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From Farm to Fork: The Role of AI in Advancing Sustainable Business Practices

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ABSTRACT

This study examines how artificial intelligence (AI) supports environmental and social sustainability in the Icelandic food industry across the full value chain—from production to retail. Using a qualitative design, five semi-structured interviews were conducted with senior executives from food production, processing, and distribution firms. Thematic analysis revealed that AI is primarily applied for automation, quality control, energy efficiency, and workplace safety. Although not initially adopted for sustainability purposes, AI delivers indirect benefits such as reduced material use, lower energy and water consumption, and minimized food waste. For instance, AI-based quality control improved efficiency in meat and fish processing, while predictive tools enhanced inventory accuracy in retail. Importantly, no evidence was found of rebound effects or increased resource use. Instead, AI contributes to sustainability mainly through operational improvements. Its adoption is largely driven by external factors such as labor shortages, regulatory pressures, and consumer expectations. Despite its promise, challenges remain, particularly in data-sharing, implementation costs, and public trust. The study highlights the importance of embedding AI in broader ethical and sustainability frameworks to ensure its long-term contribution to responsible food system transformation.

1. INTRODUCTION

There has been a growing interest in both academic and practical circles regarding the integration of sustainability within corporate value chains in recent years. It is now widely recognized that achieving sustainability targets requires aligning internal business operations with environmental and social concerns, while engaging external stakeholders, such as suppliers and consumers, across the entire value chain [1]. Within this framework, the sustainability goals of suppliers and the expectations and behaviors of customers are seen as vital elements in shaping a company's overall sustainability outcomes.

The Scope 1, 2, and 3 emissions framework helps us better understand environmental sustainability in value chains. Scope 1 refers to direct emissions from sources owned or controlled by the company. Scope 2 includes indirect emissions resulting from the production of purchased energy. Scope 3 encompasses all other indirect emissions throughout the upstream and downstream value chain [2]. This holistic approach emphasizes the need for integrated strategies that consider the comprehensive environmental impact of corporate activities.

Alongside these shifts, the rapid advancement of artificial intelligence (AI) has introduced novel technological capabilities that can improve operational efficiency. AI-driven tools are increasingly utilized for data analysis, optimization, and automation in business processes. While the resulting efficiency improvements, such as lower energy and water consumption, may yield positive environmental and social outcomes, the direct contribution of AI to sustainability goals within value chains remains insufficiently addressed in academic research.

This paper sets out to investigate the role of AI in supporting sustainability throughout the value chain, with a particular emphasis on the food sector. It explores how AI can enhance environmental and social sustainability in food production, processing, and distribution. The food industry is particularly pertinent due to its fundamental role in ensuring human health, food security, and safety [3], as well as the array of sustainability challenges it faces, including water consumption, fertilizer usage, animal welfare, and food waste [4]. Globally, food systems are responsible for nearly one-third of greenhouse gas emissions, positioning the sector as a critical area for environmental policy intervention. For example, the European Commission's Farm to Fork Strategy, part of the European Green Deal, seeks to establish a fair, healthy, and sustainable food system [5].

Emerging research indicates that food systems are particularly vulnerable to the impacts of climate change, which can affect agricultural yields, nutritional value, and food safety [6-8]. As such, improving sustainability in food value chains aligns with several United Nations Sustainable Development Goals (SDGs), including SDG 2 (Zero Hunger), SDG 12

(Responsible Consumption and Production), and SDGs 14 and 15 (Life Below Water and Life on Land) [9].

AI is increasingly seen as a tool capable of advancing sustainability agendas, mainly due to its ability to detect patterns and generate insights from large volumes of data [10]. These systems are engineered to perform tasks typically performed by humans or those beyond human capability [11]. Recent progress in machine learning and deep learning has significantly broadened AI's scope. Machine learning employs statistical techniques that enable systems to learn and improve based on the data. In contrast, deep learning has successfully identified complex patterns in large-scale datasets, including images, speech, and textual information [12].

