University Canada West

Enhancing Supply Chain Transparency through IoT: A Systematic Review, Conceptual Framework, and Case Study Insights

This thesis explores how the Internet of Things (IoT) can revolutionize supply chain transparency. We present a systematic review, a new framework, and case study insights.

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Why Transparency in Supply Chains Matters

2025 Business Reality

- Transparency is critical for ESG compliance and ethical sourcing
- Enables traceability from start to finish, building trust
- Helps detect risks early, prevent fraud, and improve supply chain resilience
- *Cited: Ahmad et al., 2024; Wang et al., 2024*

Challenges Faced by SMEs

- Struggle with high costs, outdated IT, and lack of digital skills
- Difficulty accessing affordable, real-time traceability tools
- Risk inefficiencies, non-compliance, and missed market opportunities
- *Cited: Malik et al., 2021; Bosco et al., 2024*

Research Focus: IoT-Enabled Transparency

- IoT offers scalable, user-friendly solutions for SMEs
- Helps capture real-time, actionable supply chain data
- Bridges the gap between SME needs and modern tech
- *Cited: Budler et al., 2024; Saxena & Arya, 2023*

Two-Phase Methodology

Phase 1: Systematic Literature Review

Analysis of 36 peer-reviewed articles (2018–2025) using the PRISMA model for thematic coding (PRISMA 2020 Framework).

Phase 2: Cross-Sector Case Study Validation

Findings validated through case studies of Walmart, Maersk, Volvo, ZhongAn AgriTech, and India Pharma (Bosco et al., 2024; Ahmad et al., 2024; Volvo Group, 2023; Billah et al., 2023; Jani, 2025)

PRISMA Article Screening – Phases & Counts

Identification:
214 articles retrieved using Boolean search ("IoT AND Supply Chain AND Transparency") (PRISMA 2020 Flow model ; Page 14)
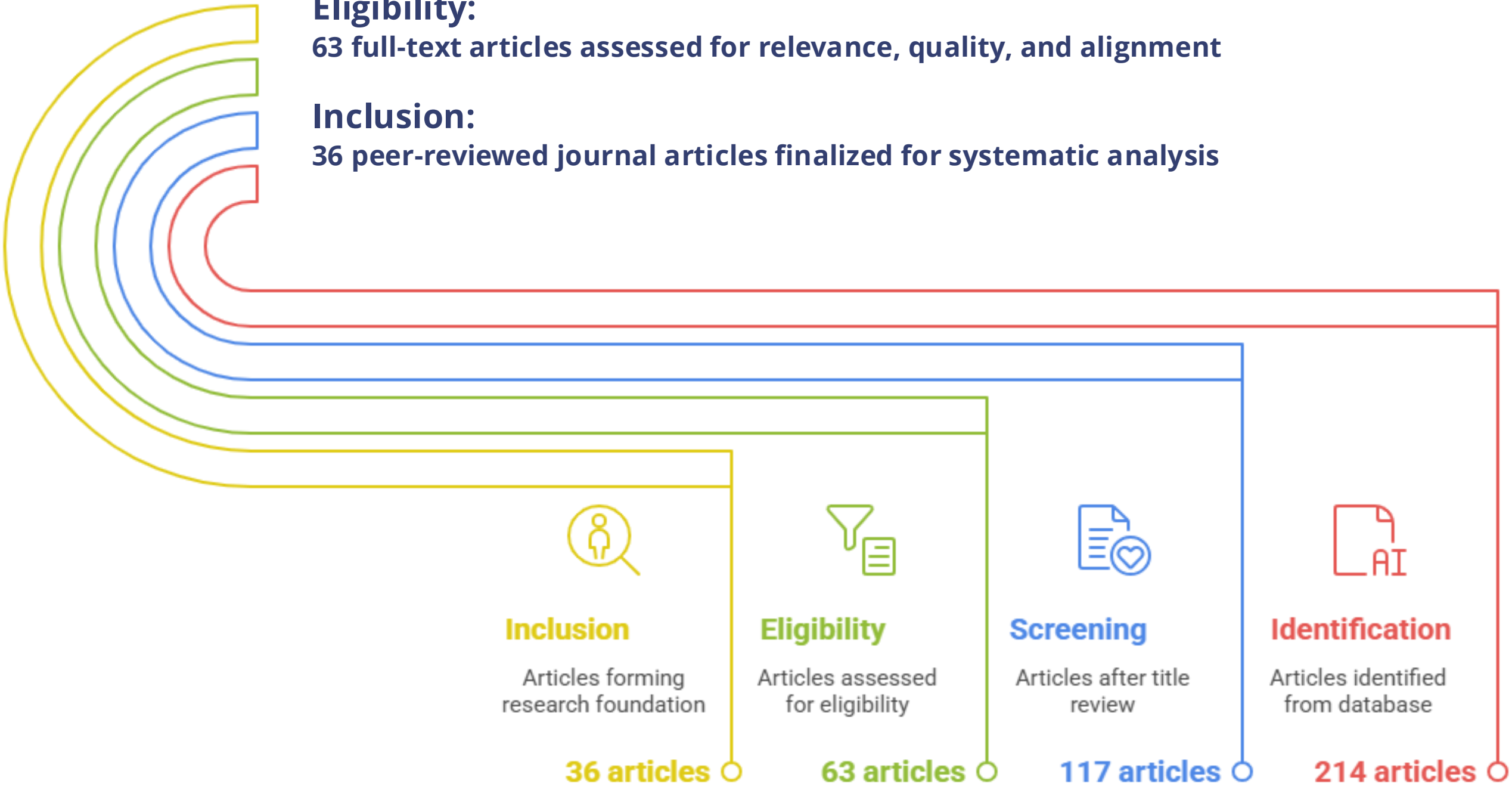
Screening:
117 articles retained after title/abstract review and duplicate removal

