ISSN 2822-0323 (Online) January - June 2026

Green Governance Policies and Technology Transform the Drinks Business for Sustainable Development

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ABSTRACT

Objective: The global beverage business is undergoing a fundamental shift toward a circular economy, driven by the synergy between stringent green governance frameworks and cutting-edge technology innovation. This study aims to review green governance policies and technology that transform the drinks industry for sustainable development.

Methods: This paper is a qualitative systematic review of scholarly papers published in Scopus, Web of Science, and Google Scholar. The content analysis was employed.

Results: This transformation is characterized by the implementation of regulatory supervision to hold firms accountable for their environmental footprints. Simultaneously, innovations in AI-driven smart manufacturing, water reclamation systems, and bio-based packaging materials are divorcing industrial expansion from resource depletion.

Conclusion: By integrating these regulatory obligations with high-tech solutions, the beverage industry is successfully reducing its carbon and water intensity, transforming waste into value, and aligning corporate profitability with the global imperatives of sustainable development.

Keywords: green governance policies, digital transformation, technology, sustainable development, drinks business, sustainability

1. INTRODUCTION

Green governance policies are comprehensive methods for sustainable management that integrate environmental preservation into government operations and decision-making. These policies aim to minimize the government's environmental footprint by enhancing resource conservation and pollution reduction, and by promoting green practices in areas such as procurement, budgeting, and public sector operations. They also attempt to integrate environmental issues across multiple sectors to achieve climate goals and ensure long-term social and economic well-being. Given the pressing need for sustainable practices and the mitigation of environmental degradation, the global environmental landscape is undergoing a significant transformation. A thorough reevaluation of business practices is required because corporate industrial activities have contributed significantly to environmental challenges. Governments now use environmental regulations as a vital tool to address these problems and encourage companies to operate more sustainably. To promote long-term environmental, social, and economic benefits, businesses worldwide are increasingly paying attention to sustainability issues. The proposed Climate Governance Framework (CG-GD) reflects the growing trend toward smart governance and seeks to align with international green initiatives. In this context, strategic, collaborative methods that strike a balance between societal, economic, and environmental interests for sustainable development are referred to as "smart governance." To create a brilliant society, smart governance incorporates citizen engagement, effective government organization, strategic use of technology, effective leadership, cooperation, interoperability, strong digital infrastructure, and adherence to green governance principles. Green investment impacts green energy consumption by encouraging producers and consumers to use clean energy sources and by improving environmental quality (Firdousi et al., 2023).

Additionally, it has been demonstrated to reduce CO2 emissions, thereby promoting environmental sustainability. Green fiscal policies, like tax breaks and public assistance, significantly reduce energy poverty and increase energy efficiency. Furthermore, green finance has been recognized as a key driver of renewable energy deployment, encouraging the implementation of green initiatives. All things considered, green investment is essential for encouraging the use of clean energy and reducing environmental pollution (Gong et al., 2023). Since renewable energy efficiently reduces greenhouse gas emissions, which are major contributors to climate change, it is crucial for long-term sustainable development. Because of its potential to increase the frequency of extreme weather events, raise sea levels, and cause other environmental issues, climate change poses a significant threat to achieving sustainable development (Razmi et al., 2021). This study aims to review green governance policies and technology that transform the drinks industry for sustainable development.

2. LITERATURE REVIEW

2.1 Green Governance Policies

Green governance policies and sustainable development technologies are transforming the drinks business by emphasizing resource efficiency, waste reduction, and operational transparency. Effective green governance involves establishing systems of rules and practices that guide responsible environmental management across the entire value chain. Key policy areas include:

2.1.1 Environmental Risk Management

Environmental risk management identifying, evaluating, and addressing potential environmental risks, such as water scarcity and pollution, through regular assessments and regulatory compliance.

