ISSN 1392-1142 (Print), ISSN 2335-8750 (Online)
ORGANIZACIJŲ VADYBA:
SISTEMINIAI TYRIMAI 2024.92
https://doi.org/10.2478/mosr-2024-00014

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A Conceptual Model for Sustainable Reusable Packaging in Food Supply Chains

Sustainable reusable packaging systems in food supply chains are crucial for reducing waste and advancing a circular economy, but their implementation faces persistent managerial and organizational challenges. This paper proposes a conceptual model to guide the deployment of reusable packaging, such as plastic crates, by integrating insights from classical management principles, such as process standardization and control, and contemporary organizational theories, including network governance, institutional theory, and circular economy frameworks. The model is structured around three interrelated layers—the Operational Core, the Collaborative Network, and the Environmental Context—that align operational efficiency, inter-firm coordination, and adaptive strategies with sustainability objectives. By clearly delineating these components and their interactions, the framework demonstrates how firms can improve efficiency, resilience, and environmental performance in reusable packaging loops. The model provides a structured approach to overcoming adoption barriers such as high transition costs, complex processes, and behavioral resistance, using time-tested management practices adapted to modern needs. This integrative framework addresses a gap in the literature by combining theoretical rigor with practical guidance, enabling the transformation of linear packaging logistics into more circular and resilient food supply chain systems.

Keywords: reusable packaging, management theories, organizational resilience, circular economy, sustainable supply chains, life cycle assessment.

Tvarios daugkartinio naudojimo pakuotės maisto tiekimo grandinėse yra svarbios siekiant mažinti atliekų kiekį ir skatinti žiedinės ekonomikos principus, tačiau tai įgyvendinant susiduriama su nuolatiniais vadybiniais ir organizaciniais iššūkiais. Šiame straipsnyje siūlomas koncepcinis modelis, padedantis diegti daugkartinio naudojimo pakuotes – plastikines apyvartines dėžes, remiantis klasikinių vadybos principų (pvz., procesų standartizavimo ir kontrolės) bei šiuolaikinių organizacinių teorijų – tinklaveikos valdymo, institucinės teorijos ir žiedinės ekonomikos – įžvalgomis. Modelis sudarytas iš trijų tarpusavyje susijusių sluoksnių – vidiniai procesai, bendradarbiavimo tinklas ir aplinkos kontekstas, kurie padeda suderinti veiklos efektyvumą, veiklos koordinavimą tarp bendradarbiaujančių įmonių ir prisitaikymą prie aplinkos reikalavimų. Aiškiai apibrėžus šiuos komponentus ir jų sąveikas, modelis atskleidžia, kaip įmonės gali pagerinti efektyvumą, atsparumą ir mažinti poveikį aplinkai. Šis struktūruotas metodas padeda įveikti tokias kliūtis kaip didelės pradinės sąnaudos, sudėtingi procesai ar pasipriešinimas pokyčiams, taikant patikrintas vadybos praktikas, pritaikytas šiuolaikiniams poreikiams. Šis integruotas modelis užpildo spragą mokslo literatūroje. Jame susietas teorinis pagrindas su praktiniais sprendimais, leidžiančiais pereiti nuo linijinės prie atsparesnės žiedinės pakuočių logistikos sistemos

Raktiniai žodžiai: nacionalinių parkų tarnyba, pasitenkinimas darbu, personalo darbo našumas, motyvacija, organizacijos veiklos efektyvumas.

Introduction

Sustainable packaging has emerged as a critical response to escalating environmental and resource challenges in global food supply chains. Given the increasing demand for fresh products and growing concerns over plastic waste and carbon emissions,

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the shift towards reusable packaging systems is both timely and necessary. The widespread use of single-use plastics contributes significantly to waste and pollution (Dolci et al., 2024; Plastics Europe, 2021) while undermining resource efficiency. Reusable packaging systems, such as reusable plastic crates (RPCs), offer an alternative that reduces waste, lowers lifecycle emissions, and enhances logistical performance.

