

Integrating Circular Economy and Blockchain Technology for Sustainable Supply Chain Development in Thai Modern Retail: A Literature Synthesis and Future Research Agenda

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Abstract

Background: Modern retail supply chains in developing economies face mounting ESG compliance pressures alongside persistent transparency and resource-efficiency deficits. Circular Economy (CE) principles and Blockchain technology have been proposed as complementary interventions; yet integrated frameworks tailored to this context remain absent from the literature. **Method:** This review synthesises peer-reviewed studies published between 2019 and 2025, identified through structured searches of Scopus and Web of Science using CE–Blockchain–supply chain keywords and screened against explicit inclusion criteria. **Findings:** Blockchain consistently functions as a trust infrastructure that enhances CE effectiveness through traceability and smart contracts, operating at operational, organisational, and ecosystem levels. Evidence is concentrated in developed-economy and sector-specific contexts. Four critical research gaps are identified: the absence of a systemic framework for developing-economy retail supply chains; limited understanding of CE–Blockchain adoption determinants in Thailand; sparse empirical measurement of specific ESG indicator impacts; and insufficient public policy analysis. **Agenda:** A five-directional future research agenda is proposed, progressing from framework development through empirical testing to policy design, providing a structured roadmap for scholars, practitioners, and policymakers pursuing sustainable retail supply chain transformation.

Keywords: Circular Economy, Blockchain, Sustainable Supply Chain, Modern Retail, ESG; Developing Economy

Introduction

Modern retail supply chains are simultaneously confronted with pressures from two converging directions. The first is the intensification of Environmental, Social, and Governance (ESG) requirements, which institutional investors, consumers, and regulators increasingly employ to evaluate and select business partners (Elkington, 1997). The second is the growing complexity of supply chains driven by omnichannel expansion and multi-tier supplier integration across national boundaries, rendering traceability and transparent resource management progressively more difficult.

Within this context, Circular Economy (CE) principles and Blockchain technology have attracted considerable scholarly attention as a conceptually complementary pairing. CE aims to restructure supply chains from the conventional linear model of take–make–dispose towards a regenerative system in which resources retain their value throughout the product lifecycle (Geissdoerfer et al., 2017). Blockchain, in turn, functions as a data infrastructure that enables circularity to be verified, trusted, and coordinated among multiple stakeholders (Upadhyay et al., 2021).

For the purposes of this review, "Thai modern retail" refers to organised retail businesses operating under standardised management systems—including hypermarkets, supermarkets, department stores, and large-format convenience store chains—with multi-branch national networks. This definition excludes traditional wet markets, informal traders, and pure-play e-commerce platforms.

A systematic review of the existing literature reveals that several knowledge gaps remain inadequately addressed, particularly in the context of modern retail in developing economies. This article pursues three objectives: first, to synthesise the development of scholarly knowledge concerning CE–Blockchain integration in supply chains; second, to identify research gaps in the context of Thai modern retail; and third, to propose a structured future research agenda with clearly articulated directions that can be developed into actionable research projects. This study explicitly aims to synthesise CE–Blockchain knowledge, analyse Thai retail constraints, and propose an actionable research agenda.

The article is structured as follows. Section 2 describes the review methodology. Section 3 presents the theoretical foundations. Section 4 synthesises contemporary literature. Section 5 analyses the Thai context. Section 6 identifies research gaps and proposes the future agenda. Section 7 presents conclusions and contributions.

Review Methodology

A structured literature search was conducted in Scopus and Web of Science using the combined search string: ("*blockchain*" OR "*distributed ledger*") AND ("*circular economy*" OR "*sustainable supply chain*") AND ("*retail*" OR "*supply chain management*"). The search was restricted to peer-reviewed journal articles and conference papers published between January 2019 and March 2025, with no language restriction applied at the search stage; however, only English-language records were retained for full-text screening given the target publication audience.

The synthesis was conducted thematically rather than statistically, as the corpus is heterogeneous in method and context. Four thematic clusters were identified inductively: (1) Blockchain as a CE enabler, (2) organisational dynamic capabilities, (3) sector-specific

empirical evidence, and (4) barriers and systemic constraints. The synthesis matrix in Section 4 operationalises this classification. This review acknowledges that the relatively small number of studies ([X]) and the focus on English-language publications are methodological limitations, but this approach is used to meet international publication standards while recognising that some relevant Thai and local studies may not be included.

Theoretical Foundations

1) Triple Bottom Line and Sustainable Supply Chain Management

The Triple Bottom Line (TBL) framework proposed by Elkington (1997) is an important concept in sustainable supply chain management because it helps organisations consider economic, social, and environmental aspects together, and it has been further developed into the ESG framework, which also includes governance and links to international standards such as the Global Reporting Initiative (GRI Standards, 2021) and the Task Force on Climate-related Financial Disclosures (TCFD, 2017).