The practical application of sustainable practices will be guaranteed by the inclusion of green board committees in the governance structure. Additionally, enterprise risk management is an important tool for identifying risks that affect economic, social, and environmental practices while protecting the environment and community. The implementation of risk management ensures a coordinated and integrated response to different risks that could damage the company's reputation and financial performance (Shah et al., 2022). In the context of the conversation, integrating enterprise risk management and sustainability into a green governance framework will provide businesses with a range of ways to create value. Additionally, risks to society and the environment are predicted to negatively impact economies over the next 10 years. To reduce environmental, social, and governance (ESG) risks, corporate boards must implement enterprise risk management. As a result, the company may be exposed to a wide range of ESG-related risks through its business operations. The company's profitability would suffer significantly if the risks were not managed. Adopting enterprise risk management (ERM) is essential for managing new risks, given its extensive impact on the company's operations (Ali et al., 2021).

2.1.2 Target Setting and Reporting

Target setting and reporting measurable environmental targets (e.g., net-zero emissions by a specific date, water reduction goals) and reporting progress transparently through established frameworks such as the GRI Standards or the SBTi. The regulatory framework and enforcement mechanisms in place significantly affect how well government subsidy programs promote green transformation. To guarantee that subsidies are allocated to truly sustainable projects, a strong regulatory framework that outlines precise goals, qualifying requirements, and compliance standards is necessary. Maintaining program integrity and achieving desired environmental outcomes depend on effective enforcement mechanisms, including monitoring, reporting, and

penalties for non-compliance. The impact of subsidies may be weakened, and opportunities for abuse may arise from inconsistencies or gaps in the regulatory framework (Shan & Ji, 2024). It has been recognized that corporate board committees (GBC) are a key governance instrument that facilitates boardroom decision-making and improves corporate performance. Organizations have been prompted by a shift in risk perception to create specialized board committees capable of handling new ethical and sustainable challenges. The creation of a committee capable of managing and supervising stakeholder demands is also made possible by the increasing pressure from stakeholders (Burke et al., 2020). Since the green board committee supports the board of directors in tasks and decisions related to the company's sustainability, establishing GBC is crucial for businesses. Although GBC has been given different titles or names, its purpose and objectives remain the same, integrating sustainability throughout the company. According to Shah et al. (2021), GBC plays four crucial roles in ensuring the company's sustainability: strategy formulation, risk management, sustainability reporting, and management oversight.

2.1.3 Stakeholder Engagement

Stakeholder engagement is partnering with public and private entities, including suppliers, local communities, and NGOs, to advance environmental stewardship initiatives. Because corporate governance is regarded as a key mechanism for coordinating the interests of all stakeholders and propelling businesses toward sustainability, companies typically strengthen their corporate governance structures to promote such practices (Jan et al., 2021). Although a number of corporate governance frameworks have been developed to improve a company's performance, the idea of "green governance" has received less attention. The company's accountability to various stakeholders is reflected in the disclosure of reports on social and environmental sustainability practices (SESP), which enhances its performance and fosters a positive reputation (Hamad et al., 2020). By promoting social progress and protecting the environment, the pursuit of sustainable practices aims to increase stakeholder value and bring transparency to the business's operations. Businesses frequently implement environmental sustainability strategies to enhance environmental health by reducing the risk of pollution, climate change, global warming, and the depletion of natural resources, all of which negatively affect ecosystems.

Furthermore, the government is closest to the people and addresses issues at the local level. It is the local government of a rural, suburban, or urban area, where residents exercise self-government and manage their affairs and resources through derived powers, responsibilities, functions, and roles enshrined in the constitution or regulatory laws (Adekoya, 2020). As a third-tier organization, local government is ensured to have democratically elected representatives to oversee community resources and engage in value creation and grassroots development. The terms "local" and "government" combine to form the word "local government." Local refers to interactions between common people who are confined to the same

geographic area of villages, districts, communities, or municipalities and who share the same culture, tribes, values, customs, and language. The government is the legal body responsible for local community administration, self-government, and self-taxation (Adekoya, 2024). Furthermore, the establishment of a committee capable of managing and supervising stakeholder demands is made possible by the increasing pressure from stakeholders. Establishing Green Board Committees (GBCs) has become essential for businesses, as they support the board of directors with tasks and decisions related to the company's sustainability. Although GBC has been given different titles or names, its purpose and objectives remain the same, integrating sustainability throughout the company (Shah et al., 2022).