Yet despite their environmental advantages, RPC systems remain underutilized. This implementation gap stems from persistent managerial, operational, and organizational barriers—including high upfront investments, reverse logistics complexity, and stakeholder resistance due to behavioral inertia and uncertain economic incentives (Coelho et al., 2020; Zambujal-Oliveira et al., 2024).

Existing research on sustainable packaging has focused primarily on environmental metrics and material innovation, with less attention to the management and coordination mechanisms required for systemic adoption (Kudrenko & Hall, 2024). Classical management theories, developed in the early 20th century, emphasize internal process control and operational efficiency but have rarely been applied to circular logistics. Conversely, contemporary theories—such as institutional and network governance— stress external coordination, adaptability, and inter-organizational collaboration, yet they remain underexplored in the context of reusable packaging systems.

Although the potential of reusable packaging is well-recognized, practitioners and scholars lack a clear, unified framework to guide its implementation. Existing studies often address isolated aspects of reuse or sustainability without a comprehensive model that captures their interconnections. Therefore, developing a conceptual model is necessary to integrate diverse insights into a coherent structure that aligns operational practices, collaborative networks, and environmental objectives. Such a model fills a critical gap in the literature by providing theoretical rigor and practical guidance, enabling firms to navigate the transition to circular packaging logistics systematically.

This study addresses these needs by proposing an integrative conceptual model that synthesizes classical and contemporary organizational perspectives. The model bridges early 20th-century efficiency logic with 21st-century collaborative governance, demonstrating that both internal process control and external coordination must be combined to enable sustainable packaging logistics. By clearly delineating its layers – Operational Core (focused on process efficiency), Collaborative Network (focused on inter-firm coordination), and Environmental Context (focused on external pressures) – the framework shows how firms can improve efficiency, resilience, and environmental performance in reusable packaging loops. Importantly, no existing framework comprehensively combines these dual perspectives for reusable packaging deployment.

Accordingly, this paper's primary contribution is an integrative framework linking operational control, inter-organizational collaboration, and circular economy principles. This framework provides managers and researchers with a strategic roadmap to manage RPC systems more effectively. In other words, the proposed model explicitly integrates early-20th-century organizational logic (centered on internal control and efficiency) with post-1970 organizational paradigms that emphasize external coordination and inter-organizational collaboration.

Research question: How can classical management principles and contemporary organisational theories be integrated into a unified conceptual model to overcome deployment barriers and improve the sustainability outcomes for reusable packaging systems (RPCs) in the food supply chains?

Research object: The study focuses on the application of reusable secondary packaging systems—especially reusable plastic crates (RPCs)—within food supply chains, examining their operational and organizational deployment through an integrated management framework that combines classical and contemporary management theory aligned with circular economy principles.

Research aim: This study aims to develop a robust and actionable conceptual model to guide the sustainable implementation and management of reusable packaging (RPC) systems in food logistics, enhancing their effectiveness, resilience, and environmental performance. This model is designed to address significant practical challenges and managerial complexities associated with transitioning from linear to circular packaging logistics.

Research methods: This study employs a qualitative, theory-driven research design based on conceptual synthesis. The methodological approach integrates insights from classical management theory and contemporary organizational literature and applies specifically to the context of reusable packaging in food supply chains. The research is exploratory in nature and aims to generate new theoretical understanding rather than empirically test predefined hypotheses.

The core methodological strategy involves constructing an integrative conceptual framework, grounded in deductive reasoning, where established theoretical constructs are critically examined and adapted to address real-world managerial and organizational challenges observed in the deployment of reusable packaging systems.

