According to a publication by McKinsey Global Institute, AI has the potential to deliver additional global economic activity of around $13 trillion by 2030 or about 16% higher cumulative GDP compared to today (Bughin et al., 2018). However, the cost of implementing AI can also be significant.

According to a press release by Gartner, (Gartner, 2024) cost of Gen AI implementation ranges from $5 to $20 Million which are quite significant. However, many are yet to see value of the investments. While pockets of profits are seen by early adopters with 15.8% revenue increase, 15.2% cost savings, and 22.6% productivity.

However, this may vary by use case, job type and worker skill level. Based on the above insights, research by Gartner (Gartner, 2024) predicts 30% of the projects will be abandoned after the proof of concept.

Costs incurred in different GenAI deployment approaches

	Consume Commercial GenAI apps	Embed GenAI APIs in custom apps	Extend GenAI models via data retrieval	Customize GenAI models via fine-tuning	Build Custom models from scratch
Use case	Coding assistants	Personalized sales content creation	Document search with RAG	Virtual assistant	Medical, insurance or financial services LLMs
Upfront costs	~$100K to $200k	~$750K to $1M	~$750K to $1M	~$5M to $6.5M	~$8M to $20M
Recurring costs (per user per year)	~$280 to $550	~$790 to $1.2K	~$1.3K to $11K	~$8K to $11K	~$11K to $21K

Figure 2.3. Costs of different Gen AI deployment approaches (Source: Gartner, 2024)

2.5 AI supply chain

Building an effective data management supply chain could have significant impact and lead to game changing benefits. A report by Deloitte says this and further states that forward looking companies are applying a product mindset on data. This approach on applying a product mindset would mean treating data as an input, inventory and product. Data would be treated as a commodity that is sourced, processed and monetized in a supply chain (Verma et al., 2025).

In their research Lee et al (2024) introduce the term Generative AI – Supply chain. Focusing on the legal consequences and copyright laws, their approach goes upward from technical design to downward usage of the solution (Lee et al., 2024). They further go on to break down that Gen AI is not one product from one company but an output from an ecosystem. Widder and Nafus (2023) share how AI is built using existing software that passes through many stages before becoming a finished product or service in an imagined supply chain.

AI like any other software product or service is dependent on a supply chain. However, unlike other software products of services, AI's input is highly dependent on updated data, one that needs to be constantly refreshed, and its supply chain would best follow the digital supply chain approach. McKinsey refers to the Digital Supply Chain as Supply chain 4.0, where the use of IoT, robotics and advanced analytics of big data are part of supply chain management (Alicke et al., 2016).

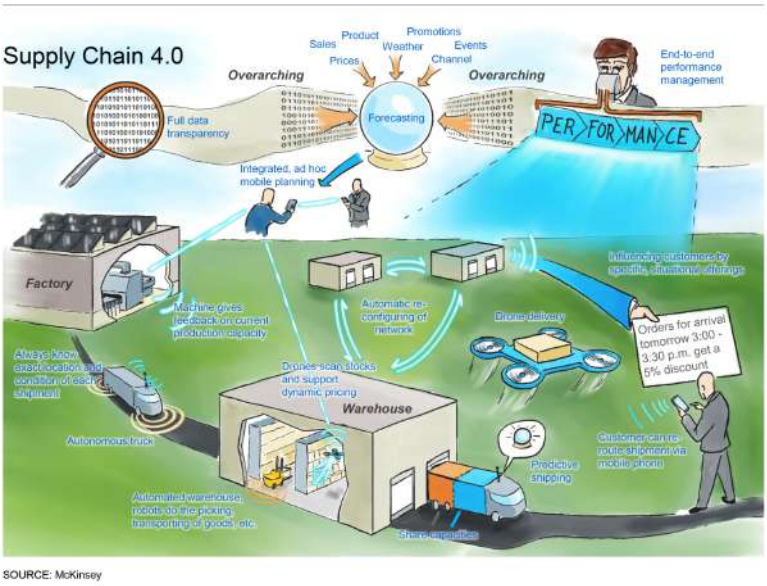

Figure 2.4. Visual representation of supply chain 4.0 (Source: Alicke et al., 2016)

The digital supply chain would be constantly sourcing and utilizing data from various sources including users input in creating solutions and outputs through AI. As Deloitte's study (Verma et al., 2025) puts it, data is constantly in motion moving quickly from person to machines and back. They share that the magic of AI comes from transforming data to value and profit and enhancing experiences.

A good example of data monetization are LLMs where enterprises are opting for sourcing LLMs to expand their AI capability, Forbes report mentions that the hybrid LLM strategies are on the rise (MSV, 2025).

Data is key to AI and managing data is critical to AI development. In the Deloitte research article Verma et al (2025) share that challenges in data management comes from bad data, data not interconnected or integrated, unclean data, and the lack of data enrichment. Adding that the lack of a data culture and responsibility for good data increases this challenge.