2.1.4 Circular Economy Commitment

The circular economy commitment involves implementing policies that prioritize a circular economy approach, focusing on returnable packaging, the use of recycled materials, and the minimization of single-use plastic. Industry-specific factors determine whether government subsidy programs are successful. These factors include the sector's environmental impact, the availability of green alternatives, and the degree of technological readiness. For instance, industries with established green technologies, such as renewable energy, might respond more favorably to subsidies than industries with few sustainable alternatives. Subsidy programs can have a greater impact and promote green transformation more successfully if they are customized to the unique requirements and features of each industry (Shan & Ji, 2024).

2.1.5 Sustainable Sourcing

Ensuring raw material sourcing is transparent and ethical, incorporating sustainable agriculture practices that balance business value with environmental and social impacts. Public procurement is more than just the process of acquiring goods and services; it is also a way to: promote and strengthen public policies (Romadiyanti, 2022); implement and drive government strategic policies, activities, and solve various societal problems (Allen, 2021; Uyarra et al., 2020); provide social value for the local community and its citizens (Gidigah, Agyekum & Baiden, 2021); solve issues like inequality, climate change, aging, and biodiversity loss (Kundu, James & Rigby, 2020; Selviaridis, Luzzini & Mena, 2023); and promote social and environmental sustainability and economic development. To achieve value creation, good governance, sustainable development, economic growth, and societal well-being, public procurement also promotes the green economy through fairness, equity, efficiency, product quality, competitive bidding, cost-effectiveness, and transparency in procurement. Public procurement enables the public sector to finance and carry out government initiatives in a variety of areas, including waste and the environment, power and renewable energy, agriculture, work and housing, health, education, and security. It entails purchasing, leasing, renting, or purchasing supplies (Bawole & Adjei-Bamfo, 2020). It entails purchasing, leasing, working, renting, or obtaining supplies (Bawole & Adjei-Bamfo, 2020). Public procurement remains a major part of the country's

economy, accounting for a substantial share of government spending and activities. Furthermore, fundamental components of good governance, value creation, and sustainable development include efficiency, accountability, transparency, competitive bidding, and probity in public procurement policies and practices. Three steps make up the public procurement process: contract management, final payment, and public needs assessment.

2.2 Sustainable Development Technology

Sustainable development technology involves technology innovations that are crucial for implementing these policies and achieving sustainability goals. Key technologies include:

2.2.1 Renewable Energy Integration

Renewable energy integration using solar-powered systems, biomass boilers, and other renewable sources to power production facilities and reduce reliance on fossil fuels. In addition to lowering greenhouse gas emissions, using clean energy can improve air quality, promote economic growth, and create jobs. For example, solar and wind energy provide significant employment opportunities while reducing our dependency on imported oil. Although there are many obstacles to the shift to clean energy, long-term, sustainable economic growth remains essential. In addition to funding clean energy research and development, we also need to make it easier for businesses and individuals to adopt clean energy practices (Xia et al., 2022). Due to its significant implications for sustainable development, environmental preservation, and energy security, clean energy has become a major force in shaping the global landscape (Jahanger et al., 2023). Given the global challenges posed by climate change and the depletion of fossil fuel reserves, adopting renewable energy sources, such as solar, wind, hydro, geothermal, and biomass, is necessary to transition to a low-carbon economy. Clean energy offers a multifaceted approach that not only reduces pollution and greenhouse gas emissions but also boosts economic development, technological innovation, energy efficiency, community empowerment, and international cooperation (Musah et al., 2022). To ensure the resilience and prosperity of future generations, it is imperative that sustainable energy be adopted globally. The ability of RE to lessen the destruction caused by climate change is at the heart of its importance (Alsagr, 2023). Rising sea levels, extreme weather, and ecosystem disruptions are all consequences of global warming, which is driven by greenhouse gas emissions from burning fossil fuels.