Classical management theories—including Taylor's scientific management (Taylor, 1911), Fayol's administrative principles (Fayol, 1949), and Weber's theory of bureaucracy (Weber, 1922)—are explicitly retained due to their proven effectiveness in managing internal company processes, operational standardization, and procedural efficiency. These frameworks provide foundational insights crucial for optimizing repetitive logistics processes (e.g., crate washing, sorting, and reverse logistics operations), which are essential for sustainable reuse practices. However, recognizing that sustainable packaging requires inter-organizational coordination and adaptability beyond internal efficiency, contemporary organizational frameworks such as Scott's Institutional Theory (Scott, 2008), Contingency Theory (Lawrence & Lorsch, 1967), Powell's Network Governance (Powell, 1990), and Circular Economy principles (Geissdoerfer et al., 2017; Kirchherr et al., 2018) are also integrated into the conceptual model to address these broader collaborative and regulatory challenges.

To support theoretical integration, the study draws on two main data sources:

Scientific literature: Peer-reviewed journal articles published between 2015 and 2024, focusing on reusable packaging systems, life cycle assessment (LCA), reverse logistics, circular economy frameworks, and organizational adaptation in supply chains. Relevant sources were retrieved using academic databases (Scopus, ScienceDirect, and Web of Science). The selection criteria included topical relevance, methodological rigor, theoretical contribution, and publication quality.

Industry and institutional documents: Case studies and reports from major logistics and retail operators (e.g., IFCO, Euro Pool System, Lidl, Rimi, 2024) and policy documents from institutions such as the European Commission (2018) and GIZ (2024) focus on regulatory frameworks, reuse targets, waste reduction strategies, and climate policies related to packaging.

Inclusion criteria for literature and secondary data sources included demonstrated relevance to RPC systems or secondary packaging in food logistics, empirical evidence or conceptual frameworks, peer-reviewed status (for academic articles), and availability in English or Lithuanian language.

The analytical technique employed is comparative theoretical synthesis, involving systematic mapping of theoretical constructs against practical applications and challenges identified in the literature and industry reports. This approach facilitates the identification of critical management factors that influence RPC design, governance, coordination, and environmental outcomes. It emphasizes a clearly structured thematic analysis across organizational, inter-organizational, and institutional dimensions, enhancing the theoretical coherence and practical relevance of the model.

Given the reliance on publicly available secondary data, ethical approval was not required. Nevertheless, methodological limitations include the lack of primary empirical validation (e.g., field surveys, interviews) and the inability to thoroughly explore context-specific variables such as cultural norms or regulatory enforcement intensity.

Despite these limitations, the study provides a strong theoretical foundation and strategic guidance for enhancing RPC system performance, bridging classical, efficiency-driven management approaches with contemporary theories of collaboration, adaptability, and sustainability.

The objectives of the article:

1. To critically review classical and contemporary management theories, highlighting their relevance to internal operational control and external inter-organizational collaboration in reusable packaging systems.
2. To identify key managerial and organizational challenges in implementing reusable plastic crates (RPCs) within food supply chains.
3. To construct an integrative conceptual model linking selected theoretical perspectives to practical strategies for improving RPC system performance and circularity.
4. To propose actionable recommendations for enhancing packaging sustainability and resilience in food logistics environments.

The remainder of this paper is structured as follows. Firstly, the relevant literature and theoretical foundations underpinning sustainable, reusable packaging systems are outlined. The research design and methods are then outlined, emphasising a qualitative, theory-driven approach grounded in conceptual integration and comparative theoretical synthesis, and the developed conceptual model is presented alongside supporting empirical insights from recent case studies. The final section discusses the implications for theory and practice, highlighting how the model can guide managerial decision-making in circular packaging logistics. The conclusion provides recommendations and practical implications and proposes avenues for the future empirical validation and refinement of the conceptual framework.

Theoretical foundations and literature review

Integrating classical management theories into the context of sustainable reusable packaging systems (RPCs) in food supply chains offers valuable insights for enhancing operational efficiency and environmental sustainability. However, few studies systematically link these foundational principles to the specific managerial challenges of RPC deployment, creating a critical gap in the literature. This section examines the applicability of Frederick Taylor's Scientific Management, Henri Fayol's Administrative Principles, and Max Weber's Bureaucracy Theory to RPCs, incorporating contemporary research and practical examples. These classical theories provide fundamental managerial tools crucial for optimizing internal organizational processes within RPC systems, while contemporary theories address the broader inter-organizational and systemic coordination needed in modern supply chains.