This study examines how Icelandic food industry companies utilize AI technologies to drive sustainability initiatives. It focuses on applying AI tools, including automation and predictive analytics, as well as resource optimization, across various stages of the food value chain.

The paper is structured as follows: first, we provide a literature review to clarify key concepts and terminology related to AI and sustainability in value chains. An explanation of our research methodology follows this. We then present the findings based on qualitative interviews with stakeholders from the Icelandic food industry. Finally, we discuss the implications of these findings and propose future research directions.

2. LITERATURE REVIEW

2.1 Sustainability in the food industry value chain

Seuring and Müller [1] conceptualized a sustainable value chain as one that synchronizes the management of material, informational, and financial flows with stakeholder coordination throughout the production, distribution, and consumption stages. Crucially, this coordination must simultaneously address environmental, social, and economic goals. This tripartite framework highlights the inherent complexity of integrating sustainability into corporate activities, where balancing competing priorities often leads to trade-offs [13].

Building on this approach, the Food and Agriculture Organization [3] introduced the Sustainable Food Value Chain Framework, which promotes a comprehensive integration of sustainability across all phases of the food chain, encompassing production, processing, distribution, and consumption. This integration is underpinned by robust governance mechanisms, which include contractual arrangements, institutional alignment, and active engagement from private sector actors.

Environmental sustainability in food value chains encompasses diverse concerns, including greenhouse gas emissions, water use, biodiversity preservation, waste management, and safeguarding soil health and ecosystems. Social sustainability encompasses labor rights, occupational health and safety, cultural values, community well-being, nutrition, and animal welfare. Meanwhile, economic sustainability is concerned with profitability, employment creation, fiscal contributions, and the long-term resilience of food supply systems [3].

At the policy level, the European Commission's “Farm to Fork” strategy articulates food system sustainability within the broader aims of environmental protection and public health [4]. This strategy envisions a shift toward food systems that are climate-resilient, resource-efficient, and socially equitable, while simultaneously ensuring competitiveness and nutritional adequacy. Achieving these goals requires building resilience in the face of ecological and economic disruptions, minimizing chemical inputs, and addressing persistent inefficiencies, such as food waste and energy-intensive logistics.

Contemporary scholarship increasingly advocates for a dynamic understanding of food system sustainability, emphasizing adaptability and interconnections across multiple levels, from local production to global supply chains [14, 15]. Scholars now call for "transformative" approaches that move beyond incremental improvements and seek structural change in institutional arrangements, power dynamics, and consumption habits [16]. This shift opens new avenues for investigating the potential contributions of AI.

2.2 Artificial intelligence and the pursuit of sustainability

AI has gained prominence as a potentially disruptive enabler of innovation aligned with sustainability objectives. AI technologies excel at processing large datasets, identifying complex patterns, and supporting automated decision-making, which can collectively enhance operational performance [10]. These capabilities are particularly advantageous in industries like food production and distribution, where operations are inherently complex and data-intensive.

AI's applications in sustainability encompass resource efficiency, predictive maintenance, waste minimization, and supply chain optimization. For example, AI can forecast agricultural yields or consumer demand, enabling precise production scheduling and reducing excess inventory and spoilage. Moreover, machine learning and deep learning models can simulate various operational scenarios, improving system-wide logistics and energy use.

Nonetheless, the literature also points to several challenges and dilemmas. Barriers such as implementation costs, a shortage of skilled personnel, and internal resistance can impede AI adoption. Ethical and societal concerns, including privacy risks, algorithmic discrimination, surveillance, and job displacement, are especially pressing in labor-intensive sectors that rely heavily on seasonal or low-skilled workers [17]. Researchers [18] caution that while AI may deliver incremental sustainability gains, it could also perpetuate unsustainable production systems without accompanying institutional reform.