2.2.2 Advanced Water Management

Advanced water management involves employing advanced filtration and membrane technologies to recycle and treat processed water, significantly reducing water consumption and wastewater discharge. Water management systems have evolved from reactive, manual operations to intelligent, data-driven governance, reflecting a larger shift in urban infrastructure (Boyle et al., 2022). The need for sustainable resource use, growing urbanization, and climate

pressures are the main forces behind this shift. To manage distribution networks and identify issues such as leaks or contamination, water utilities primarily relied on manual observation, paper-based records, and routine inspections (Gray & Kovacova, 2021).

In addition to being labor-intensive, these techniques had limited predictive or timely insights. As a result, maintenance was frequently reactive rather than proactive, leading to inefficiencies, service interruptions, and higher operating expenses. Furthermore, decision-making processes were severely hampered by the absence of real-time data. Before issues showed up as obvious damage or service complaints, operators had limited insight into system performance. Water organizations entered the digital water era with the emergence of big data and IoT technologies. IoT sensors, telemetry, and centralized data platforms were integrated during this phase, allowing for basic automation and ongoing monitoring (Gibson, 2024).

Moreover, utilities can now gather large amounts of operational data from dispersed sources to support trend analysis, performance tracking, and predictive maintenance. Digital water platforms, in contrast to previous systems, enabled data-driven decision-making by combining data from several subsystems into a single dashboard. Designing future-ready water management strategies that align with both local implementation constraints and global sustainability goals requires an understanding of this developmental path. A persistent effort to enhance operational efficacy, environmental stewardship, and institutional adaptability is reflected in the shift from manual to intelligent governance (Dai et al., 2025).

2.2.3 Sustainable Packaging Innovation

Sustainable packaging innovation involves investing in new materials, such as plant-based or edible packaging, and utilizing lightweighting techniques and ultrasonic bottle-cleaning machines to reduce packaging waste and water/chemical use. One classic example of a systemic sustainability issue that cannot be resolved by individual innovations or the actions of a single actor group is the growing amount of packaging waste, littering, and plastic pollution caused by food packaging. Reducing the quantity of plastics in packaging—typically multilayered materials that are more challenging to recycle—replacing fossil plastics with biomaterials or biodegradable materials, and making packaging more recyclable are among the current solutions being explored. Without modifications to a more comprehensive packaging and waste management system, none of these solutions can produce the intended outcomes. This means that, in addition to innovative packaging, business models for recycling, consumer incentives for sorting, and technologies to track and identify packaging materials in industrial sorting stations are also required. Additionally, the efficiency of the markets for recycled materials affects recycling goals. According to Jacob and Ekins (2020), this is linked to the original product design. They contend that directionality, demand articulation, policy coordination, and reflexivity should be characteristics of transformative innovation policy. In a nutshell, these requirements require policymakers to express the underlying demand and clearly define the direction of sustainability

transitions. While demand articulation failures are related to a lack of spaces or competencies to anticipate and learn from user demand signals, directionality is frequently hindered by a lack of a shared vision for transformation or by inadequate or absent regulations and funding instruments to guide change. Innovation policy should also engage more thoroughly with other policy domains that control sustainability transformations, such as energy, transportation, industrial, health, and environmental policies. Similar assertions have also been made in discussions of environmental policy, contending that more methodical connections between environmental and innovation policies are necessary to achieve sustainability transformation. Accordingly, innovation policies should be guided by sustainability goals (Pihlajamaa & Akerman, 2025).