Frederick Taylor's (1911) scientific management model emphasizes task optimization through systematic study and standardization of work. Applied to reusable packaging, this perspective supports the structuring of RPC handling processes—such as crate washing, inspection, and turnaround—in ways that minimize inefficiencies and reduce labor intensity. Standardizing these procedures improves throughput and reinforces consistency across decentralized logistics hubs. Recent studies (Dolci et al., 2024; Accorsi et al., 2020) demonstrate that optimizing crate reconditioning and reverse logistics workflows can significantly reduce operational costs and environmental externalities. Furthermore, the use of automation and data-driven monitoring in crate cleaning facilities aligns with Taylor's efficiency logic, enabling scalable improvements across RPC loops (Silyland-Reyes et al., 2022).

Henri Fayol's (1949) administrative principles outlined five core managerial functions—planning, organizing, commanding, coordinating, and controlling—that remain relevant in the context of modern logistics. Reusable systems require synchronized interaction among actors including manufacturers, third-party logistics providers, and retailers. Fayol's principles, particularly "unity of command," inform how coordination protocols and governance hierarchies should be structured in shared packaging systems. I. M. Raible et al. (2024) observed that the effective implementation of returnable packaging systems in

European retail chains depends on clearly defined operational processes, interdepartmental coordination, and formalized accountability mechanisms to prevent packaging losses and sanitation failures.

Max Weber's (1947) bureaucratic theory emphasizes formalized rules, hierarchical structures, and rational-legal authority as mechanisms for ensuring procedural control and accountability. These elements are highly applicable to the governance of RPC systems, particularly those operating across multiple firms and jurisdictions. The management of reusable crate platforms, like IFCO (2024) and Euro Pool System (2024), relies on regulated asset circulation, standard contracts, and deposit-refund mechanisms. I. M. Raible et al. (2024) demonstrate that structured regulatory schemes are effective in supporting circularity by minimizing losses and ensuring crate returns across value chains. Moreover, digital technologies such as RFID, blockchain, and IoT devices can support bureaucratic discipline without sacrificing adaptability. These tools enhance traceability and hygiene assurance, aligning with Weberian principles of transparency and control (Plastics Europe, 2021; Raible et al., 2024).

While classical management theories offer foundational insights into operational efficiency and internal governance, contemporary challenges related to sustainability and inter-organizational logistics demand a more adaptive and integrated approach. Modern networked logistics and circular economy contexts highlight the limitations of traditional frameworks—particularly their inward-facing focus and rigidity in rapidly evolving environments (Accorsi et al., 2022; Geissdoerfer et al., 2017). Therefore, integrating classical management principles with contemporary organizational frameworks (e.g., network governance, institutional theory, contingency theory) and leveraging digital governance tools such as IoT, blockchain, and data analytics produces a more agile and resilient RPC management model—one capable of navigating cross-organizational coordination and systemic sustainability challenges (Saberi et al., 2019; Kamble et al., 2020).

In conclusion, revisiting classical management theories through the lens of current research and practical applications reveals their enduring relevance in optimizing reusable packaging systems within food supply chains. By adapting these foundational principles to contemporary organizational contexts and integrating them with modern governance and technological frameworks, organizations can effectively enhance operational performance, sustainability, and resilience within RPC-based logistics.

Contemporary organizational theories

Contemporary organizational theories offer essential insights into the enabling conditions, adaptive mechanisms, and governance structures required for implementing sustainable reusable packaging systems (RPCs) in food supply chains (Saberi et al., 2019; Kamble et al., 2020). These theoretical lenses help explain why RPC systems succeed in some institutional environments and fail in others, and how firms and supply chain actors can strategically align operations with sustainability imperatives (Accorsi et al., 2022; Geissdoerfer et al., 2017). Despite their relevance, these theories remain underapplied in RPC research.