Eligibility:
63 full-text articles assessed for relevance, quality, and alignment

Inclusion:
36 peer-reviewed journal articles finalized for systematic analysis

Inclusion
Articles forming research foundation
36 articles

Eligibility
Articles assessed for eligibility
63 articles

Screening
Articles after title review
117 articles

Identification
Articles identified from database
214 articles

What the Literature Reveals (RQ1)

Agri Sector

Real-time crop data significantly **reduced spoilage by 27%.** This enhances freshness and reduces waste (Wang et al., 2024; Bosona & Gebresenbet, 2023; Vitaskos et al., 2024)

Pharma Sector

Blockchain traceability **decreased counterfeits by 25%.** This ensures drug authenticity and patient safety (Ahmad et al., 2024; Araujo et al., 2022; Volvo Group, 2023).

Logistics Sector

IoT enables predictive and paperless movement. This optimizes routes and improves delivery efficiency (Ivanov & Dolgui, 2021; Tao et al., 2018; Dakhia et al., 2025).
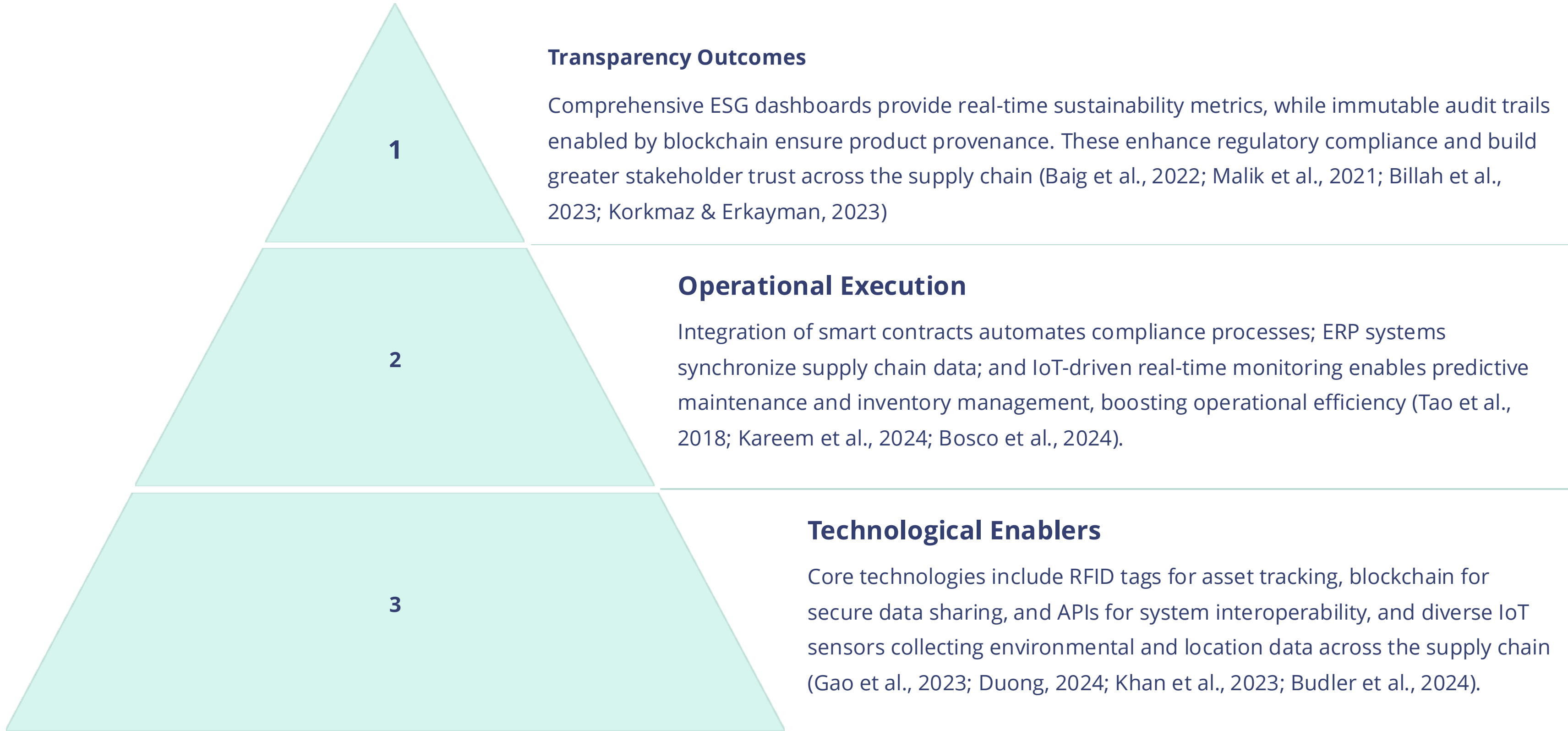
What Helps or Hinders IoT Adoption (RQ2)

Key Enablers

- Advanced cloud and edge computing enabling real-time analytics and decision-making (Baig et al., 2022 – cloud, blockchain).

- Seamless integration of RFID with blockchain for secure and transparent traceability (Malik et al., 2021 – modular integration).

- Flexible modular APIs supporting ESG-compliant dashboards for sustainability reporting (Budler et al., 2024 – APIs and ESG compliance)

- Government incentives and financial support programs reducing upfront costs (Ahmad et al., 2024 – government support and digital literacy)

- Increasing digital literacy and targeted training programs for SME staff (Budler et al., 2024; Wang et al., 2024)

Common Barriers

- 42% of IoT projects fail due to legacy system incompatibility and poor interoperability (Budler et al., 2024 – 42% failure due to interoperability)

- High initial setup and maintenance costs limit SME adoption potential (Wang et al., 2024 – digital infrastructure limitations)

- Shortage of skilled personnel to manage complex IoT infrastructure effectively (Korkmaz & Erkayman, 2023 – data privacy concerns)

- Resistance to organizational change and concerns over data privacy and cybersecurity (Ahmad et al., 2024 – cost and skill gaps)

- Limited broadband access and unstable network infrastructure in some regions (Ahmad et al., 2024; Wang et al., 2024).