Building a transformative data organization

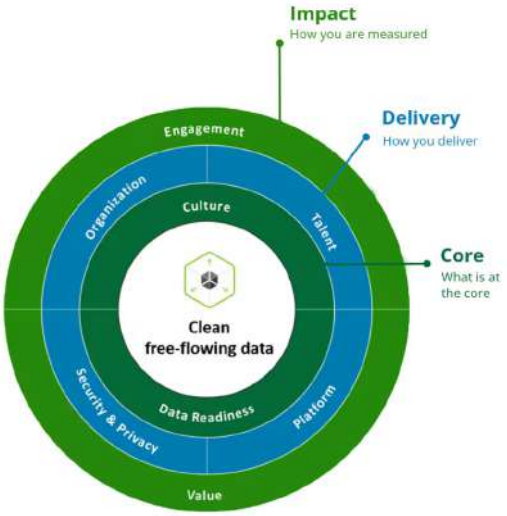

Figure 2.5. The magic behind turning data into profit (Source: Tello and Subramanian, 2022)

Verma et al (2025) further shares how data management can be improved through:

- Modernizing data infrastructure
- Data democratization
- Integration and ingestion of data
- Standardization
- Data cleaning and curation

They further stress on the need for a robust, repeatable and scalable value chain.

With a focus on Gen AI, Gartner research share that, some of the parameters of oversight risks include Lack of transparency, Accuracy, Bias, Intellectual property and copyright, Cyber security and fraud and Sustainability (Gartner, 2025). Further they also recommend, defining responsible use especially cutting across geographies:

- Risk mitigation
- Transparent and easily manageable consent process
- Content creators are compensated
- Monitoring of the entire lifecycle

It is important to understand this supply chain clearly in the development of AI and ensure processes are designed to ensure appropriate data governance. Effective planning and management of the AI supply chain is critical to ensure responsible and sustainable AI. Starting from sourcing of data to end-of-use, the supply chain would need to ensure appropriate sourcing, safe and sustainable data storage, ethical use, responsible data conversion, outcomes, traceability and data management at end of life.

3 Problem Statement

AI is growing in leaps and bounds, at the same time, it is also riddled with challenges, criticism and fear. A better understanding of these challenges can help us take actions that can improve the outcome.

3.1 Success rate of AI implementation

While AI has been changing the world, there are also instances where it has failed. Lu (2024) citing HBR states that the failure rate is quite high - around 80% of AI projects fail. They also recommend focusing on the following to ensure success: selection, development, evaluation, adoption and management. A key thread across is the design process from understanding the user, the business objective, the value and impact it creates in selection, to engaging users as part of the development process, experimentation to ensure evaluation before release, engaging the users to ensure confidence in the solution, enabling a constant refresh of data to be relevant.

There could be many reasons why AI may fail. For every success story, there are equal number of analyses on why AI fails as well. Given below are some common pitfalls (Lu, 2024)

1. Not Solving the right problem
2. Innovation Gap
3. Not useful and do not achieve intended results
4. Low hanging opportunities are missed
5. Do not generate value
6. Ethics, Bias and Social Harm

A common factor across these reasons for failure is a clear understanding of the problem to solve and designing to solve it to address the customers problem, hallucinating AI capability and what are the limits to the problems it can solve, lack of understanding wider implications and the need to factor it all right from the design.

According to Forbes research, some of the common reasons why AI fails (Francis, 2024)

- Overfitting: AI models do not account for untrained data.
- Edge-case neglection: Failing to test for scenarios that are on the boundaries of the solution.
- Correlation dependency: Superficial correlation leading to unreliable outcomes.
- Data bias: Training on incomplete data leading to bias in the data.
- Underfitting: Not robust enough to be trained on the available data.
- Data drift: Unable to meet changes overtime.

3.2 Challenges in AI implementation

According to Deloitte research, challenge in implementation in AI stems from data that is not integrated or interconnected, bad data, unclean data, poor management of data and lack of data enrichment. In their State of AI survey, they had identified 40% adopters reporting low or medium level sophistication across a range of data practices (Verma et al., 2025).

AI implementation also has a negative impact on the global environment and social fabric too. The large data centres that support AI have been found to impact air, water, and land. Additionally, further social impacts to neighbourhoods are by way of light, sound, and even cost of living.

Data management and AI need significant power and resources. When creating data centers, a conscious effort needs to be made to ensure there is positive impact to the environment, society and economy. According to IEA (2025) AI and data centers are consuming about 1.5% of the global electricity. This could come from Servers, Storage systems, networking equipment, cooling and environmental control systems, uninterrupted power supply systems, and other infrastructure necessary for the running of these centers.

According to the Environmental and Energy Study institute, data centers have a significant impact on water where a large data center can consume 5 gallons per day which is equivalent to the consumption of a town of 50,000. The study also calls for the use of direct to chip cooling to reduce the need for water and energy usage. The Environmental and Energy Study institute also suggest the usage of metrics such as Water usage effectiveness and power usage effectiveness to monitor and improve the efficiency of these data centers (Yañez-Barnuevo, 2025).

According to Bush (2025)from the university of Alabama at Brimingham societies are impacted by data centers by energy consumption that is increasing the pressure on the grid and increasing cost of power. The high use of fresh water impacts the water available for these societies. To generate power these sometimes use diesel generators impacting the quality of air to levels of 200 to 600 times more nitrous oxide in the air.

According to the Smithsonian magazine, (Chen, 2025) noise pollution from neighboring data centers reach up to 90db. The National Wildlife federation (Kandasamy, 2025) share that data centers increase the impact of air, light, noise and other pollutants.

3.3 Risks in AI implementation

The OECDs report (OECD, 2025) on AI risk and incidents share that there been a sharp rise in incidents post November 2022.

AI incidents and hazards as reported by reputable international media, January 2016-January 2024, OECD. The report shares these risk related to bias, discrimination, polarization, privacy infringements, security and safety issues.