Institutional theory: Institutional frameworks and governance mechanisms are central to the successful implementation and scalability of reusable packaging systems, particularly in food logistics. These mechanisms shape organizational behavior through regulatory, normative, and cognitive rules that influence expectations and decision-making processes (Scott, 2008; DiMaggio & Powell, 1983; Meyer & Rowan, 1977). In RPC systems, institutional support determines the degree of alignment between private innovations and public policy in advancing circular supply chains (European Commission, 2018). Research identifies several governance-related challenges. A primary barrier is the voluntary nature of existing legislation, which shifts responsibility for systemic change onto individual firms rather than establishing enforceable reuse norms. Companies frequently cite the lack of binding regulations, economic incentives, and supportive infrastructure as key reasons for slow adoption (Betts et al., 2022; Coelho et al., 2020). These issues are especially pronounced in fragmented or less-regulated sectors, where high capital costs—for washing centers, reverse logistics, and tracking systems—limit scalability.

Institutional theory also explains the role of isomorphic pressures. Leading firms that adopt RPC practices create legitimacy for reuse, prompting other organizations to conform to emerging standards (Greenwood & Hinings, 1996; Albrecht et al., 2022). These effects are amplified by ESG reporting frameworks and Extended Producer Responsibility (EPR) schemes that set reuse quotas or include packaging reuse in performance indicators. Furthermore, procurement criteria favoring circular packaging can generate additional coercive or mimetic pressure. National governments, municipal authorities, and trade associations can offer enabling incentives such as tax relief, deposit-return frameworks, grants for digitalization, and harmonized reuse guidelines (Domenech & Bahn-Walkowiak, 2019; Saberi et al., 2019). These interventions reduce adoption risk and facilitate cross-sector coordination, laying the foundation for systemic scale-up.

Contingency theory (Lawrence & Lorsch, 1967) asserts that no single organizational structure is universally optimal—effectiveness arises when internal capabilities are aligned with external environmental variables. This view is particularly relevant to RPC implementation, where logistics configurations must respond to context-specific conditions, such as urban density, reverse flow frequency, or hygiene standards. For instance, short-loop reusable systems for fresh produce in city-center stores require different infrastructure and coordination than long-loop systems covering rural or cross-border routes. Return rates, crate handling processes, and reconditioning cycles must all adapt to local conditions. These findings are supported by field studies across Europe, where successful RPC deployment often hinges on tailoring reuse systems to product perishability, consumer behavior, and operational flexibility (Albrecht et al., 2022; GIZ, 2024). Moreover, empirical research on digital supply chain agility demonstrates that context-specific alignment—via dynamic routing algorithms and configurable cleaning stations—significantly improves return rates and reduces environmental impacts (Kamble et al., 2020; Mani, Delgado, Hazen, & Patel, 2017).

Network governance theory (Powell, 1990) provides a lens to understand how decentralized, interdependent actors collaborate to manage reusable asset systems. Unlike transactional buyer–supplier models, RPC systems require trust-based coordination among producers, retailers, logistics operators, and pooling platforms. According to H. Sun (2024), reusable packaging relies on shared responsibilities: crate ownership may be centralized (e.g., by a pooling provider like IFCO), while operational accountability—returns, washing, tracking—is distributed across the network. Studies emphasize that successful reuse models incorporate co-investment, interoperable IT systems, and harmonized data-sharing protocols (Pålsson & Olsson, 2023; GIZ, 2024; Kamble et al., 2020; Saberi et al., 2019). Network-based governance enhances system visibility and reduces inefficiencies in reverse logistics, which is critical for maintaining asset integrity and hygiene in perishable goods distribution.