Dauvergne [18] critically examines the assumption that technological efficiency directly leads to sustainability. He warns of rebound effects, where increased efficiency lowers costs and stimulates consumption, amplifying environmental impact. Additionally, the high energy demand associated with certain AI technologies, particularly those requiring intensive computation and large datasets, may conflict with carbon reduction targets [17].

These challenges underscore the importance of integrating AI within responsible governance frameworks that foster ethical, inclusive, and context-aware innovation. A growing body of literature advocates for a "responsible AI" agenda that balances technological outcomes with broader social legitimacy and ecological considerations [19].

2.3 Artificial intelligence and the pursuit of sustainability

AI presents multiple opportunities to intersect with sustainability initiatives within the food sector. One significant contribution is enhancing transparency and traceability throughout the value chain, allowing stakeholders to access real-time data for improved decision-making [6]. AI supports smart farming practices, including crop surveillance, precision irrigation, and animal health monitoring, at the production level, which are key pillars of digital agriculture.

Climate adaptation is another critical domain for AI applications. Predictive analytics can help anticipate extreme weather, pest infestations, or logistical bottlenecks, enabling food system actors to take proactive measures [6]. In food processing, AI-driven quality control systems provide efficient, non-invasive product inspections, resulting in reduced food waste compared to manual inspection methods [20, 21].

Furthermore, AI can significantly enhance logistics by streamlining transport routes, tracking environmental conditions during delivery, and minimizing energy consumption and spoilage. These capabilities are especially relevant in cold chains and other time-sensitive supply contexts.

These AI applications demonstrate their dual function as technological enablers and strategic tools for sustainability in the food industry. However, their full potential depends on policy support, ethical oversight, and sensitivity to local needs and infrastructure limitations.

3. MATERIALS AND METHODS

The objective of this study is to investigate the extent to which AI is being applied to advance corporate sustainability objectives in the food sector. It used a qualitative approach, relying on semi-structured, in-depth interviews with participants representing various points along the food value chain.

Five interviews were conducted: one with a stakeholder involved in food production, three with executives from food processing firms, and one with a representative from the retail distribution segment. The production and processing stage interviewees included senior leaders responsible for sustainability and quality control, innovation management, AI implementation, strategic development, and value chain coordination. The retail distribution interviewee was the company's chief executive officer. An interview overview table is provided below (see Table 1).

A purposive sampling method was adopted to ensure the inclusion of key actors with relevant expertise from different segments of the value chain. This targeted approach was chosen to obtain in-depth, context-specific knowledge about how AI is operationalized in sustainability initiatives. The methodology's strength lies in capturing a range of strategic and operational perspectives within the industry.

Given the exploratory nature of the research, the study does not aim to generalize findings beyond the Icelandic food industry. It does not include direct comparisons with international cases, though such comparative studies are suggested for future research. Cross-country investigations could provide valuable insight into how institutional settings, regulatory environments, or technological maturity influence the use of AI for sustainability purposes.

Interviews were conducted virtually using videoconferencing platforms between February and April 2023. Each session lasted between 60 and 90 minutes and was recorded using Otter.ai transcription software. Both researchers reviewed the transcripts for accuracy. One researcher conducted the initial coding of the transcripts, and the coded material was then analyzed by the second. To strengthen the reliability of the analysis, the second researcher also reviewed the coding, and the two researchers collaboratively interpreted the data and derived conclusions.

Table 1. Interview overview

#	Date	ID	Company	Part of the FVC	Position and Background
1	14.03.23	I1	CO1	Food Processing	Automation Center Manager, Automation and Emerging Technologies Innovation
2	20.03.23	I2	CO1	Food Processing	Sustainability Project Manager, Sustainable Innovation
3	24.03.23	I3	CO1	Food Processing	Director, Strategic Partnerships & Programs, Global Innovation Leadership Team
4	28.03.23	I4	CO2	Fishing and Processing	Chief Innovation Officer, Innovation and Climate Affairs
5	04.04.23	I5	CO3	Purchasing, Warehousing, Distribution (+ Retail)	Managing Director, General Management

The semi-structured interview protocol covered five key areas of inquiry (presented as well in Table 2):

- The company's current use of AI and the interviewee's definition of AI.
- The degree to which AI is embedded in corporate strategic planning or how AI relates to sustainability, particularly in goal formulation and implementation.
- The observable effects of AI on business operations and the value chain components where these effects are most pronounced.
- Obstacles to the broader adoption of AI technologies in the food sector.