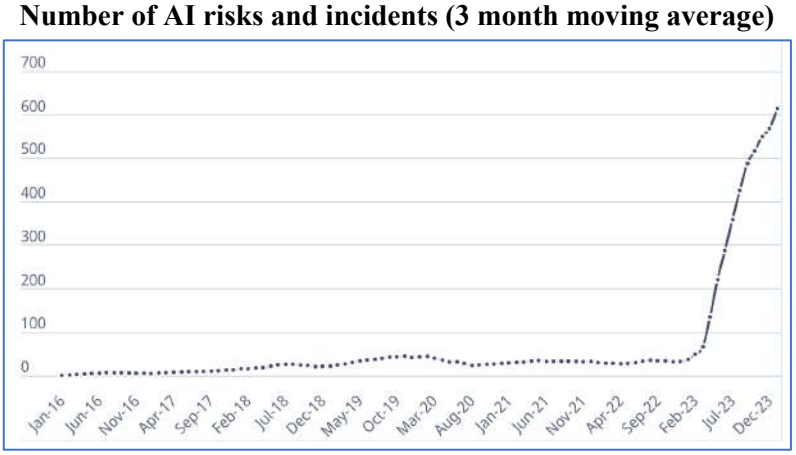

Figure 3.1. Number of AI risks, incidents - 3 month moving average (Source: OECD, 2025)

The MITs AI risk taxonomy classifies risks based on 7 Domains (Slattery et al., 2024):

- Discrimination and Toxicity
- Privacy and security
- Misinformation
- Malicious actors and misuse
- Human computer interaction
- Socio economic and environmental
- AI System safety, failure and limitations

Domain Taxonomy of AI risks

Domain / Subdomain	
1	***Discrimination & Toxicity***
1.1	Unfair discrimination and misrepresentation
1.2	Exposure to toxic content
1.3	Unequal performance across groups
2	***Privacy & Security***
2.1	Compromise of privacy by obtaining, leaking or correctly inferring sensitive information
2.2	AI system security vulnerabilities and attacks
3	***Misinformation***
3.1	False or misleading information
3.2	Pollution of information ecosystem and loss of consensus reality
4	***Malicious actors & Misuse***
4.1	Disinformation, surveillance, and influence at scale
4.2	Cyberattacks, weapon development or use, and mass harm
4.3	Fraud, scams, and targeted manipulation

Domain / Subdomain	
5	***Human-Computer Interaction***
5.1	Overreliance and unsafe use
5.2	Loss of human agency and autonomy
6	***Socioeconomic & Environmental Harms***
6.1	Power centralization and unfair distribution of benefits
6.2	Increased inequality and decline in employment quality
6.3	Economic and cultural devaluation of human effort
6.4	Competitive dynamics
6.5	Governance failure
6.6	Environmental harm
7	***AI system safety, failures, and limitations***
7.1	AI pursuing its own goals in conflict with human goals or values
7.2	AI possessing dangerous capabilities
7.3	Lack of capability or robustness
7.4	Lack of transparency or interpretability
7.5	AI welfare and rights

Figure 3.2. The AI risk taxonomy by MIT (Source: Slattery et al., 2024)

It was found through this study that 41% of risks were caused by AI where post deployment risk was at 62% as against 13% before deployment. Further intentional risk was at 34% (Slattery et al., 2024).

AI Risk Database

Category	Level	Proportion
Entity	Human	39%
	AI	41%
	Other	20%
Intent	Intentional	34%
	Unintentional	35%
	Other	31%
Timing	Pre-deployment	13%
	Post-deployment	62%
	Other	25%

Note. Totals may not match due to rounding.

Figure 3.3. The AI risk database table by MIT (Source: Slattery et al., 2024)

These levels are alarming, and they call for better and improved governance from design, development to deployment of AI. This would mean building a sustainable end-to-end supply chain from sourcing, storage and handling, product development and responsible deployment.

4 Approach

4.1 Sustainable AI

Sustainable AI goes beyond addressing the environmental goals in Sustainable Development Goals (SDGs), it needs to ensure all relevant touchpoints in the SDGs are addressed. It is about bringing change in the entire lifecycle of AI products which addresses both ecological and social issues in the development of AI. Sustainable AI covers all aspects holistically that include hardware powering AI, the methods to train, the actual processing of AI and needs to address the entire lifecycle of AI from design to use (van Wynsberghe, 2021).

Figure 4.1. Sustainable Development Goals (Source: United Nations, 2019)

Sustainable AI is an approach that emphasizes long term viability and responsible use of AI which includes environmental sustainability, ethical use of data, and social impact of AI applications (Raman et al., 2024).

For AI to be sustainable, it needs to be able to address all three dimensions of sustainability, the environment impact due to AI, societal impact and economic impact. To demonstrate the impact on the environment, Strubell et al (cited in van Wynsberghe, 2021) shares that training a single Natural Language Processing (NLP) model leads to about 600,000 lbs. of CO2e. Generative AI requires considerable computing power that can lead to increase in energy consumption and in turn carbon emissions (Raman et al., 2024).

4.2 Ethical AI

The UN news report of December 2020, (UN, 2020) shares how AI was the cause of wrongful arrest of an African American person in the state of Michigan due to the tools inability to recognize difference when handling data related to black faces, or incorrect grading of students in the UK from low-income neighborhoods based on existing grades and track record without considering the potential of different grading systems as compared to schools attended by wealthier students.