2.2.4 Industry 4.0 Technologies (IoT, AI, Big Data, Robotics)

Using interconnected sensors and AI-powered platforms to monitor production processes, optimize energy use, prevent waste, and enable predictive maintenance. By improving forecast model accuracy, AI has the potential to reduce system imbalance, particularly in energy production from variable resources such as solar and wind. Bennagi et al. (2024) highlight that by enhancing production forecasts using meteorological data, AI algorithms facilitate more efficient grid integration of renewable energy sources. Demand management apps with AI support maximize energy consumption patterns in smart grid systems (Arumugham et al., 2023). Despite inadequate infrastructure, AI applications accelerate energy transformation, particularly in developing nations. Zheng et al. (2025) claim that AI increases the success of renewable energy investments in low-income economies, thereby facilitating access to energy. In a similar vein, AI technologies offer sustainability and energy efficiency in microgrids and smart buildings. AI is also crucial to the financial optimization of energy systems (Talaat et al., 2023). AI improves financial sustainability, boosts cost-effectiveness, and supports investment decisions. In this context, artificial intelligence is regarded as both a technological advancement and a tactical instrument for the growth of a clean energy economy. AI's effects on sustainable development are assessed from both environmental and social perspectives. Lastly, some research suggests that in the future, AI and quantum computing will work together to solve more complex energy system issues. AI will accelerate the development of clean energy technologies across a range of areas, including performance prediction and material discovery. According to Maleki et al. (2022), this method shows that AI technologies will play a crucial role in building both the present energy structures and a future that is climate-neutral.

2.2.5 Carbon Capture and Conversion

Carbon capture and conversion involves developing innovative solutions, such as technologies that capture CO2 emissions from fermentation and convert them into usable ethanol or other products, thereby reducing the operation's carbon footprint.

Green technologies play a complementary role in both environmental sustainability and climate change mitigation. Green technology advancements also help nations maximize the use of renewable resources, thereby lowering CO2 emissions (Ulucak, 2021). Regardless of GDP, a nation's governmental institutions determine its environmental quality, as pollution tends to increase in nations with lax environmental laws (Egbetokun et al., 2020). The effectiveness of institutions enables the use of renewable energy sources and the achievement of sustainable development. Other recent works have confirmed these conclusions. To reduce CO2 emissions, institutional quality is essential. In fact, while regulatory quality and the rule of law increase CO2 emissions, political stability, government efficiency, democracy, and corruption control decrease CO2 emissions (Teng et al., 2021; Azam et al., 2021a, b). Serious environmental disasters have been caused by rising global temperatures and the reduction of CO2 emissions to net zero (Obobisa, 2022). Fossil fuels must be used to power renewable energy systems and reduce CO2 emissions. Renewable energy sources for addressing climate change and global warming include wind, solar, and ocean power (Kenner & Heede, 2021; De La Pena et al., 2022). In fact, Yuan et al.'s 2022 research confirmed this interaction and found that renewable energy reduces CO2 emissions, demonstrating its effectiveness in achieving carbon neutrality. The primary policy implication is that the current literature has established that introducing governance dynamics can reduce CO2 emissions. Principal component analysis (PCA) yields a governance composite indicator that either decreases environmental degradation or has a negative effect on CO2 emissions. Policymakers should take note of this finding because it raises the question of whether governance policies should be implemented in tandem to address CO2 emissions. Therefore, effective political governance—that is, the election and replacement of political leaders—appropriate economic governance—that is, the creation and execution of sensible policies that provide public goods—and strong institutional governance—that is, the respect that citizens and the State have for the institutions that regulate their interactions with one another—should be implemented concurrently with the main governance policies. Additionally, by adjusting institutions and governance to accommodate the introduction of new technologies, policymakers may reap greater benefits from digitization. Adoption of renewable energy should signal to decision-makers that it is time to stop using fossil fuels, which change the climate, and hasten the switch to renewable energy (Traore & Asongu, 2023).