Follow-up questions and clarifying probes were used to encourage elaboration and uncover emerging insights. Analytical triangulation between the two researchers during the coding and interpretation phases helped to reinforce methodological robustness, ensuring both consistency and credibility of findings. Table 3 provides a flowchart of the research approach.

Overall, this research design was developed to provide a detailed understanding of how AI is perceived and applied in the context of sustainability transitions within the Icelandic food industry. By drawing on the experience of senior industry practitioners, the study contributes practical perspectives to the broader academic dialogue on digital transformation and sustainable value chain management.

Table 2. Interview guide

Category	Description	Question
Briefing	Setting the stage	Confirming consent to transcription and use of personal data Clarification of the time frame of the interview and any other questions, if available
Introduction	Background of Interviewee	Could you elaborate on your role at COX, i.e., your responsibilities, tasks, and area of expertise?
Strategy	Integration of AI	Does COX use a specific definition of artificial intelligence? If yes, which definition is that? To what extent does COX integrate AI into its strategy and vision? What are the main objectives for AI integration at COX?
Value Chain	Understanding of the value chain and where AI is most impactful	Could you outline the current state of COX's AI integration /implementation in the value chain? Are there parts of the value chain (within COX and upstream and downstream) where AI is particularly impactful? Which ones and how so?
Sustainability	Relationship between sustainability and AI	Does COX use AI with the specific objective to support the achievement of sustainability goals? Even if the answer to the previous question might be *no* How does AI influence sustainability at the different stages in the value chain? Where do you see the most significant potential for AI to support sustainability along the value chain?
Applications & Potential	Illustration of applications and assessment of AI's potential within the industry	Are there any additional areas of application (along the value chain) you can imagine leveraging AI for? Out of total investments, how much does COX invest in AI?
Limitations	Challenges and limitations	Do you see any major hurdles for further integration of AI?
Debriefing	Round-up	Ensuring the interviewee has no further comments or remarks Clarifying availability and consent for possible follow-up questions and thanking the interviewee for participation

Table 3. Research flowchart

Step	Description
1. Research Design	Qualitative, exploratory study focused on the Icelandic food industry and AI use in sustainability.
2. Sampling Strategy	Purposive sampling of key actors across the food value chain. Criteria included medium-to-large firms, active AI application, and sustainability relevance.
3. Data Collection	Five semi-structured interviews were conducted via videoconferencing. Each session lasted 60–90 minutes and was recorded and transcribed.
4. Data Coding	Both researchers reviewed transcripts. Initial coding by researcher 1, followed by validation and refinement by researcher 2.
5. Thematic Analysis	Cross-case comparisons led to emergent themes. Categories were structured based on the interview guide.
6. Synthesis and Reporting	Findings presented through narrative, tables, and representative quotes from interviewees.

4. RESULTS

This section outlines the main insights from the interviews, organized according to the thematic categories established in the guide. The first part explores how participants conceptualize and utilize AI. The second explores its integration into broader corporate strategy. The third focuses on the perceived link between AI and sustainability outcomes. The fourth identifies areas within the value chain where AI has had the most significant impact. Finally, the fifth examines the key obstacles to wider adoption of AI in the food industry.

4.1 Definitions and uses of artificial intelligence

Interviewees offered varied but consistent interpretations of AI, acknowledging its complexity and evolving nature. While no single, fixed definition emerged, participants generally recognized AI as a broad and rapidly developing domain. One manager in food processing reflected:

"Management sees AI as the future for both design and production. We may not fully understand what that entails, nor do they, but we've initiated projects that generate clear, immediate results. That's helped our team recognize the value of adopting AI."