Focusing of ethical AI development, UNESCO (UNESCO, 2023) proposes 10 core principles to layout human rights centered ethical AI:

1. Proportionality and No harm: Risk assessments ensure there is a legitimate aim for AI development.
2. Safety and Security: Vulnerabilities should be addressed.
3. Privacy and Data Protection: Privacy must be protected and adequate data protection.
4. Multi stakeholder and Governance collaboration: International law and national sovereignty need to be respected and participation of diverse stake holders.
5. Responsibility and accountability: auditable and traceability.
6. Transparency and Explainability: Transparency should be balanced with Privacy and data protection
7. Human oversight and determination: AI should not displace human responsibility and accountability.
8. Sustainability: assessed against the SDGs.
9. Awareness and literacy: Public understanding of AI
10. Fairness and nondiscrimination: AI should promote social justice, fairness and take an inclusive approach.

Figure 4.2. UNESCO's policy areas on ethics of AI (Source: UNESCO, 2023)

4.3 Safe AI

According to Deloitte when using AI, personal details like names, addresses might be used unintentionally leading to exposure and misuse of sensitive data. Further giving an example of how if a healthcare company, uses a retrieval system on patient records for medical professionals to access a patient's medical history this may also expose the data (Norton et al., 2025).

It is important when designing and developing AI that checks, mistake proofing, alerts, auto screening and blocking are in place to ensure no accidental or unintentional sensitive data is exposed beyond its intended use. It should also be built to comply with data privacy and protection laws such as GDPI which help define controls for data protection.

4.4 Secure AI

Deloitte reports that Palo Alto Networks reported that AI-Generated code was the top concern for security and information technology leaders. Further, Deloitte surveyed leaders who expressed concerns that AI might inadvertently amplify vulnerabilities increasing the risk of data breaches, malware, and other attacks (Norton et al., 2025).

It is important that in the design and development of AI, both machine and human enabled checks need to be in place to validate any potential vulnerabilities and ensure the AI system is secure, and all vulnerabilities discovered are fixed before release for use.

4.5 Inclusive AI

According to McKinsey where there is a strong focus on performance and operational requirements in the development of AI, there is less focus on ethical requirements (Mayer et al., 2025).

McKinsey research on 'Use of benchmarking for Gen AI tools'

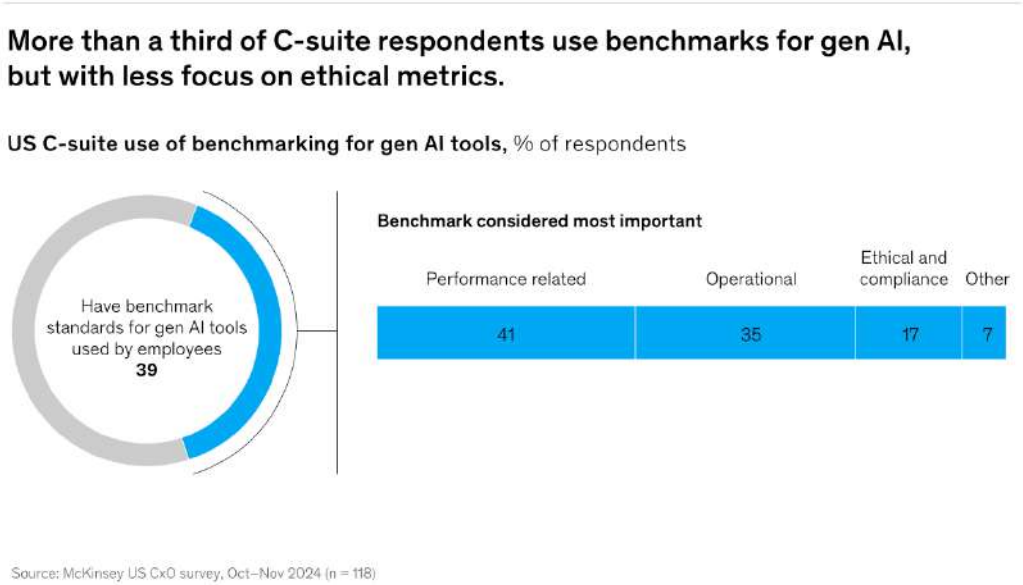

Figure 4.3. C-suite use of benchmarking for Gen AI tools (Source: Mayer et al., 2025)

Building AI with a sustainable approach needs to start at the very beginning rather than as an afterthought. This would be from conceptualization to design through development, its maintenance till

discontinuation. This would mean to have a sustainable design approach, one that is humane, human centric, inclusive, and circular.

While design is an important part of any implementation, there has been little engagement of design in AI. According to Churchill et al., (2018) there is little or no engagement of interaction designers or HCI researchers in the development of AI. There is a need for Human Centered AI that does not focus only on algorithmic performance but also human user needs and satisfaction. A key reason highlighted for this is to avoid, biased data sets, discrimination and privacy threats (Windl et al., 2022). Further they share that designers are unaware what AI can do. It is also said that privacy concerns and powerful predictive algorithms that threaten consumer autonomy can generate resistance (Carmon et al., 2019).

In their paper on 'Leading with AI for a sustainable future', Soans and Kostandinovic (2023) share that the human desire to increase our capabilities will drive the change and growth in AI and leadership is critical to ensure the change is a good for all. Further sharing a leadership model for AI which is Proactive, Responsible, Ethical, Collaborative, Inclusive, with a Systems Approach and with Empathy.