The 3-Layer IoT Framework (RQ3)

1

Transparency Outcomes

Comprehensive ESG dashboards provide real-time sustainability metrics, while immutable audit trails enabled by blockchain ensure product provenance. These enhance regulatory compliance and build greater stakeholder trust across the supply chain (Baig et al., 2022; Malik et al., 2021; Billah et al., 2023; Korkmaz & Erkayman, 2023)

2

Operational Execution

Integration of smart contracts automates compliance processes; ERP systems synchronize supply chain data; and IoT-driven real-time monitoring enables predictive maintenance and inventory management, boosting operational efficiency (Tao et al., 2018; Kareem et al., 2024; Bosco et al., 2024).

3

Technological Enablers

Core technologies include RFID tags for asset tracking, blockchain for secure data sharing, and APIs for system interoperability, and diverse IoT sensors collecting environmental and location data across the supply chain (Gao et al., 2023; Duong, 2024; Khan et al., 2023; Budler et al., 2024).

Case Study Synthesis (RQ4)

Walmart (Kamath, 2020; Ahmad et al., 2024)	Retail	Blockchain-based product traceability system	Achieved 2.2 seconds average time to track product origin and journey, enhancing recall efficiency and food safety
Maersk (Billah et al., 2023; Maersk & IBM, 2021)	Logistics	TradeLens platform powered by IBM Blockchain	Streamlined customs clearance, reducing processing time by 20% and improving shipment transparency
Volvo (Volvo Group, 2023; Khan et al., 2023)	Automotive	Ethical sourcing framework integrated with IoT sensors and blockchain verification	Ensured ESG compliance by verifying parts origin and supplier practices in real-time
ZhongAn (Duong, 2024; ZhongAn Tech, 2023)	AgriTech	IoT-enabled smart farming sensors with real-time data analytics	Monitored crop conditions remotely, enabling real-time yield tracking and predictive harvesting
India Pharma (Ahmad et al., 2024; Araujo et al., 2022)	Pharmaceutical	Cold chain IoT loggers with blockchain record keeping	Reduced spoilage risk by 30% through continuous temperature monitoring and secure data logs

Canadian SME Roadmap (Adapted Framework)

Step 1: Digital Readiness Audit

Evaluate current digital infrastructure and identify gaps. For example, Bothwell Cheese optimized their processes through this assessment (Bothwell Cheese, 2023)

Step 2: Integration Planning

Develop a comprehensive plan to integrate IoT seamlessly with existing systems. For example, Happy Planet enhanced sustainability with clean food packaging (Ahmad et al., 2024)

Step 3: Pilot IoT Deployment

Deploy small-scale IoT solutions to test effectiveness and scalability. For example, Chudleigh's Bakery piloted smart temperature sensors successfully (Budler et al., 2024).

Step 4: ESG Scaling & Funding

Expand IoT implementation to support ESG compliance. Leverage tools such as CDAP, Hyperledger, and open-source platforms for funding and scaling (Manupati et al., 2020).

Practical & Policy Implications

For SMEs

- Implement a structured IoT adoption roadmap to achieve ESG compliance, including digital readiness audits and pilot deployments (Ahmad et al., 2024)

- Reduce supply chain risks through real-time monitoring, enhancing product traceability and boosting consumer trust (Malik et al., 2021)

- Leverage IoT-driven efficiencies to improve operational performance and gain competitive advantage in sustainable markets (Bosco et al., 2024).

For Policymakers

- Support SME digital transformation with targeted funding programs like CDAP, facilitating scalable IoT integration for ESG goals (Hyperledger Foundation, 2023)

- Promote open-source platforms such as Hyperledger to ensure secure, interoperable supply chain transparency solutions (Manupati et al., 2020)

- Advance national innovation agendas by incentivizing sustainable practices that foster inclusive economic growth and environmental stewardship (Duong, 2024)

Rethinking Supply Chains for a Transparent Future

- Transparency is now essential

- IoT integration is no longer optional

- Our framework helps SMEs move from complexity to clarity

- Thank you for your time and attention

Thank You for Your Time & Attention

Thank you for joining us today. We covered IoT, transparency, and innovation for SMEs.

Please feel free to ask any questions.

Certificate of Completion

This document certifies that

Ashutosh Jani

successfully completed the Course on Research Ethics based on the Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans (TCPS 2: CORE 2022)

Certificate # 0001318898

2 August, 2024