Beyond the Bean: Stakeholder Dynamics and Mapping, and Waste Management in the Coffee Supply Chain

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Abstract: Coffee is undeniably one of the most widely consumed beverages, yet it is generating massive amounts of waste all along the supply chain from production to consumption, which is posing serious environmental and socio-economic problems. The stakeholders of the coffee supply chain remain responsible for resolving this issue and coordinated contributions are crucial to managing effectively this challenge. However, this study sheds lights on fragmented coffee supply chain actors' relationships which often lead to inefficiencies, resulting in difficulties in waste generation, limited valorization, and weak regulations. Furthermore, the increased consumer demand for high-quality coffee intensifies pressures on the whole supply chain contributing to overproduction and waste accumulation from one perspective and quality degradation and market instability from another perspective. This study provides a strategic mapping of the coffee supply chain, elucidates the roles and responsibilities of key stakeholders and provides a framework for coffee supply chain waste management by conducting an in-depth analysis of policy reports, industry publications, and secondary data sources. The findings expose critical gaps in connections, where individual actors engage in isolated sustainability initiatives, but a lack of cohesive collaborative strategies prevents large-scale waste reduction. The study highlights how gaps in regulatory frameworks enable unsustainable practices to persist, slowing progress toward the effective integration of circular economy principles. This research emphasizes the pressing need for stronger stakeholder collaboration, more robust policies, and industry-wide incentives to enhance waste valorization. A significant change can be driven if on one hand, the coordination between producers and consumers is ameliorated and strengthened by clearer regulatory mechanisms and on the other hand, if coffee waste is traced, minimized and repurposed efficiently. These findings provide essential guidance for policymakers, businesses, and researchers working to advance sustainability in the coffee industry and transition toward a more circular, resource-efficient and intelligent supply chain.

Keywords: Coffee supply chain, coffee waste management, stakeholder analysis, sustainability, mapping

1. Introduction

This is the appealing aroma of coffee, valued worldwide, which in fact denotes a daily ritual for different cultures, hiding from our view the most complex web, existing as the coffee supply chain. Our research goes beyond the superficial attractiveness of coffee to delve deep into the complexities of a journey from seed to cup, with an especial focus on unveiling the challenges of sustainability and the opportunities that are implicit in the coffee supply chain. From Latin America to Africa and Asia, coffee production accounts for over fifty developing countries, with some 20–25 million families depending on its production worldwide, while more than 2.25 billion cups are consumed every day (Dilebo, 2019; Loftfield et al., 2016). The structure of the coffee value chain, largely identical across countries, includes cultivation, processing, roasting, and consumption stages—each presenting distinct environmental, social, economic, and governance challenges. Each stakeholder along the chain—from small growers struggling in turbulent markets to processors and roasters engaging with sustainability agendas—faces unique constraints and opportunities. The industry is also at the crossroads of global sustainability issues such as deforestation, soil degradation, and unequal trade dynamics; therefore, collaborative strategies for a sustainable coffee supply chain are urgently needed.

This research is informed by recent Systematic Literature Reviews (SLRs) on the sustainability of coffee supply chains (e.g., Breitler et al., 2022; Levy et al., 2021), which highlight persistent fragmentation in stakeholder coordination, uneven power relations, and limited integration of circular economy strategies. These reviews revealed that while many actors pursue sustainability goals, their efforts are often isolated and disconnected from broader waste management or governance frameworks. In response to these findings, this study develops a conceptual framework that maps stakeholder roles and relationships across the coffee value chain and identifies leverage points for promoting circularity through waste valorization, policy reform, and multi-actor collaboration. The framework integrates trends and challenges identified in literature, including environmental impact, socio-economic vulnerabilities, governance gaps, technological innovations, and stakeholder engagement. The global coffee industry, worth over USD 200 billion annually, faces serious sustainability challenges, including deforestation and climate impacts (Grüter et al., 2022; Kath et al., 2022; Velmourougane & Bhat, 2017). Economic sustainability is also precarious, as many farmers face poverty due to price volatility and resource constraints. Other pressing social issues include labor rights and gender equity. Smallholder farmers, particularly in developing countries, are further burdened by market uncertainty and climate vulnerability. Meanwhile, exporters and retailers contend with increasingly complex regulations, high quality demands, and operational costs. As Bager et al. (2022), Gerard et al. (2019), Tarigan et al. (2022), and Ferreira & Ferreira (2018) argue, innovative waste valorization strategies—such as the reuse of spent coffee grounds and cascara—represent promising avenues for enhancing sustainability. Mapping and optimizing stakeholder interactions in the coffee supply chain is therefore essential to building long-term resilience and enabling systemic transformation. This paper aims to critically examine the coffee supply chain through the lens of sustainability and circular economy, with three core objectives:

(1) to identify and classify key stakeholders and their roles,
(2) to analyze power asymmetries and stakeholder dynamics that influence decision-making, and
(3) to explore waste management practices and valorization opportunities for transitioning toward a more circular supply chain.

The structure of the paper is as follows:
Section 2 presents the methodological approach, which is based on qualitative document analysis and guided by Stakeholder Theory, Supply Chain Network Theory, and Circular Economy principles.
Section 3 discusses the main findings in five parts:
(1) identification of stakeholders in the coffee supply chain,(2) stakeholder mapping and classification by influence, role, and position, (3) analysis of stakeholder dynamics and power asymmetries, (4) reuse opportunities for coffee waste, including energy production, organic fertilizer, cosmetics, and biopolymers, and (5) the role of digital innovation in improving traceability, efficiency, and sustainability.
Section 4 concludes by summarizing the key insights and offering strategic recommendations to enhance coordination, support waste valorization, and foster a more inclusive and circular coffee supply chain.

2. Materials and methods

This study adopts a qualitative, document-based research approach grounded in the systematic analysis of scholarly literature, institutional reports, and sectoral publications. The research focuses on stakeholder dynamics, governance structures, and waste management practices in the global coffee supply chain. The study began with a comprehensive desk review of sources retrieved from academic databases (Scopus, Web of Science, Google Scholar) and institutional repositories (e.g., International Coffee Organization, Ellen MacArthur Foundation). Documents published between 2000 and 2024 were prioritized, with a focus on peer-reviewed and interdisciplinary studies covering environmental science, supply chain management, and sustainability. Selected materials were analyzed through a deductive coding process, guided by three interrelated theoretical lenses: Stakeholder Theory, Supply Chain Network Theory, and Circular Economy Principles. This analytical framework allowed for the identification of key stakeholder roles, power relations, and opportunities for waste valorization within the coffee supply chain. The research process is illustrated in Figure 1, which outlines the methodological workflow followed in this study—from source selection and screening to coding and synthesis. These steps informed the development of stakeholder typologies and interaction maps, which underpin the findings discussed in Section 3.