Leading with AI for a sustainable future – Leadership model

Figure 4.4. Leading with AI for a sustainable future (Source: Soans and Kostandinovic, 2023)

The design and development of AI need a Human centric approach understanding how interested parties would be impacted by this solution. Interested parties could be investors, customers, suppliers, society operating in and all persons working with the existing process - Business Owners, Investors, Employees, Customers, Suppliers, and Society.

4.6 Stakeholder Safeguards

4.6.1 Business owner and investor protection

To ensure business owners and investor protection and a vision to provide a return on investments, leaders need to understand:

- Market need for the solution is validated through appropriate studies and tests.
- Solution is able to meet customer requirements verified through prototyping.
- Risks and challenges, dependencies and constraints in bringing the solution to market is evaluated and tested.
- Most of all it needs to be Scalable either through new markets, solving new challenges, or creating iterations of the solution.
- Securing assets and ethical use of assets should follow compliance activities such as Intellectual Protection and Copyright to ensure protection of one's own work and credit for the work of others.

4.6.2 Employee safeguards

One of the most interested parties impacted by the implementation of AI are employees of the processes that the AI will impact. It should not be that one night these employees wake up to know that their roles have changed or are not there. Therefore, it is imperative that leaders who lead such AI initiatives, need to be aware of how their decisions with AI can impact these employees and enable a process for employees to transition from the old to the new process by:

- Ensuring proactive information and participation of employees in the change and to address any resistance to change.
- Engaging workers in the design and development process. Given their wealth of knowledge and experience in these processes and with customers, the would be key to the development of the solution to be effective and meet customer requirements.
- Create learning and development activities to enable workers to transition to new or alternate solutions with new or enhanced skills provided by the organization.

According to Saenz et al (2020) the greatest potential of AI will come from tapping the potential of mutual learning between people and machines. They further share that in a study carried out on 20 case studies, many organizations underestimated the value of using predictive capabilities of algorithms with human capability of intuition leading to missed opportunities.

They suggest that machine and humans can work together to increase the capability of AI. Combining human awareness and AI systems design can make different configurations. Creation of a collaborative approach in the AI strategy will only enhance the outcomes rather than deploying a competitive approach which may limit the outcomes.

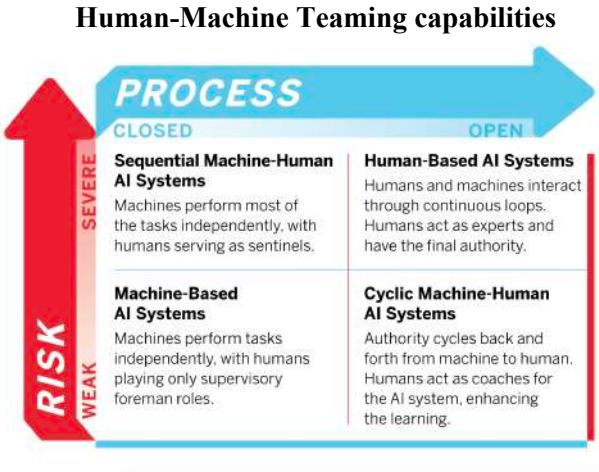

Figure 4.5. Designing AI systems with Human-Machine teams (Source: Saenz et al., 2020)

4.6.3 Customer Care

Customers' needs are critical for the success of any product or service and need steps to ensure customer needs are known, validated and confirmed to:

- Evaluating customer needs is critical to know if the product is addressing a known gap.
- Validating customer needs through prototyping and testing would be essential to ensure the product or service meet the needs of the target customers.
- Enabling customer participation in the design and development ensures early validation of customer requirements and also builds knowledge for improving customer experience.
- Ensuring use of data for training that represents all target customers. Target customers can be diverse in their own way. Learning and understanding the target groups and their diverse needs would go a long way in building sustainable products.
- AI is a data centric product or service. Therefore, it is important that this data is also free of bias that can impact its customers in any way. To ensure data is bias free we need to have systems and processes in place to eliminate any potential bias and plans to mitigate any risk in the data.

In the world of AI, data plays a critical role especially in Machine Learning. Much of this data can also come from content which is widely available. According to McKinsey, (Mayer et al., 2025) there are initiatives to improve explainability allowing for output of models to be tracked back to the information that created the decision. Deloitte (Norton et al., 2025) shares about the Data and Trust Alliance's Data Provenance Standard a collaborative effort of 19 corporations to document leading practices. The transparency coalition call on, for 'Do not train' data designation to prevent the use of any data and act as a copyright.

The transparency coalition additionally, has come out with new command concepts to infuse data transparency, such as Training data verification requests, Training data deletion requests etc. (Transparency Coalition, 2025)

According to Soans and Kostandinovic (2023) data needs to be diverse to avoid risk of bias and discrimination so as to ensure inclusive outcomes. Further diversity is not just limited to a single frame but can be from an intersection of various frames. According to R Rajagopal and Provodnikova (2024) a person can have multiple dimensions of diversity, called intersectionality. It is important that relevant data for target customers, their dimensions and intersectionality are adequately sourced for training and

development to avoid bias in the AI. Intersectionality is about structures that makes certain identities the consequence of vulnerability (Crenshaw et al., 2013 cited in R Rajagopal and Provodnikova, 2022). Every attempt should be made to avoid bias of any kind and intersectionality is sometimes overlooked as dimensions are validated in singularity.