2) Circular Economy as a Supply Chain Strategy

Geissdoerfer et al. (2017) established that CE represents a system redesign rather than incremental optimisation. Whereas efficiency-focused approaches retain the linear logic of the supply chain while reducing waste at the margins, CE demands the reconstruction of the system from product design and material selection through to reverse logistics and resource recirculation. The four operational principles of CE—Reduce, Reuse, Recycle, and Recover—each imply different supply chain configurations and inter-organisational coordination requirements. Nandi et al. (2021) extended this framework by demonstrating that CE in supply chains is inherently a systemic phenomenon. Their analysis of post-pandemic supply chain redesign illustrates that CE principles can simultaneously enhance sustainability performance and build resilience against supply disruptions, a finding with direct implications for retail supply chains exposed to high demand volatility.

3) Blockchain as a Trust Infrastructure

Saberi et al. (2019) argue that a fundamental constraint of modern supply chains is information asymmetry—the unequal distribution of data about product origins, compliance standards, and quality attributes among supply chain actors. Blockchain addresses this constraint through three core properties: immutability, transparency, and traceability. Smart Contracts extend these properties into the operational domain by enabling automatic execution of agreed conditions—such as sustainable sourcing certification—without requiring manual verification or intermediary oversight (Upadhyay et al., 2021). The convergence of these properties justifies treating Blockchain not as a data management tool but as an institutional mechanism that lowers transaction costs and enables coordinated action in multi-party circular supply chains.

4) Multi-Level Analytical Framework

This review adopts a multi-level analytical framework integrating three theoretical lenses. The Resource-Based View (RBV) explains why organisations with superior IT assets and data infrastructure are better positioned to implement CE–Blockchain systems. The Dynamic Capabilities View (DCV) explains why technology investments alone are insufficient and why the ability to sense, seize, and transform is equally decisive (Meier et al., 2023). Institutional Theory explains why adoption trajectories diverge across national contexts—organisations respond differently to regulatory pressures, normative expectations, and mimetic forces depending on their institutional environment (Mukherjee et al., 2025). The integration of these three lenses is more adequate for explaining the heterogeneity of CE–Blockchain outcomes than any single framework applied in isolation.

Synthesis of Contemporary Literature

Blockchain as a CE Enabler: Mechanisms and Evidence

Upadhyay et al. (2021) proposed a multi-level framework positioning Blockchain as a CE enabler at operational, organisational, and ecosystem levels. This multi-level framing was an important departure from earlier literature that treated Blockchain as a primarily technological intervention. Rejeb et al. (2023), drawing on a systematic literature review, identified five mechanisms through which Blockchain supports CE: enhancing supply chain transparency, tracking materials and products across their lifecycle, enabling verifiable waste management and recycling, certifying sustainable practices among suppliers, and creating incentives for partners to participate in circular systems. Their analysis revealed that these mechanisms are interdependent: data transparency is a prerequisite for effective waste management, which in turn enables credible incentive structures. This interdependence has methodological implications, suggesting that isolating a single mechanism may underestimate the systemic value of CE–Blockchain integration.

Schmidt et al. (2024) catalogued systemic barriers across four categories: technical complexity and the absence of shared data standards; high initial investment and uncertain short-term returns; the requirement for process and culture change; and regulatory and infrastructure constraints. The identification of non-technical barriers challenges the implicit assumption in much earlier literature that overcoming technical challenges is sufficient for successful implementation—a finding that carries particular weight in developing-economy retail contexts where governance and infrastructure constraints are more pronounced.

Organisational Capabilities and Dynamic Readiness

Meier et al. (2023) propose that three dynamic capabilities are essential for CE–Blockchain implementation: sensing capabilities (identifying opportunities and threats), seizing capabilities (mobilising resources and reconfiguring processes), and transforming capabilities (adapting continuously based on operational learning). The implication is that Blockchain investment is necessary but not sufficient; organisations must concurrently develop internal capabilities to integrate technology with process redesign and stakeholder coordination. For multi-tier retail supply chains with diverse supplier bases, this capability-building challenge extends across organisational boundaries, requiring what Meier et al.

(2023) describe as "circular supply chain orchestration" rather than unilateral firm-level action.

Sector-Specific Empirical Evidence

Pakseresht et al. (2022), studying food supply chains, found that Blockchain significantly reduced food waste through real-time monitoring of storage conditions and freshness verification—a finding directly applicable to the Fresh Food and FMCG categories central to modern retail operations. Yontar (2023a) analysed critical success factors in agri-food supply chains and found that institutional factors—regulatory support, infrastructure readiness, and partner incentive systems—carry weight comparable to technical factors. This is consistent with the institutional logic developed by Mukherjee et al. (2025), who found that institutional pressures and internal resources jointly determine CE performance improvements achieved through Blockchain adoption.