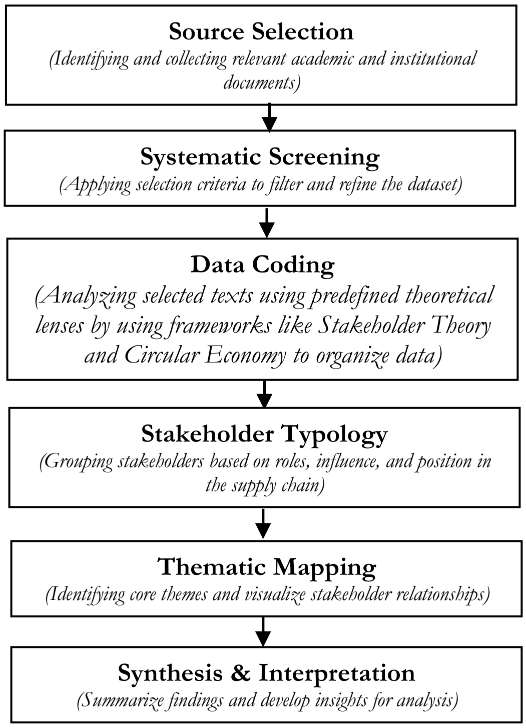

Figure 1. Key stages of the research process

3. Main findings

3.1. Stakeholders in the Coffee Supply Chain

Delving into the intricate web of the coffee supply chain reveals a tapestry woven by an array of stakeholders, each wielding unique influence and responsibility in the journey of coffee from farm to cup (Pichayakul, 2023; Inouye and Kling, 2020). At its heart lie the growers, resilient individuals laboring amidst climate vulnerabilities and market volatility (Bastian et *al*., 2021; Guido et *al*., 2020). Their toil sustains the foundation of the industry, with initiatives promoting sustainable farming practices offering pathways to empowerment and resilience (Ims & Zsolnai, 2023; Dragusanu et *al*., 2022). Yet, their efforts are only a part of the broader ecosystem that encompasses exporters, importers, roasters, manufacturers, and retailers, each navigating their own challenges and opportunities (Lacap et *al.*, 2022). Collaborative endeavors streamline trade and expand market reach, ensuring the seamless flow of coffee beans across borders (Dolbec et *al.*, 2022; Pereira et *al.*, 2021). Meanwhile, consumer preferences emerge as a driving force, shaping demands for ethical sourcing, sustainability, and quality (Gayle & Lin, 2022; Khalil et *al.*, 2021). In essence, the coffee supply chain thrives on the symbiotic relationships forged by these stakeholders, where each entity's actions ripple through the entire ecosystem, ultimately shaping the industry's trajectory.

Table 1: Primary and secondary stakeholders of the coffee supply chain

Stakeholder	Function
Farmers	Responsible for cultivating coffee beans, farmers are the foundation of the supply chain. They are directly affected by environmental conditions and market fluctuations.
Processors	These stakeholders handle the post-harvest processing of coffee cherries, including pulping, fermenting, drying, and milling.
Exporters and Importers	They facilitate the movement of coffee beans from producing countries to global markets, ensuring compliance with trade regulations
Roasters	Roasters transform green coffee beans into aromatic products familiar to consumers, influencing flavor profiles and quality.
Retailers and Cafés	These entities sell the final product to consumers, playing a role in marketing and customer education.
Government Agencies	They regulate agricultural practices, trade policies, and environmental standards, impacting the operations of primary stakeholders.
Non-Governmental Organizations (NGOs)	NGOs often support sustainable practices, provide training, and advocate for fair trade
Certifying Bodies	Organizations like Fair Trade and Rainforest Alliance certify coffee products that meet specific ethical and environmental standards.
Consumers	Their preferences and purchasing decisions influence the entire supply chain, driving demand for sustainable and ethically produced coffee.

3.2. Stakeholder Mapping and Classification

The coffee supply chain stakeholders can be categorized by position (upstream, midstream, downstream), function (production, processing, consumption), and level of influence (low to high). Table 2 presents a simplified categorization used for stakeholder mapping—an analytical tool that uncovers major actors, their relationships, interests, and areas of conflict. These approaches are grounded in such techniques as power-interest grids and social network analysis, which inform participatory policy and governance interventions that are targeted (Bryson, 2004). Stakeholder mapping also reveals the lopsided balance of influence and responsibility along the chain. Smallholder farmers, for example, are at the center of production but often lack bargaining power due to limited access to resources, information, and technical assistance. On the other hand, midstream actors (importers, exporters, roasters) exercise great influence over prices, quality specifications, and market trends. Downstream actors, such as retailers and consumers, drive demand and shape sustainability aspirations, but are likely to be disconnected from social and environmental conditions at the production end (Bitzer et *al.*, 2012). Cross-cutting actors—like state agencies, certifiers, and NGOs—fulfill key governance roles. NGOs can provide capacity-building and promote sustainable practices, certifiers can build ethical sourcing models, and governments can provide enabling environments through policy and investment in infrastructure (Dentoni et *al.*, 2012). Coordination among these groups, however, is usually absent, with the consequence of fragmented efforts and diminished systemic impact. Effective stakeholder engagement involves more than identification; it requires active communication, shared objectives, as well as mechanisms for resolution of disagreements and collective action. Participatory mapping, for instance, can potentially unlock local knowledge, align stakeholder interests, and enable the co-design of context-specific and system-informed interventions. Reframing stakeholder relations through such inclusive processes is fundamental to building a more circular and resilient coffee supply chain (Ostrom, 1990).