AI was primarily associated with process automation, image analysis, and monitoring temperature and energy use, commonly supported by machine learning tools. These were frequently described as foundational steps toward more advanced applications. Many respondents noted that AI holds potential throughout the value chain, with quality control repeatedly cited as a central use case, especially for real-time monitoring and intervention. As expected, data is critical in enabling AI by providing the transparency needed for informed decision-making.

Interestingly, the drive to adopt AI was not always internally motivated. In several cases, external partners, particularly customers or suppliers already utilizing AI, pushed companies toward adoption. A food production manager remarked:

"We understand how our value chain works, where we add value, and where sustainability fits in. We collect data throughout the process, although we haven't utilized AI to manage the chain directly. But our partners have, which shows us the path we'll need to take."

This comment highlights the ripple effect of AI adoption, suggesting that integration may accelerate as it becomes embedded in partner operations and industry standards.

4.2 AI as part of corporate strategy

AI is increasingly embedded within broader corporate strategies, often as part of wider digital transformation initiatives to boost efficiency. In several cases, AI plays a significant role in shaping the long-term vision for food production, particularly in terms of sustainability. One food processing executive explained:

"Sustainability means extracting as much value as possible from every gram of raw material and doing it at the lowest cost. AI is crucial in helping us achieve that."

The ability to collect and analyze data is a key enabler of this strategy, helping identify inefficiencies and areas for optimization. All interviewees emphasized the growing importance of data-driven decision-making. Still, the extent of strategic implementation varied across organizations.

One participant described how both conventional metrics and non-traditional inputs, such as community concerns, are being integrated into sustainability strategies:

"We track standard supply chain metrics and qualitative feedback, like how people feel about ship noise in the fjords. That data helped us consider switching to electric engines. To us, that's also part of sustainability."

The findings suggest that AI initiatives are not isolated but are often housed within departments focused on innovation, sustainability, and strategic development. However, companies are at different stages in their journey, particularly in terms of internal awareness and understanding of AI's full potential.

4.3 Sustainability benefits attributed to AI

While sustainability was not always the initial motivator for deploying AI, many of its benefits support sustainability objectives. These include efficiency improvements, waste reductions, and enhanced forecasting capabilities. In retail logistics, demand prediction tools were particularly praised for their ability to fine-tune inventory and reduce surplus. Across the board, firms reported hiring more sustainability professionals and using broader performance indicators to assess their sustainability progress.

One CEO noted the growing interconnection between sustainability and other key strategic aims:

"Sustainability is one of three main strategic pillars, alongside automation and digitalization. These linked advances in one area often drive improvements in the others. It's a competitive edge now, but also a matter of survival."

Participants expressed a comprehensive understanding of sustainability, including reducing raw material usage, lowering energy consumption, and minimizing operational waste. As one manager put it:

"AI helps us cut down on material inputs, save money, and improve efficiency. That's what sustainability means to us, it's all interconnected."

External forces, such as tightening regulations and environmental standards (e.g., emissions tracking, ESG compliance), also emerged as major drivers of AI adoption. Assigning financial values to environmental metrics, such as carbon emissions, was becoming more prevalent. Social expectations encouraged firms to innovate responsibly and reduce food costs, aligning with broader equity and inclusion goals.

4.4 Key areas of impact of the value chain

Most participants agreed that AI's current influence is most strongly felt in increasing precision during production and processing. Some emphasized that its usefulness extends to earlier phases, such as system design and layout. AI tools are used to model production workflows and evaluate whether machines operate at peak efficiency in terms of water and energy use.

The COVID-19 pandemic marked a turning point for many companies, underscoring the role of AI in enabling rapid responses to changing market conditions. One respondent recalled:

"When schools and restaurants shut down, we had to quickly retool our packaging lines for home use. AI made it possible to adapt quickly. Without it, we couldn't have kept up."