4.6.4 Supplier Partnership

Suppliers play a critical role in the AI journey and could be impacted by either termination, revision or inclusion. Either way, there needs to be a structured approach to engage with suppliers to ensure

- Proactive communication to existing suppliers to determine the feasibility for change.
- Collaborative plan to sunset existing inputs with minimal impact to suppliers of the existing process.
- Clarity of information on the inputs needed to ensure new inputs received meet desired requirements.

4.6.5 Society Relationship

In the implementation of AI, society too is significantly impacted. Society is represented as customers, suppliers, resources, employees, and the economy.

Societies may also benefit from AI and its data centers. According to research by PWC, they could be in the form of jobs, improved education systems, increase in Research and Development, internet connectivity, infrastructure, revenue for local businesses, and GDP (PWC, 2023).

To ensure an inclusive approach for AI on society it would require:

- Studies to verify impact of AI on the impacted societies.
- Further awareness of all positive and negative impacts to society to be made transparent as part of this implementation.
- Participation of society in planning and development of the solution will ensure inputs that may have impact on the solution design.
- Appropriate verification and adherence to local regulations to ensure compliance as local regulations are built to ensure protection of local communities.
- Conducting studies and sharing insights on how the local economy can benefit will create a well thought through design.
- Collaborative working to ensure improved solutions that benefits the solution and society.

As there may be both positive and negative impacts to society due to AI and its data centers, planning data centers without understanding the impact to society, can lead to the resistance to the very societies that they may benefit. To work collaboratively, data centers can pivot to how renewable energy can be generated from the large surface areas these data centers cover. Adapting renewable energy, it can transform from a high consumption consumer draining energy from the grid to a provider of energy to these communities. It can shift from creating pollution from generators to a source of clean energy. From depleting neighboring water resources, data centers can create improved freshwater recycling through systems such as capturing vapor from evaporative cooling. Instead of deforestation, it should determine how it can adapt forest cooling to reduce temperature, noise and vibration to the community. From inheriting bias, it can transform to build inclusivity. From volatility in economies, it can provide stability through improved insights and value.

It is imperative that when AI and its supporting system such as data centers are being conceptualized, designed and developed the impact it creates to society needs to be factored and designed for. A systems approach in creating a positive impact and limiting negative impacts.

5 Inclusive and sustainable design

An inclusive and sustainable design is one that can encapsulate multiple dimensions of success:

- Self
- Environment
- Social
- Economy

This can also be called the SE^2 model (Self, Environment, Social, Economy)

The SE^2 Model for Inclusive and Sustainable design

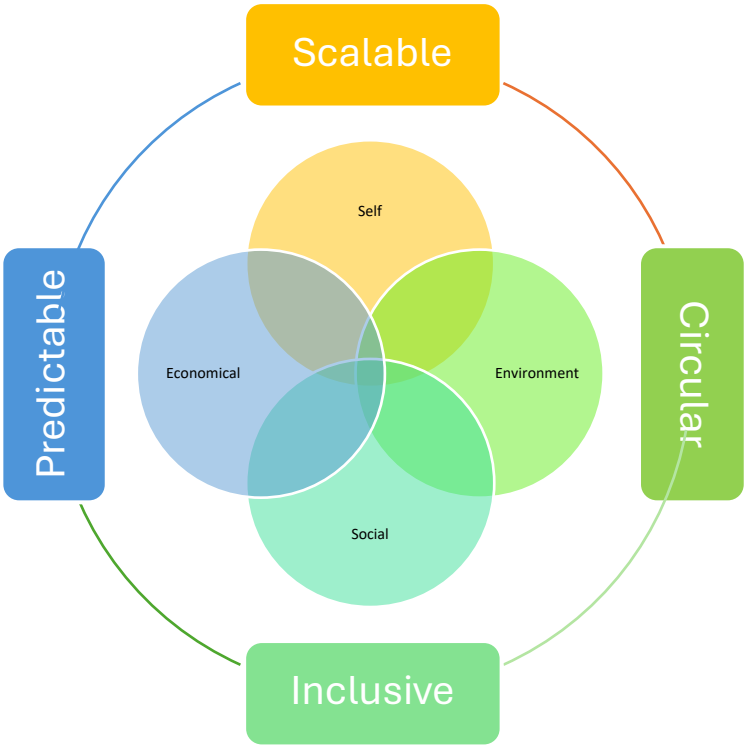

Figure 5.1. SE^2 Model for Inclusive and Sustainable design (Source: authors' own)

5.1 Four entities for sustainability

The focus to sustainability would need to be on the four key entities of Self, Environment, Economy and Social.

5.1.1 Self:

Sustainability starts with the ability for Self to sustain growth and profitability consistently. Organizations developing AI solutions need to evaluate, design and develop AI with the intent to ensure these solutions have the ability to grow. To be sustainable, the AI design needs to be feasible, viable and desirable. This means it should meet the customers requirement, is technically possible and is financially viable. It also needs to ensure growth where the design is scalable.

5.1.2 Environment:

All activities have an impact on the environment directly or indirectly. It could impact the present affecting life on the planet, or its impact to other living organisms, it could also have an impact on the environment of the future. A sustainable AI design needs to ensure the ability to understand the environmental impact of such solutions, be it deforestation to create data centers, the demand for energy utilizing critical limited resources, or the emission of greenhouse gases which are outcome of these data centers energy needs. Data centers also have high impact on water, light and sound. The creation of Green data centers will enable a positive impact to the planet and a more inclusive one.