Table 2: Classification and influence of the coffee supply chain

Stakeholder Group	Position	Function	Influenc e
Smallholder farmers	Upstream	Cultivation	Medium
Cooperatives	Upstream	Aggregation & negociation	Medium
Prcessors	Upstream/ Midstream	Transformati on	Medium /High
Exporters & Importers	Midstream	Trade & logistics	High
Roasters	Midstream	Value addition	Hugh
Retailers	Downstream	Distribution	High
Consumers	Dowstream	Consumptio n	Medium
NGOs	Cross cutting	Advocacy & training	Low/me dium
Goverments	Cross cutting	Regulation	High

Certifiers (e.g.,Fairtrade)	Cross cutting	Standard regulation	Medium

3.3. Stakeholder Dynamics and Power Relations

The power relations in the global coffee value chain are strongly influenced by structural power asymmetries, which are primarily based on historical and economic power differences between the Global North and the Global South. The coffeelands countries—particularly in some regions of Latin America and sub-Saharan Africa—are most often ensnared in disadvantageous positions in the global value chain, dominated by powerful downstream actors. Multinationals, such as large roasters and retailers, exert substantial control over branding, prices, and access to world markets, while smallholder farmers—the backbone of coffee production—are frequently exposed to high price volatility, market insecurity, and climate risk (Bitzer et al., 2012). This disequilibrium is not merely economic but also institutional, as producers lack voice and agency in international forums where the standards and dynamics of the coffee trade are decided. The interactions among stakeholders along the supply chain are governed by a combination of formal institutions—such as contracts, certification schemes, and sustainability standards—and informal relations based on trust, cultural similarities, and learning exchange. As illustrated in Figure 2, these interactions are complex and often asymmetrical, with downstream actors exerting greater influence over upstream producers. Certification schemes (e.g., Fair Trade, Rainforest Alliance), for instance, attempt to improve market access and promote sustainability practices, though their effectiveness in redistributing value is contested (Ponte, 2002). Simultaneously, farmer cooperatives can also serve as critical intermediaries, enhancing producers' bargaining power by consolidating production, facilitating access to credit and training, and enabling greater participation in value-added activities. NGOs and civil society organizations also play a fundamental role in offering technical assistance, guaranteeing transparency, and facilitating more inclusive governance arrangements. Even with such efforts, sharp tensions remain due to conflicting interests among different stakeholders. Retailers and roasters, for example, are typically concerned with consistency of quality, supply chain efficiency, and cost control to satisfy customers and shareholders. Producers, by contrast, are more concerned with income stability, food security, land rights, and the environmental impacts of intensive production (Neilson, 2008). These conflicting priorities can breed mistrust and undermine cooperation, particularly in the absence of forums for meaningful discussion and collective decision-making. To counteract these distortions and create more equitable associations, various models of participatory governance have emerged. Multi-stakeholder arrangements (MSIs), public–private partnerships, and roundtable debates offer inclusive settings for negotiation, conflict resolution, and co-planning of sustainable strategies. Examples include the Global Coffee Platform and the Sustainable Coffee Challenge, which aim to rally diverse actors—producers, traders, NGOs, and consumers—around a shared vision of cooperation, common objectives, and equitable responsibility. The success of such initiatives, however, depends largely on their capacity to foster inclusivity, openness, and accountability, and to deliver concrete and effective benefits to marginalized actors (Dentoni et al., 2012). Unless well-designed and grounded in equitable power-sharing, these platforms risk becoming tokenistic or reinforcing existing hierarchies. In the end, rebalancing power relations in the coffee value chain requires more than technical fixes or market incentives. It demands a radical shift toward participatory governance, grassroots capacity building, and the alignment of producers' social and environmental values with decision-making processes. Only through such interventions can the industry shift toward greater justice, sustainability, and resilience.

