EcoSupplyChain: A Blockchain-Enabled Dual-Flow Framework for Counterfeit Prevention, Profit Transparency, and Sustainable Recycling

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Abstract—Modern supply chains promise efficiency and global connectivity, yet continue to face persistent challenges such as counterfeit infiltration, opaque profit distribution, and the lack of sustainable recycling mechanisms. To address these issues, this paper presents EcoSupplyChain, a unified blockchain-based framework that integrates forward (production to consumer) and reverse (recycling) logistics into a transparent and tamperresistant ecosystem. The system involves five primary actors: government authority, factory, supplier, store, and buyer, operating on the Ethereum blockchain through smart contracts for automated verification and reward distribution. The framework tackles three major challenges: (1) product authenticity verification using cryptographic signatures and QR-based traceability, (2) transparent profit margin validation without compromising commercial confidentiality, and (3) incentivized recycling through cryptocurrency rewards and tax waivers for manufacturers. The forward chain ensures immutable tracking and profit verification across all supply stages, while the reverse chain promotes recycling participation and material recovery. By merging financial fairness, counterfeit prevention, and sustainability within a single decentralized architecture, EcoSupplyChain establishes a scalable model for secure, transparent, and environmentally responsible supply chain management.

Keyword—Blockchain, Counterfeit Detection, Profit Monitoring, Recycling Incentives, Smart Contracts, Product Traceability, Sustainable Supply Chain.

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