Yontar (2023b), using a Grey-DEMATEL methodology, ranked Blockchain characteristics by their influence on supply chain sustainability, finding traceability to be the highest-influence property, followed by transparency and data security. Chen et al. (2024), studying the Chinese automotive industry, found that top management support and IT readiness were the dominant predictors of Blockchain adoption for CE purposes—evidence that the organisational dimension identified by the DCV framework operates in developing-economy contexts analogous to Thailand.

4 Synthesis Matrix

Author(s) (Year)	Method	Industry / Region	Core Theme	Journal (Abbreviated)	Key Finding and Implication for Thai Retail
Upadhyay et al. (2021)	Conceptual / Survey	Multiple / Global	Blockchain × CE × CSR	J. Clean. Prod.	Blockchain enables CE at three levels; predominantly developed-country evidence base
Nandi et al. (2021)	Conceptual Framework	General SCM / Global	CE + Blockchain + Resilience	Sustain. Prod. Consum.	CE + Blockchain builds post-disruption resilience; relevant to multi-tier retail SCM
Pakseresht et al. (2022)	Systematic Review	Food / International	Blockchain → CE transition	Sustainability	Reduces food waste, improves transparency; directly relevant to retail Fresh Food
Meier et al. (2023)	Dynamic Capabilities	Circular SCM / Global	DCV + Blockchain + CE	Transp. Res. E	Organisational capabilities, not technology alone, determine success
Rejeb et al. (2023)	Systematic Lit. Review	Multiple / Global	5 CE-enabling mechanisms	Resour. Conserv. Recycl. Adv.	Mechanisms are interdependent; evidence base skewed toward developed economies
Yontar (2023a)	CSF Analysis / Circular	Agri-food / Turkey	Critical Success Factors	J. Environ. Manage.	Institutional factors equal in weight to technical factors

Author(s) (Year)	Method	Industry / Region	Core Theme	Journal (Abbreviated)	Key Finding and Implication for Thai Retail
Yontar (2023b)	Grey DEMATEL	General SCM / Turkey	Blockchain features × Sustainability	Clean. Logist. Supply Chain	Traceability = highest sustainability influence; prioritisation guidance for resource-constrained implementations
Schmidt et al. (2024)	Literature Review	Multiple / Global	Barriers to Blockchain → CE	Corp. Soc. Resp. Environ. Manage.	4 barrier types: technical, financial, process, regulatory; non-technical barriers underestimated in earlier work
Chen et al. (2024)	TOE-TAM Survey	Automotive / China	Blockchain adoption for CE	Sustainability	Top management support and IT readiness are dominant adoption factors; developing- economy context partially analogous
Mukherjee et al. (2025)	Institutional Theory + RBV	Multiple / Global	Blockchain → CE performance	Sustain. Futures	Institutional pressures and internal resources jointly improve CE outcomes; single-lens models are insufficient

Thai Modern Retail Context and Constraints on Knowledge Transfer

Structural Characteristics and ESG Readiness

Thai modern retail supply chains are characterised by pronounced multi-tier complexity, encompassing large-scale international suppliers and small-scale community producers whose digital readiness and data infrastructure capacity differ substantially. While large retailers listed on the Stock Exchange of Thailand are increasingly subject to ESG disclosure requirements, the information systems that underpin such disclosures—particularly at the supplier level—remain underdeveloped. Thailand's BCG Economy Policy explicitly articulates ambitions aligned with CE principles (NESDC, 2021), yet lacks specific mechanisms to incentivise or standardise Blockchain adoption in retail supply chains. These conditions create a structural gap between policy intention and operational capability that the existing international literature has not systematically examined.

Constraints on Knowledge Transfer from International Studies

Three categories of constraints limit the direct transferability of knowledge from the existing literature to the Thai modern retail context. The first is geographic and infrastructural: the majority of empirical studies reviewed have been conducted in the European Union, the United States, or China—jurisdictions with more advanced digital infrastructure, clearer data governance frameworks, and greater Blockchain pilot experience than Thailand. The second is sectoral: the industries most represented in the literature (food, agriculture, automotive) have supply chain structures and competitive dynamics that differ from multi-category modern retail, where assortment breadth,

seasonal demand patterns, and omnichannel integration create distinct traceability challenges.

The third constraint is methodological. Technology adoption models commonly employed—TOE-TAM and Institutional Theory frameworks—have been tested in contexts where managers possess prior Blockchain exposure and clear IT investment authority. In Thai modern retail, where the majority of organisations remain at the feasibility assessment stage, these models may require adaptation to capture early-stage adoption dynamics and intra-organisational persuasion processes. Recognising these constraints, the following section identifies the resulting research gaps and proposes an agenda to address them.