2.2.6 Blockchain for Traceability

Blockchain for traceability involves utilizing blockchain solutions to ensure supply chain transparency, verify product authenticity, and track carbon footprint data, building consumer trust. To create, manage, store, and exchange data without a centralized server, a blockchain system employs encryption. Blockchain technology increases information transparency and discourages information manipulation by distributing information storage, making it difficult to alter previously recorded data (Shin et al., 2020). Blockchains are decentralized data structures or ledgers that enable the secure storage of digital transactions without a centralized authority. Blockchain technology promotes sustainability by improving transparency, accountability, and

traceability through secure, immutable records. Blockchain enables tracking of goods from the point of origin to the point of consumption in supply chain management, thereby guaranteeing ethical sourcing and minimizing environmental impact (Ehsan et al., 2022). For instance, blockchain can offer comprehensive details about the provenance, manufacturing processes, and shipping of goods in the food sector. This openness encourages ethical and sustainable behavior while enabling customers to make knowledgeable decisions. Furthermore, by monitoring waste streams, ensuring appropriate disposal and recycling, and minimizing illicit dumping, blockchain can simplify waste management procedures (Lin et al., 2021). By enabling peer-to-peer energy trading, blockchain can reduce reliance on conventional centralized grids, allowing people and communities to trade excess renewable energy (Sahebi et al., 2023). Blockchain-based energy platforms can encourage the use of clean energy sources, enabling people to take an active role in the switch to renewable energy. Moreover, blockchain technology can create energy marketplaces where prosumers can sell excess energy to consumers, fostering a decentralized and resilient energy system (Ying et al., 2022).

3. METHODOLOGY

Systematic thematic content analysis is a rigorous qualitative method for identifying, analyzing, and reporting patterns (themes) in textual or visual data, combining structured coding with interpretive depth to reveal underlying meanings beyond surface-level content by immersing in data, generating initial codes, grouping potentially themes, refining themes, defining scope, and producing a rich, narrative report that reach the research objective.

This study's methodology adapts from the studies of Andriani & Siripipatthanakul (2025) in five methodology stages as follows;

Stage 1: Determination of the Unit of Analysis through purposive sampling based on related topics and keywords.

Stage 2: Data Collection based on the scholarly papers in Scopus, Web of Science (WOS), and Google Scholar, mainly between 2020 and 2025.

Stage 3: Critical Discourse Analysis: Data analysis using content analysis.

Stage 4: Framing Analysis: Data analysis using thematic analysis.

Stage 5: Integration and Interpretation of Findings: Data synthesis.

4. RESULTS

4.1 Grammarly Results

The appropriateness of grammar is 97% (American English), and the plagiarism rate is 5% (similarity to online sources).

4.2 Word Clouds

Figure 1. Word Clouds
https://wordart.com/create (January 14, 2025).

5. DISCUSSIONS

Green technology, also known as sustainable or eco-friendly technology, is essential to solving today's environmental problems. It includes a wide range of creative approaches, procedures, and methods intended to lessen the negative effects of human activity on the environment while promoting social progress and economic expansion.

According to Zhou et al. (2022), green technology is distinguished by its dedication to environmental sustainability, which aims to minimize resource consumption, reduce emissions, and enhance ecological resilience. Environmental regulations are dynamic and ever-changing, adapting to new environmental issues and scientific discoveries. These rules cover a wide range of topics, such as waste management, greenhouse gas emissions, air and water quality, and biodiversity preservation (Clarke et al., 2020). Furthermore, in the present era of growing environmental concerns and climate change, the significance of green technology innovation cannot be emphasized (Abbas, 2020). In fact, green technologies play a crucial role in the worldwide endeavor to mitigate climate change. By implementing energy-efficient technologies, sustainable land-use practices, and renewable energy sources, they help reduce greenhouse gas emissions, thereby stabilizing global temperatures.

Environmental Preservation: Innovations in green technology are essential for maintaining ecosystems, protecting biodiversity, and lessening the detrimental effects of human activity on the environment. They lessen resource depletion, pollution, and habitat destruction. By maximizing resource use and reducing waste production, green technologies advance resource efficiency. With the goal of minimizing the extraction and consumption of limited resources, they provide sustainable solutions for urban development, agriculture, and industry. Additionally, by lowering reliance on fossil fuels and diversifying energy sources, green technologies improve energy security. As a result, economies are less susceptible to price swings and disruptions in the energy supply. Finally, the green technology industry contributes to job creation and economic expansion. Investments in sustainable agriculture, clean energy, and environmentally friendly infrastructure boost economic growth and generate job opportunities (Shan & Ji, 2024).