Investor expectations are also shifting. Several participants noted that demonstrating efficiency and humane practices is becoming critical for attracting capital. Concepts such as "green financing" and new "greenfield" production facilities are becoming increasingly relevant. In particular, monitoring and reducing waste, especially in meat and fish processing, was considered a significant asset.

Quality assurance was another area where AI has made significant inroads. While human inspectors were once the norm, participants acknowledged the limitations of manual inspection, including inconsistency and subjectivity. AI allows for comprehensive, real-time evaluation, even at high processing speeds:

"AI boosts both efficiency and savings. Companies that don't adapt will be left behind. One-third of all food is wasted, AI can help address that while improving public health and animal welfare."

4.5 Challenges to broader AI implementation

Despite strong enthusiasm for AI, several significant hurdles remain. A major issue is the sharing of data across the value chain. Participants emphasized that collaboration is essential for unlocking AI's full benefits, but trust and competitive concerns make data-sharing difficult.

"There's immense value in sharing performance data, but it requires trust. Otherwise, it becomes a big competitive risk."

Cost was another frequently mentioned barrier. High implementation costs and uncertain returns continue to deter some firms, although many believe that expenses will decrease over time as the technology becomes more mainstream.

Public perception was cited as a subtler, yet influential, barrier. Associations with controversial practices, such as animal slaughter or intensive resource extraction, can shadow technological innovations in the food sector. Still, respondents argued that AI could help shift this narrative by contributing to ethical goals, like reducing the number of animals needed for food, lowering emissions, and improving energy efficiency, in line with broader societal values.

5. DISCUSSION

This section evaluates the current applications of AI in Iceland's food industry. It considers how its role might expand to further support sustainability across the production, processing, and distribution stages. A review and insights from interviews with industry stakeholders representing multiple points along the food value chain inform the discussion.

5.1 AI as a driver of environmental and social sustainability

AI Academic research highlights numerous sustainability-related advantages of incorporating AI into food systems, particularly in terms of environmental and social outcomes. On the ecological side, AI technologies enhance efficiency by reducing inputs like water, fertilizers, and energy while maintaining or increasing productivity. Innovations such as precision agriculture, route optimization in logistics, and real-time energy monitoring exemplify these gains. From a social perspective, AI has been linked to improved food safety, reduced waste, and enhanced labor conditions, particularly when it replaces hazardous, monotonous, or physically demanding work.

Interview findings echo these trends. Across firms that have implemented AI solutions, the primary motivators were operational performance, automation, resource optimization, and data-informed decision-making. While these applications were not constantly introduced with sustainability as the explicit goal, they frequently produced positive environmental and social spillovers. AI-driven quality assurance, for example, enables continuous, non-invasive inspection processes that outperform manual checks in both accuracy and consistency, significantly benefiting food safety.

The findings of this study suggest that AI functions primarily as an enabler of sustainability through improved operational efficiency, rather than as a direct strategic driver of sustainability. While none of the firms interviewed implemented AI with sustainability as the core objective, many reported that AI tools inadvertently contributed to reduced material use, energy and water savings, and lower levels of food waste. In this sense, AI supports sustainability as a secondary benefit emerging from efforts to optimize production and resource use. The results confirm previous literature that frames AI as an indirect lever for sustainability [11], reinforcing the need for firms to explicitly embed ethical and sustainability criteria into digital innovation strategies to maximize impact [9, 14].

5.2 Ethical and infrastructural considerations

Contrary to some of the challenges emphasized in existing literature, such as a lack of digital infrastructure, high implementation costs, and insufficient technical capabilities, the Icelandic participants did not identify these issues as significant constraints. This discrepancy may reflect Iceland's strong digital foundation and high levels of technological adoption. Nonetheless, participants pointed out the importance of updating education and vocational training systems to keep pace with the evolving technological landscape and ensure that future professionals are equipped to work in increasingly AI-driven environments.