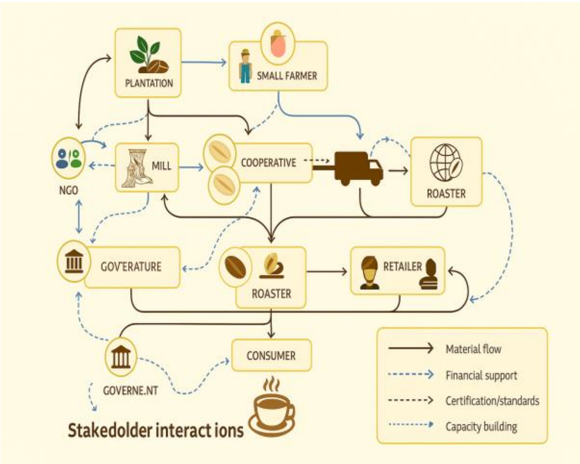

Figure 2. Coffee supply chain stakeholders mapping and interactions

3.4. Reuse Opportunities of Coffee Residues

Despite such interventions, tensions are still high because different actors have different interests. The roasters and the retailers will, for example, appreciate consistency of quality, efficiency through the supply chains, and cost reduction as a means to meet consumer desires and shareholders as well. For their part, the producers may prioritize income stability, food security, land rights, and environmental effects of intensive cultivation (Neilson, 2008). These competing priorities can foster distrust and undermine cooperation, particularly if there are no forums for earnest dialogue and collaborative decision-making.

To address these imbalances and foster more balanced relationships, various participatory governance arrangements have emerged. Multi-stakeholder initiatives (MSIs), public-private partnerships, and roundtable dialogues offer open forums for negotiation, conflict resolution, and co-designing sustainability approaches. Illustrations include the Global Coffee Platform and the Sustainable Coffee Challenge, which aim to rally various stakeholders—from producers and traders to NGOs and consumers—to have common objectives and share responsibility. The success of these initiatives, however, hinges largely on their ability to offer inclusivity, transparency, and accountability and to yield concrete benefits to marginalized players (Dentoni et *al.*, 2012). Without balanced design and fair power-sharing, these sites are likely to be tokenistic or reinforce current hierarchies. Lastly, remaking the power balance in the coffee value chain is not a matter of technical solutions or market incentives. It is a matter of a paradigm shift to participatory governance, grassroots capacity building, and a redefinition of the social and environmental value of the producers. Only through such radical transformations can the industry aspire towards greater justice, sustainability, and resilience.

3.4.1. Bioenergy Production from Coffee Waste

The calorific value and organic matter of coffee wastes, like spent coffee grounds (SCG), coffee pulp, and husks, are high, and hence these wastes are excellent feedstocks for bioenergy. Anaerobic digestion and direct combustion are some of the most promising technologies. Anaerobic digestion is the degradation of organic compounds by microbes without oxygen, giving biogas—a gas largely composed of methane and carbon dioxide—which can potentially be utilized in the generation of electricity, heat, or even vehicle fuel. SCG also suits anaerobic digestion owing to its lipid and carbohydrate contents and high methane yield (Hossain et *al.*, 2021). On the other hand, the low water content and high energy content of SCG and husks when dried make them good candidates for direct combustion or co-firing with other biomass feedstocks in thermal power plants. This is already practiced in some coffee-producing countries to power coffee drying processes or local energy grids (Rijo et al., 2021). In addition, SCG is also capable of producing bio-oil through pyrolysis, providing an alternate avenue for renewable energy. These technologies reduce the environmental footprint of waste disposal and promote local energy independence. By incorporating waste-to-energy facilities in coffee value chains, farmers are not just avoiding environmental degradation as greenhouse gas emissions and water contamination but are also creating economic worth from renewable energy generation. Nonetheless, issues like system costs, provision of infrastructure, and policy support need to be dealt with in order to upscale these technologies successfully in developed and developing environments.

3.4.2. Agricultural Valorization as Organic Fertilizer and Soil Amendment

Coffee processing generates enormous quantities of organic waste—such as SCG, coffee pulp, and husks—that contain high levels of macro- and micronutrients and are therefore valuable in agriculture. These wastes contain high nitrogen (N), phosphorus (P), and potassium (K) and organic carbon, which are essential soil fertility and porosity components. Coffee waste can be transformed into high-quality organic fertilizer using composting or co-composting with other organic wastes. Composting alleviates the phytotoxicity of caffeine and polyphenols in raw SCG, and the end product is efficient and safe for application in soil (Ragauskaitė & Šlinkšienė, 2022). Coffee waste composting has been shown to improve microbial activity, water holding capacity, and plant growth promotion, particularly in poor or degraded soils. It also aligns with sustainable and regenerative agricultural principles by reducing dependence on synthetic fertilizers and minimizing leaching of nutrients into waterways. Besides composting, SCG has also been trialed as a direct mulch or feedstock for vermicompost, which further broadens its agricultural applications. Field trials have also confirmed yield improvements in various crops, including vegetables and cereals, when treated with coffee-derived compost (Simões et *al.*, 2020). Yet, the extensive use of such practices is still limited in most production areas because of the lack of infrastructure, technical capacities, and regulatory frameworks. Encouraging the farm valorization of coffee by-products not only minimizes environmental degradation but also generates circular economy opportunities for rural development, particularly if supported by capacity-building measures and training activities for farmers.