Accountability, equity, and transparency are the cornerstones of procurement efficiency. Additionally, a competitive procurement process allows the procuring entity to purchase products, services, and labor from contractors or service providers who offer the best value for the money. Competitive bidding will help the public procurement process avoid corrupt practices, nepotism, collusion, favoritism, and resource waste. Additionally, it will strengthen the procurement process's good governance, equity, fairness, transparency, value, product quality, innovation, sustainable development, and cost-effectiveness. In the procurement process, the probity principle encompasses integrity, honesty, and moral behavior. To promote good governance, value creation, and sustainable development, it allows the procuring entity to protect

procurement activities with a strong process that can withstand scrutiny of honesty, openness, and prudence (Adekoya, 2024).

Environmental regulations have become essential tools for tackling the numerous environmental issues that the world community faces. These rules cover a broad range of actions, guidelines, and standards intended to monitor, manage, and mitigate the effects of human activity on the environment. Governments at all levels—local, national, and international—enact and implement them with the main objectives of advancing sustainability, preserving ecosystems, and defending public health. Furthermore, although environmental regulations are crucial for protecting the environment and general welfare, businesses frequently face significant compliance challenges. Businesses across a variety of industries must navigate a maze of rules, each with its own specifications, oversight protocols, and reporting requirements (Peng & Jai, 2022).

There may be significant financial and operational costs associated with adhering to these regulations. Businesses must make significant investments in pollution control technologies, modify their production processes to reduce waste and emissions, and establish strict monitoring and reporting systems to comply with environmental regulations. These initiatives frequently necessitate substantial changes in corporate strategy and culture, which may affect profitability and competitiveness. Innovation in green technology is centered on sustainability. By tackling the interrelated issues of environmental, economic, and social sustainability, green technologies are essential instruments for attaining a sustainable future. They help establish a circular economy, which preserves ecological balance, minimizes waste, and conserves resources. Green technology innovation promotes a shift from a linear, resource-intensive model of production and consumption to a circular, regenerative model in the quest for sustainability. Cradle-to-cradle design, which ensures products are designed for reuse, recycling, or composting at the end of their life cycle, is an example of this change (Shan & Ji, 2024).

Furthermore, to create innovation policies that would facilitate a more drastic transition to sustainable packaging, greater focus should be placed on how negotiations over the desired transformation goals are organized at both the national policy and the individual innovation funding program levels. According to Grillitsch et al. (2019), there is still a dearth of research in innovation policy studies regarding how the directionality of transformative innovation policies is affected by institutionalized and path-dependent interest conflicts between actors, as well as how the unequal power relations should be addressed in the design of deliberation and reflection over the policy goals. In addition to being dominated by established players in the packaging industry, there was very little coordination between national environmental and innovation policies and very little involvement of actors outside the industry, such as citizens, cities, or other industries (such as the IT sector), in the negotiations. There is a chance that guidelines for transformative sustainability innovation policies will remain at a very general level, and innovation policies will only be able to encourage small changes in the current system if the problem of repeating and maintaining existing institutionalized relations in guiding innovation

pathways is not resolved (Pihlajamaa & Akerman, 2025). In fact, the energy industry has undergone a remarkable transformation in recent years due to the adoption of artificial intelligence (AI) technologies, particularly in the production and consumption of renewable energy. The impact of AI on renewable energy systems is discussed in the literature from various angles, including improved forecast accuracy, operational efficiency, cost reduction, and support for sustainable development objectives (Wang et al., 2025).