However, researchers and industry actors consistently viewed ethical concerns as critical. Trust in AI systems is crucial, especially when sensitive or competitive data is shared among firms or when AI informs critical operational or regulatory decisions. Ethical dimensions such as transparency, traceability, fairness, and accountability must be prioritized [22], especially given the potential consequences of failure in food safety, misinformation, or employment practices.

There is also growing awareness of AI's indirect environmental and social consequences. As noted by Dauvergne [18] and Ryan [17], efficiency does not automatically equate to sustainability. For example, productivity gains can lead to higher overall consumption, a phenomenon known as the rebound effect. Moreover, AI systems' energy demands and reliance on rare-earth elements for hardware infrastructure can contribute to additional environmental pressures, potentially negating some of the sustainability gains they aim to achieve.

Adoption of AI was primarily driven by external pressures such as labor shortages, regulatory compliance, and growing consumer expectations for transparency and sustainability [10]. Internal drivers included efficiency gains and risk reduction. However, several barriers were also identified, including high implementation costs, data availability issues, and resistance to change [5]. Notably, participants emphasized the challenge of integrating AI across organizational silos and the need for better infrastructure and training to support widespread adoption [13].

5.3 Toward responsible AI in food systems

Navigating these complexities requires developing a responsible AI framework specific to the food sector. This involves embedding AI innovation within larger sustainability and ethical strategies, ensuring that technological advancements align with the long-term health and resilience of food systems. Such a framework should be inclusive, incorporating the perspectives of all relevant stakeholders, farmers, processors, consumers, policymakers, and civil society, and flexible enough to evolve alongside technological developments.

The findings from this study suggest that Iceland's food industry is well-positioned to lead in adopting responsible AI. The combination of digital readiness, societal trust, and a culture of innovation provides a solid foundation. However, progress must be managed carefully, balancing the benefits of automation and efficiency with the need to uphold human-centered values and minimize ecological harm. This includes designing AI systems that reflect local conditions and priorities, as well as introducing oversight mechanisms to track their broader impact.

As the industry increasingly relies on data, establishing robust data governance practices will be vital. Ensuring ethical, secure, and reciprocal data sharing, particularly between firms that might also be competitors, will be a key area for future research and policy intervention. Transparency around data usage and decision-making processes will also be essential to maintaining stakeholder trust and upholding the legitimacy of AI in food systems.

Although AI contributed positively to sustainability outcomes, its role remains largely implicit. Few companies had formal policies linking AI use to corporate sustainability strategies, raising concerns about accountability and governance. This underscores the importance of developing responsible AI frameworks that align technological innovation with ethical standards and sustainability objectives [16]. Future progress will depend on stronger cross-sector collaboration, investment in digital capabilities, and clear regulatory guidance to ensure that AI serves long-term societal and environmental goals [12].

6. CONCLUSION

In summary, AI has significant potential to enhance the environmental and social sustainability of food value chains. Realizing this potential, however, depends on how AI is understood, deployed, and governed. Rather than treating AI solely as a technical fix, it should be embraced as a component of broader systemic change that embeds sustainability values into the core of food sector operations and decision-making.

This study is subject to several limitations. First, the small sample size, limited to five expert interviews, reflects the exploratory nature of the research and restricts the breadth of perspectives captured. Second, the focus on the Icelandic food industry introduces a strong regional context that may not be representative of other countries with different institutional frameworks, technological maturity, or regulatory environments. Future research would benefit from a broader empirical base, including cross-country comparative studies that examine how contextual factors shape the adoption and impact of AI in food value chains. Such comparative analyses could also help identify globally applicable patterns and context-specific challenges in aligning AI with sustainability goals. In addition, longitudinal research would provide valuable insights into the enduring effects of AI on sustainability metrics while also helping to uncover any unintended consequences or ethical challenges that may arise over time.

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