5.1.3 Social

Society is diverse, with diverse needs and expectations and any solution in AI needs to be inclusive to create, build and improve talent locally. It also needs to enable growth in markets it caters to or in geographies it operates from. An inclusive approach will be including all interested parties in it design-to-decline stage planning and implementation.

Further processes and supply chains for all resources including that of human talent need to be circular. This will enable a positive impact to environment, society, lower the risk of resistance and regulatory penalties, greater desirability to its customers increasing adoption and growth and value to stakeholders.

5.1.4 Economic

Vagadia (2020) suggests that while the analysts predict a growth in GDP, it can also have a negative outcome when services provided by AI is free, disrupting exiting chargeable services, which may have negative impact on the GDP. They also state that the positive impact of AI is also mirrored by its destabilizing effect on economy and social life. Additionally, he suggests it could have an impact on wages, job losses, and inequality.

Deployment of AI needs to be predictive on its impact on the economy both locally and globally. This calls for greater understanding of its systemic impact and to be transparent to show how these solutions can both be positive, negative or both in various contexts. Providing predictive insights on the economic viability is critical for economic sustainability in the markets it operates from or impacts.

6 Conclusion

AI can be a source for great positive change. Today its business attractiveness is enticing many to explore AI and LLMs as service and product providers and the numbers will only grow. All this is happening while still guardrails are still being understood and built. If AI needs to continue to lead to be a positive force for change, AI development needs to be planned, structured, managed, built inclusive, sustainable and evaluated for Business, Environmental, Social and Economical sustainability right from its design stage to its degeneration. This would need to be by using circular approaches in utilization of resources be it people or the other resources of the planet. It also needs to be inclusive to ensure incremental value and not detrimental value to all its stakeholders including its investors, employees, customers, society and the economy.

References

Alicke, K., Rachor, J., and Seyfert, A. (2016) 'Supply Chain 4.0 - the next-generation digital supply chain*'*.

Anthes, G. (2017) 'Artificial intelligence poised to ride a new wave'. *In Communications of the ACM* (Vol. 60, Number 7, pp. 19–21). Association for Computing Machinery. https://doi.org/10.1145/3088342 (Accessed: 02 December 2025)

Bughin, J., Seong, J., Manyika, J., Chui, M., and Joshi, R. (2018) 'Notes from the AI frontier: Modelling the impact of AI on the world economy*'*. https://www.mckinsey.com/featured-insights/artificial-intelligence/notes-from-the-ai-frontier-modeling-the-impact-of-ai-on-the-world-economy (Accessed: 04 March 2026)

Bush, M. E. (2025, October) 'Construction and Consequences: The Human Impacts of Artificial Intelligence Data Centers'. *Human Rights Institute Blog - University of Alabama at Birmingham.*

Carmon, Z., Schrift, R., Wertenbroch, K., and Yang, H. (2019) 'Designing AI Systems That Customers Won't Hate*'*. https://mitsmr.com/2qY8i35 (Accessed: 03 December 2025)

Chen, A. X. (2025, September) 'A.I. Is on the Rise, and So Is the Environmental Impact of the Data Centers That Drive It'. *Smithsonian Magazine.*

Chui, M., Roberts, R., Yee, L., Hazan, E., Singla, A., Smaje, K., Sukharevsky, A., and Zemmel, R. (2023) 'The economic potential of generative AI: The next productivity frontier*'*. *McKinsey & Company, (2023)*

Churchill, E. F., Van Allen, P., and Kuniavsky, M. (2018) 'DESIGNING AI*'*. https://dl.acm.org/doi/pdf/10.1145/3289188#page=37 (Accessed: 06 January 2026)

Francis, J. (2024, November) 'Why 85% of your AI models may fail. *Forbes Technology Council'*.

Gartner. (2024, July) 'Gartner Predicts 30% of Generative AI Projects Will Be Abandoned After Proof of Concept By End of 2025'. *Gartner Press Release.* https://www.gartner.com/en/newsroom/press-releases/2024-07-29-gartner-predicts-30-percent-of-generative-ai-projects-will-be-abandoned-after-proof-of-concept-by-end-of-2025 (Accessed: 13 March 2026)

Gartner. (2025, September) 'Gartner Experts Answer the Top Generative AI Questions for Your Enterprise'. *Gartner*.

IEA. (2025) 'Energy demand from AI. *Energy and AI'*.

Kandasamy, A. (2025, September) 'More data centers, more environmental problems? National Wildlife*'*.

Kinzler, R. (2023) 'AI AND YOU: HOW ARTIFICIAL INTELLIGENCE SHAPES OUR DAILY LIVES*'*. https://doi.org/10.13140/RG.2.2.26650.82881 (Accessed: 02 December 2025)

Lee, K., Cooper, F., and Grimmelmann, J. (2024) 'Talkin' 'Bout AI Generation: Copyright and the Generative-AI Supply Chain'. *Journal of the Copyright Society of the U.S.A.*, *2024*.

Loucks, J., Crossan, G., Sarer, B., Widener, C., and Bucaille, A. (2024, November) 'Autonomous generative AI agents: Under development'. *Deloitte - Tech, Media & Telecom*. https://www.deloitte.com/us/en/insights/industry/technology/technology-media-and-telecom-predictions/2025/autonomous-generative-ai-agents-still-under-development.html (Accessed: 06 January 2026)

Lu, E. (2024, April) 'Why do AI projects fail*'*. *Towards Data Science*.