3.4.3. Extraction of Bioactive Compounds for Cosmetics and Nutraceuticals

Spent coffee grounds (SCG) are beginning to be investigated as a sustainable source of various bioactive compounds which include but are not limited to caffeine, chlorogenic acids, polyphenols, trigonelline and lipids. All of these bioactive compounds exhibit antioxidant, anti-inflammatory and antimicrobial properties. Extraction methods for these bioactive compounds include: solvent extraction, supercritical CO_2 extraction, ultrasound-assisted extraction and so on depending on the required purity and intended end use. The cosmetic industry are utilizing compounds in spent coffee grounds in skin care products. Compounds in spent coffee grounds eliminated free radicals and reduce oxidative stress that may be either a large contributor to skin aging or inflammatory effects (Henni et *al.*, 2023). Polyphenols and chlorogenic acids, are being explored for their potential to lower blood glucose levels, sable metabolic disorders, and protect cardiovascular health, for use in health products and pharmaceuticals (Lestari et *al.*, 2022). The lipids are being used in body creams and lotions with emollient and moisturizing action. Valorizing spent coffee grounds for bioactive compounds can go further than as an extracted bioactive product, to provide businesses new consumer products in which sustainability aligns with the circular economy principles, and develop markets for high value products not related to the coffee industry. The market opportunity for sustainable or upcycled ingredients is only continuing to develop and respond to consumer demand, and it is not only important to have sustainable through ecologically responsive options available or when so much waste can be repurposed as a product. But, it is also essential to emphasize that the efficiency of extraction, regulatory approval, and product development methods will determine the potential for all these SCG products.

3.4.4. Production of Biopolymers and Functional Materials

The lignocellulosic structure and carbon-based character of coffee by-products—primarily SCG and husks—present excellent potential for material science applications, including the production of biopolymers, composites, and adsorbents. SCG can be blended with natural or synthetic biodegradable polymers like polylactic acid (PLA), starch, or polyhydroxyalkanoates (PHA) to produce bioplastics suitable for packaging, agricultural films, and disposable cutlery. These composites are improved by improved separation properties, thermal stability, and biodegradability and offer a greener alternative to petroleum-based plastics (Saewan, 2022). The second major application is the production of SCG into activated carbon, a porous adsorbent widely utilized in water treatment to remove contaminants, air purification to minimize pollutants, and chemical adsorption to generate separation chemicals. Through separation and chemical activation, SCG-derived activated carbon possesses high surface area and adsorption capacity, comparable to commercial products (Matrapazi & Zabaniotou, 2020). Coffee grounds have also been utilized for the manufacture of bio-composites for construction materials and interior furnishing, merging sustainability with functional innovation. Such valorization pathways are consistent with growing interest in circular design criteria and low-impact materials. However, scalability, process optimization, and environmental impact of processing must be taken into account to ensure the overall sustainability of such alternatives. Through converting coffee waste into high-performance materials, coffee-producing and coffee-consuming countries can cut down on landfill utilization, prevent plastic waste, and encourage environmentally friendly industrial growth.

3.5. Improving Efficiency, Traceability, and Sustainability with Digital Innovation

In the quest to optimize efficiency, traceability, and sustainability within the coffee supply chain, digital innovation emerges as a formidable ally (Hindsley et al., 2020). Blockchain technology, heralded for its decentralized and transparent nature, offers unprecedented levels of traceability, enabling stakeholders to meticulously track coffee beans' journey from cultivation to consumption (Nurhazizah et *al*., 2023; Khan et *al*., 2022). Initiatives like Farmer Connect and IBM Food Trust exemplify successful implementations, endowing consumers with insights into coffee origin and quality (Bager et *al*., 2022). Furthermore, data analytics, powered by artificial intelligence, enables stakeholders to dissect vast datasets, optimizing processes and informing decisions across the supply chain (Awan et *al*., 2021). Real-time monitoring, facilitated by the Internet of Things (IoT), offers granular insights into critical factors like temperature and humidity, minimizing risks and enhancing quality control (Sastrohartono et *al*., 2023). Moreover, innovative applications of coffee waste in biofuels, renewable energy, and biodegradable materials further contribute to sustainability goals, fostering a circular economy mindset within the industry (Garcia & Kim, 2021; Díaz et *al*., 2020). As these technologies become more accessible and ingrained in industry practices, the coffee supply chain stands poised for a transformative journey towards greater efficiency, transparency, and sustainability.

