Accepted : July 11th, 2026
Published : September 30th, 2026
DOI : 10.37253/combines.v6i1.12759

Conference on Management, Business, Innovation, Education and Social Science
https://journal.uib.ac.id/index.php/combines

Logistics of Things and Sustainability: Unpacking the Role of Digital Capabilities in Logistics Performance

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Abstract

The logistics industry is undergoing unprecedented transformation driven by two major global forces: digitalization and sustainability. As supply chains become increasingly complex and environmentally scrutinized, logistics organizations are under growing pressure to improve operational efficiency while simultaneously reducing carbon emissions, energy consumption, resource wastage, and other environmental impacts. Governments, customers, and stakeholders are demanding greener logistics practices, while rapid technological advancements are reshaping how logistics activities are planned, monitored, and executed. In this context, the concept of the Logistics of Things (LoT) has emerged as a strategic approach that integrates Internet of Things (IoT) technologies, real-time connectivity, automation, analytics, and digital integration into logistics operations.

Despite the increasing adoption of digital technologies in logistics, existing research remains fragmented. Most studies have examined technologies such as IoT, blockchain, artificial intelligence, automation, and cloud computing independently, focusing primarily on operational efficiency, service quality, or financial outcomes. Comparatively little attention has been given to understanding how these technologies collectively function as organizational capabilities that contribute to Sustainable Logistics Performance (SLP). This gap is significant because sustainability has become a strategic priority for logistics organizations worldwide. Failure to understand how digital capabilities contribute to sustainability may lead firms to invest heavily in technological infrastructure without achieving meaningful environmental or social benefits. Consequently, organizations risk increased operational costs, regulatory non-compliance, inefficient resource utilization, and diminished competitiveness in increasingly sustainability-conscious markets.

The importance of this issue extends beyond individual organizations. The logistics sector contributes substantially to global greenhouse gas emissions and resource consumption. Without effective digital capabilities that support sustainability objectives, the industry may struggle to achieve international sustainability targets and national green development agendas. Therefore, understanding the mechanisms through which LoT capabilities enhance sustainable logistics outcomes is both theoretically and practically important.

To address this gap, the present study investigates the influence of five key Logistics of Things capabilities on Sustainable Logistics Performance: Smart Tracking (ST), Real-Time Data Connectivity (RDC), Automated Logistics Operations (ALO), Logistics Data Analytics (LDA), and Digital Logistics Integration (DLI). The study is grounded in two complementary theoretical perspectives: Dynamic Capabilities Theory (DCT) and the Technology–Organization–Environment (TOE) Framework.

Dynamic Capabilities Theory argues that organizations achieve sustainable competitive advantage through their ability to sense opportunities, seize them effectively, and continuously reconfigure organizational resources in response to environmental changes. Within the logistics context, LoT capabilities represent strategic resources that enable organizations to adapt rapidly to sustainability requirements and operational challenges. For example, smart tracking technologies improve sensing capabilities by providing real-time visibility of logistics assets, while data analytics capabilities enhance organizational decision-making and resource optimization. Similarly, automation and digital integration facilitate the reconfiguration of logistics processes to improve efficiency and sustainability outcomes.

The TOE framework complements DCT by explaining how technological, organizational, and environmental conditions influence the effectiveness of technology adoption and utilization. Together, these theories provide a comprehensive explanation of how LoT capabilities contribute to sustainable logistics performance by combining technological innovation with organizational adaptation and environmental responsiveness.

Based on these theoretical foundations, five hypotheses were developed. The study proposes that Smart Tracking, Real-Time Data Connectivity, Automated Logistics Operations, Logistics Data Analytics, and Digital Logistics Integration each have a positive and significant effect on Sustainable Logistics Performance.

A quantitative research design was employed using a cross-sectional survey approach. The target population consisted of logistics organizations operating in transportation, warehousing, distribution, freight forwarding, and third-party logistics (3PL) sectors. Purposive sampling was adopted because respondents were required to possess specialized knowledge and professional experience in logistics, supply chain operations, sustainability, or digital transformation initiatives. Eligible respondents included managers, supervisors, executives, and logistics professionals directly involved in strategic or operational decision-making.

Questionnaires were distributed over a three-month period through professional logistics networks and industry contacts. A total of 260 questionnaires were distributed, of which 223 were returned. After data screening and removal of incomplete responses, 210 valid responses were retained for analysis, resulting in an effective response rate of approximately 80.8 percent. This sample size exceeds the minimum requirements for Structural Equation Modeling (SEM), ensuring adequate statistical power and robustness.

Measurement items were adapted from established studies in logistics, supply chain management, digital transformation, and sustainability literature. All items were measured using a five-point Likert scale ranging from strongly disagree to strongly agree. Data analysis

was conducted using SPSS and AMOS Version 29. Confirmatory Factor Analysis (CFA) was performed to assess reliability, convergent validity, and discriminant validity. Subsequently, Structural Equation Modeling (SEM) was used to evaluate the hypothesized relationships.

The expected findings indicate that all five Logistics of Things capabilities will positively influence Sustainable Logistics Performance. Specifically, Smart Tracking is expected to enhance logistics visibility, reduce transportation inefficiencies, and improve resource utilization. Real-Time Data Connectivity is anticipated to facilitate information sharing and coordination among supply chain partners, thereby reducing delays and operational waste. Automated Logistics Operations are expected to improve process efficiency, minimize human error, and optimize resource deployment. Logistics Data Analytics is predicted to emerge as the strongest predictor of Sustainable Logistics Performance by enabling data-driven decision-making and proactive sustainability management. Digital Logistics Integration is expected to strengthen collaboration across supply chain partners, improve information transparency, and facilitate sustainable operational practices.

The anticipated results are expected to support the propositions of Dynamic Capabilities Theory by demonstrating that sustainable performance is not generated solely through technology adoption but through the development and deployment of organizational capabilities. Likewise, the findings are expected to reinforce the TOE framework by highlighting the importance of technological readiness and organizational capability development in achieving sustainability outcomes.

This study contributes to the literature in several ways. First, it advances the emerging Logistics of Things literature by conceptualizing LoT as a multidimensional capability construct rather than a collection of isolated technologies. Second, it extends sustainability research by identifying specific digital capabilities that contribute to sustainable logistics outcomes. Third, it integrates Dynamic Capabilities Theory and the TOE framework to provide a comprehensive theoretical explanation of how digital capabilities generate sustainability value. Finally, the study offers practical guidance for logistics managers and policymakers seeking to accelerate digital transformation while achieving environmental and operational sustainability objectives.

In conclusion, this research responds to the growing need for evidence-based understanding of how digital transformation can support sustainable logistics development. As logistics organizations face increasing pressure to balance economic performance with environmental responsibility, the effective deployment of Logistics of Things capabilities may serve as a critical pathway toward achieving long-term sustainable competitiveness. The findings are expected to provide valuable insights for academics, practitioners, and policymakers seeking to leverage digital innovation to create more sustainable and resilient logistics systems.

Keywords:
Logistics of Things (LoT); Sustainable Logistics Performance; Digital Capabilities; Dynamic Capabilities Theory; Technology–Organization–Environment (TOE) Framework; Supply Chain Digitalization