Marr, B. (2019, December) 'The 10 Best Examples Of How AI Is Already Used In Our Everyday Life'. *Forbes - Innovation - Enterprise Tech*.

Mayer, H., Yee, L., Chui, M., and Roberts, R. (2025, January) 'Superagency in the workplace: Empowering people to unlock AI's full potential'. *McKinsey & Company*.

Microsoft. (2025) 'Generative AI vs. other AI types*'*. *Microsoft*. https://www.microsoft.com/en-us/ai/ai-101/generative-ai-vs-other-types-of-ai (Accessed: 08 April 2026)

MSV, J. (2025, June) 'From Adoption To Advantage: 10 Trends Shaping Enterprise LLMs In 2025'. *Forbes*.

Norton, K., Li, T., Davis, T., Mossburg, E., Kearns-Manolatos, D., Bansode, S., Thomas, C., and Ferrer, A. B. (2025, February) 'How can tech leaders manage emerging generative AI risks today while keeping the future in mind?' *Deloitte*.

OECD. (2025) 'As AI use grows, so do reported incidents*'*.

PWC. (2023) 'Economic, Environmental, and Social Impacts of Data Centers in the United States Including Statewide Impacts for Arizona, Ohio, and Virginia*'* *pwc*. www.datacentercoalition.org (Accessed: 04 March 2026)

R Rajagopal, L., and Provodnikova, A. (2023) 'Building A Thrive Mindset And Heartset In The Age Of AI'. *Global Journal of Business and Integral Security*. https://doi.org/10.2139/ssrn.5177443 (Accessed: 04 March 2026)

R Rajagopal, L., and Provodnikova, A. (2022) 'REDUCING INEQUALITIES THROUGH INTERSECTIONALITY*'*. SSBM

R Rajagopal, L., and Provodnikova, A. (2024) 'Creating metacognitive strategies to unlock potential'. In *SSRN*. SSBM.

Raman, R., Pattnaik, D., Lathabai, H. H., Kumar, C., Govindan, K., and Nedungadi, P. (2024) 'Green and sustainable AI research: an integrated thematic and topic modeling analysis'. *Journal of Big Data*, *11*(1). https://doi.org/10.1186/s40537-024-00920-x (Accessed: 06 January 2026)

Saenz, M. J., Revilla, E., and Simón, C. (2020) 'Designing AI Systems With Human-Machine Teams*'*. https://mitsmr.com/33yyiRl (Accessed: 05 January 2026)

Schank, R. C. (1987) 'What Is AI, Anyway?*'*

Slattery, P., Saeri, A., Grundy, E., Graham, J., Noetel, M., Uuk, R., Dao, J., Pour, S., Casper, S., and Thompson, N. (2024) 'The AI Risk Repository: A Comprehensive Meta-Review, Database, and Taxonomy of Risks from Artificial Intelligence*'*. https://doi.org/10.48550/arXiv.2408.12622 (Accessed: 06 January 2026)

Soans, F., and Kostandinovic, B. (2023) *'*LEADING WITH AI FOR A SUSTAINABLE FUTURE*'*

Tello, J., and Subramanian, L. (2022) 'The magic behind turning data into profit*'*.

Transparency Coalition. (2025) 'TCAI urges adoption of 'Do Not Train' data and Training Data Request prompts'. *Transparency Coalition.*

UN. (2020, December) 'Bias, racism and lies: facing up to the unwanted consequences of AI'. *UN News*.

UNESCO. (2023) 'UNESCO's Recommendation on the Ethics of Artificial Intelligence. Artificial Intelligence & Emerging Technologies*'*.

United Nations. (2019) 'E SDG Poster 2019_without UN emblem_PRINT. In SDG Poster*'*. (https://www.un.org/sustainabledevelopment/news/communications-material/ (Accessed: 23 April 2026)

Vagadia, B. (2020) 'Digital Disruption'. *Switzerland: Springer International Publishing*.

van Wynsberghe, A. (2021) 'Sustainable AI: AI for sustainability and the sustainability of AI. AI and Ethics*'*, *1*(3), 213–218. https://doi.org/10.1007/s43681-021-00043-6 (Accessed: 06 January 2026)

Verma, A., Sharma, P., Patwari, P., Ferrer, A. B., Kearns-Manolatos, D., and Alibage, A. (2025, February) 'Four data and model quality challenges tied to generative AI'. *Deloitte Center for Integrated Research*.

Widder, D. G., and Nafus, D. (2023) 'Dislocated accountabilities in the "AI supply chain": Modularity and developers' notions of responsibility'. *Big Data and Society*, *10*(1). https://doi.org/10.1177/20539517231177620 (Accessed: 22 March 2026)

Windl, M., Feger, S. S., Zijlstra, L., Schmidt, A., and Wozniak, P. W. (2022, April 29) 'It Is Not Always Discovery Time: Four Pragmatic Approaches in Designing AI Systems'. *Conference on Human Factors in Computing Systems - Proceedings*. https://doi.org/10.1145/3491102.3501943; (Accessed: 06 January 2026)

Yañez-Barnuevo, M. (2025, June) 'Data Centers and Water Consumption'. *EESI*.

Zewe, A. (2023, November) 'Explained: Generative AI'. *MIT News*.