Using sustainable resources and green investments in the economic sectors can lead to both economic growth and a sustainable environment. It has been found that increasing green bonds significantly encourages investment in renewable energy and reduces pollution. Environmental regulations have many advantages for businesses and society, despite the difficulties in complying with them. Cleaner practices and technologies are developed and adopted because of these regulations, which serve as catalysts for innovation. Regulations encourage research and development aimed at lowering environmental footprints by establishing clear environmental standards (He et al., 2023). Environmental regulations also help businesses reduce risk. They protect a company's market position and brand image by reducing the legal and reputational risks associated with environmental violations. By establishing themselves as leaders in sustainability and responsible corporate citizenship, businesses that proactively adopt and surpass regulatory standards can obtain a competitive edge (Li et al., 2023). From a social standpoint, environmental laws are essential for tackling major global issues, including habitat destruction, air and water pollution, and climate change. They help to mitigate environmental disasters, protect natural resources, and enhance public health. In conclusion, environmental laws are essential to the pursuit of a sustainable and ecologically conscious future. They have significant advantages in terms of innovation, risk mitigation, and environmental protection, despite the difficulties they present for companies. Fostering a peaceful coexistence between economic development and environmental stewardship requires an understanding of how environmental regulations are linked to corporate practices and their effects on businesses.

The implementation of smart water technologies has shown great promise for promoting environmental sustainability and economic growth. These systems promote sustainable urban and rural development and increase operational effectiveness and resource allocation by integrating cutting-edge information and communication technologies (ICT). Additionally, ICT integration promotes greater transparency and public involvement in water governance, which, in turn, supports economic stability. It highlights how citizens can monitor usage, report problems, and participate in decision-making processes through digital tools like web dashboards and mobile apps. In the end, this participatory approach contributes to more effective resource allocation and service delivery by strengthening consumer and utility provider trust. Furthermore, real-time water-quality monitoring with chemical sensors enhances efforts to protect the environment. In contrast to conventional sampling techniques, which frequently overlook fleeting pollution events, it examines the use of sensor technologies in ongoing water quality assessment. Aquatic ecosystems and public health are preserved by early warning

systems and prompt interventions made possible by real-time data (Yaroshenko et al., 2020). Furthermore, innovation policy has historically been seen as an area of economic policy that focuses on encouraging the creation and adoption of beneficial new technologies and other solutions within society. It is intimately linked to policies on science and technology that support innovation and its governance. As a result, the idea of science, technology, and innovation (STI) policy is frequently used by institutions such as the OECD to highlight the connections among these fields. A focus on innovation policy usually signifies a desire to develop and implement new goods, services, and procedures in order to realize the economic and societal potential of new knowledge. Failures in policy coordination can be attributed to either horizontal, cross-sectoral coordination or vertical, multi-level coordination. Additionally, long-term transformations would require systematic temporal coordination, which has proven to be difficult. According to Pihlajamaa and Akerman (2025), reflexivity failures pertain to the absence of systems and practices for monitoring, experimenting, and inclusively involving actors for mutual learning and anticipation.

6. CONCLUSIONS

Green governance policies and technologies are transforming the beverage sector, advancing sustainable development by integrating environmental, social, and governance (ESG) principles into core business processes. This change entails implementing rigorous environmental standards to minimize carbon footprints, managing water responsibly, and innovating in packaging. For example, firms are adopting internal carbon pricing and transitioning to renewable energy sources to energize their production facilities. The adoption of recycled materials and the transition to reusable packaging methods are driven by consumer demand and government initiatives, including directives on single-use plastics. The sector is using data analytics, artificial intelligence, and Internet of Things (IoT) sensors to optimize supply chains, improve manufacturing efficiency, and monitor resource use in real time, thereby reducing waste. Blockchain technology is essential for ensuring transparency and traceability, enabling firms to authenticate ethical sourcing and allowing customers to make educated decisions. These integrated initiatives transcend mere compliance, signifying a major transition towards a more resilient, transparent, and ecologically sustainable business model for the beverage industry.

7. LIMITATIONS AND RECOMMENDATIONS

This paper is a systematic review article that employs thematic content analysis. It may not include respondents; thus, questionnaires or interviews are suggested for further studies.

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