Research Gaps and Future Research Agenda

Systematic Identification of Research Gaps

Four critical research gaps emerge from the synthesis. The first is the absence of a systemic, validated framework specifically designed for CE–Blockchain integration in modern retail supply chains under the constraints of a developing economy. The second concerns limited understanding of adoption determinants in the Thai context. While Chen et al. (2024) and Mukherjee et al. (2025) offer analytical starting points, neither has been tested with Thai retail executives or calibrated to local institutional conditions. The third gap involves the absence of empirical measurement of specific ESG indicator impacts. The literature consistently argues that Blockchain supports CE performance, but quantitative evidence on the magnitude of effects on measurable outcomes—such as carbon footprint reduction, waste volume, or supplier ESG scores—is sparse, particularly in retail. The fourth gap is the lack of public policy design research targeting Blockchain-enabled CE in developing-economy retail.

Future Research Agenda

Direction 1: Development and Validation of a Systemic Framework for the Thai Context. The most urgent priority is the development of a practical, validated framework integrating CE principles with Blockchain capabilities for Thai modern retail supply chains. The core research question is: What components and implementation sequence constitute an effective, feasible, and ESG-aligned sustainable supply chain framework for Thai modern retail? Design-Based Research (DBR) is proposed as the appropriate methodology, combining contextual analysis, expert consensus, and empirical evaluation to produce a framework that is both theoretically grounded and operationally applicable.

Direction 2: Large-Scale Empirical Testing and ESG Impact Measurement. Following framework development, large-scale quantitative studies should test causal relationships between CE–Blockchain adoption and measurable ESG outcomes. Key research questions: Which supply chain processes in modern retail yield the highest CE impact when Blockchain-enabled? What organisational and contextual variables moderate these relationships? Longitudinal panel designs would capture performance trajectories over time, addressing a limitation evident across the reviewed literature.

Direction 3: Cross-Industry and Cross-Country Comparative Studies. To test the transferability of findings from Thai modern retail to adjacent sectors and geographies, comparative research should examine structurally similar supply chains in food and beverage, fashion, or consumer electronics, as well as comparable developing economies in Southeast Asia. Research questions should address: What context-specific factors differentiate CE–Blockchain requirements in Thai retail from those in other sectors or countries?

Direction 4: Integration with Emerging Technologies and Longitudinal Dynamics. Research should investigate how the integration of Blockchain with IoT sensors and AI predictive analytics performs in partially underdeveloped infrastructure environments, and whether the cost–benefit calculus justifies investment relative to Blockchain alone. Longitudinal studies tracking organisational change and sustainability outcomes over three to five years would address the gap in knowledge about sustained CE–Blockchain performance that single cross-sectional studies cannot provide.

Direction 5: Public Policy Design and Institutional Ecosystem Analysis. Core research questions: What governance mechanisms and standards development processes most effectively enable interoperability across multi-tier retail supply chains? What can Thailand learn from more advanced regulatory frameworks—such as those in the European Union or Singapore—in designing its own Blockchain-for-sustainability policy?

Conclusion and Contributions

This review has synthesised contemporary evidence on the integration of CE principles and Blockchain technology in sustainable supply chain development, with specific focus on Thai modern retail as a developing-economy context. The synthesis confirms that Blockchain functions as a trust infrastructure enabling CE at operational, organisational, and ecosystem levels. However, evidence remains concentrated in developed-economy and sector-specific contexts; non-technical barriers are systematically underweighted in the literature; and no validated framework exists for developing-economy retail supply chains.

This review advances the field in three respects. First, it provides the first systematic synthesis of CE–Blockchain integration evidence framed specifically around the developing-economy retail context, establishing boundary conditions that constrain the direct transferability of findings from advanced economies—a contribution that has not been made explicitly in prior reviews. Second, by integrating Resource-Based View, Dynamic Capabilities View, and Institutional Theory within a single analytical frame, it proposes a multi-level theoretical lens that is more adequate for explaining adoption heterogeneity than any single-framework approach applied in the reviewed literature. Third, the five-directional research agenda links identified gaps to specific research questions, methodological approaches, and policy implications, contributing not merely to a single study but to a structured research programme that scholars and practitioners can operationalise.

This review has some limitations. First, it uses only English-language publications, so some important studies in Thai or other Asian languages may not be included. Second, the number of studies is quite small, so the results may not be generalised. Third, there is no bibliometric analysis to show citation patterns. Fourth, it does not include grey literature such as government or industry reports. However, this approach follows international publication standards, and future research should include more data sources and languages.

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