4. Conclusion

The coffee supply chain is more than just a succession of parties involved in transactions and transfers; it is a complicated, transnational system characterized by structural inequities, different interests of stakeholders, and the distribution of power among them. This research has demonstrated that the various relationships between actors, from small-holder farmers and cooperatives to multinational roasters and retailers, mediate the sustainability and inclusivity of the coffee sector. Power remains largely concentrated downstream in the supply chain, particularly with downstream actors situated in the Global North, who dictate what consumers want, how prices are set, and what sustainability narrative to promote. Simultaneously, producers, particularly in the Global South, are disadvantaged by limited access to markets, weak bargaining power, and are vulnerable to various environmental and economic shocks. Stakeholder mapping and systems thinking help to identify structural constraints and areas for transformation. Through analysis of actors in the coffee sector, as well as their roles, interests and levels of influence, it is possible to devise potential interventions to promote equity, transparency and resilience. One area that has not been explored well but is important for transformative change is the management of coffee waste. The coffee production process produces various forms of waste from the time it is grown, harvested, processed and consumed; the transformation of coffee from seed to cup creates waste including pulp, husk, mucilage, silver skin and spent coffee grounds (SCG); and from all of these types of waste management practices are often inadequate, resulting in pollution of water, greenhouse gas emissions in the form of methane, and unmanaged waste in cities.

Although all of the solutions may be feasible, implemented governed frameworks, social infrastructure, or even very little coordination along the chain all contribute to barriers to implementation. This underscores the importance of institutional change as an enabler of change; in tandem with diffusion of new technologies. Financial, or collaborative multi-stakeholder space, or government policy arrangement needs to be institutionalized to align interests, build trust, and co-create value through the chain.

However, a transition to circular economy principles can create new opportunities for more sustainable waste management practices. Valorizing coffee by-products, after the roasting process, offers an environmentally pragmatic solution, and may lead to more diversified economic prospects, economic empowerment, and can provide some citizens with social backing. Four proposed examples of valorization were illustrated in this paper:

- Organic Fertilizers: This potential coffee-byproduct valorization opportunity considers the social concern for environmental damage as a result of SCG and other coffee residues being full of nitrogen, phosphorus, and potassium, SCG and other forms of coffee waste can be biofertilizers that improve soil bioavailability and use within regenerative agriculture (Ragauskaitė & Šlinkšienė, 2022; Simões et *al*., 2020).

- Bioenergy: Anaerobic digestion and biomass combustion technologies create biogas and electricity from coffee waste where potential energy alternatives are created using coffee waste and negating fossil fuel dependency (Hossain et *al*., 2021; Rijo et *al*., 2021).
- Cosmetics: Coffee waste (metaphorically) holds the treasure of bio-active compounds such as antioxidants and anti-inflammatory compounds that are useful in some sustainable cosmetic and body hygiene products (Henni et *al*., 2023; Saewan, 2022).
- Food and beverage additives: SCG and Cascara maybe utilized as functional food additives in practical and/or whole food products with functional food ingredients that contain residual dietary fiber and polyphenols for use in nutritional food (Lestari et *al*., 2022).

In the end, if we can think of a new coffee supply chain system in terms of inclusivity and circularity, we can imagine a meaningful way to move forward as opposed to a positive profit-driven linear system that is rebuilding us, as well as our ecosystems. The new system we aspire to create should encompass environmental responsibility alongside economic opportunities created through fair traded products, and social equity among those actors who fuel coffee production and consumption networks. In doing so, we can honour the contributions of the millions of smallholders production coffee, many of whom consider coffee an important commodity along with a sense of identity, livelihood, and community sustainability.

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