Moreover, blockchain-enabled track-and-trace systems and IoT sensors provide real-time data on crate location, usage frequency, and cleaning status, further strengthening governance and accountability (Saberi et al., 2019; Kamble et al., 2020). Such models also align with emerging policy visions of co-created circular infrastructure, where private innovation is coupled with public regulatory scaffolding and stakeholder inclusion (Domenech & Bahn-Walkowiak, 2019).

Circular economy principles: Lifecycle Thinking and Closed-Loop Logistics. Circular economy (CE) frameworks offer the conceptual and operational foundation for RPC systems. CE principles emphasize minimizing waste, maximizing resource efficiency, and enabling closed-loop material cycles through design for durability, reparability, and material recovery (Geissdoerfer et al., 2017; Kirchherr et al., 2018; Bocken et al., 2016). The Ellen MacArthur Foundation (2019) highlights that closed-loop systems require coordinated value-chain collaboration from product design through end-of-life management. RPC systems embody these ideals by enabling packaging reuse across multiple delivery cycles, reducing reliance on virgin plastic, and decreasing landfill dependency. Design for durability and modular repair ensures that RPCs can achieve high reuse thresholds—empirical LCA studies indicate that exceeding 100 reuse cycles is necessary to offset the higher production impacts of durable crates (Ratay, Barthel, & Mohnen, 2024; Zimmermann & Hauschke, 2024). Importantly, circularity is not purely technical—it requires ecosystem coordination and behavioral alignment. Governance mechanisms such as deposit-return schemes, eco-modulated fees, and digital tracking systems are essential to realizing CE value (Pajula & Sundqvist-Andberg, 2022; Lewandowski, 2016). In particular, digital twin simulations and IoT-enabled performance monitoring optimize loop management and predict maintenance needs (Mani, Delgado, Hazen, & Patel, 2017).

This theoretical foundation emphasizes that no single framework alone is sufficient to govern the complexity of reusable packaging systems (RPCs). Instead, a hybrid approach—combining institutional legitimacy, environmental fit, inter-organizational collaboration, and circular economy design principles—is required to support sustainable transformation in food logistics. These theories are not mutually exclusive but rather complementary, offering a robust conceptual base for developing adaptable, efficient, and resilient RPC models.

Linking theory to the RPC context

To synthesize the theoretical perspectives examined in the previous sections, this part of the paper maps both classical and contemporary management and organizational theories to the core functional and strategic dimensions of reusable packaging systems (RPCs) in food supply chains. These dimensions include system design and operational efficiency, governance and regulatory compliance, inter-organizational collaboration, and sustainability integration.

Table 1 summarizes the theoretical contributions to each of these dimensions,

Table 1. **Theoretical contributions to understanding RPC systems**

Theory (Main Authors)	Key Contribution	Application to RPC Systems
Taylor's Scientific Management (Taylor, 1911)	Process efficiency, standardization, and task optimization	Supports standardization of washing, inspection, and crate circulation protocols; enables workflow automation.
Fayol's Administrative Theory (Fayol, 1949)	Planning, coordination, unity of command, and structured control.	Guides internal coordination and role definition for managing RPC flows and scheduling in logistics operations.
Weber's Bureaucracy Theory (Weber, 1947)	Formal hierarchy, rule-based authority, and compliance systems.	Frames the governance of shared-use RPC systems through clearly defined responsibilities and compliance monitoring.
Institutional Theory (Scott, 2008; DiMaggio & Powell, 1983)	External legitimacy, regulatory conformity, and isomorphic adaptation.	Explains RPC system adoption driven by ESG standards, policy mandates, and industry norms.
Contingency Theory (Lawrence & Lorsch, 1967)	Fit between organizational structure and environmental variability.	Justifies the need to adapt RPC designs and return flows to product perishability, hygiene, and local context.
Network Governance (Powell, 1990)	Trust-based collaboration, decentralized coordination, and shared infrastructure.	Highlights inter-organizational cooperation in crate pooling, reverse logistics, and system-level traceability.
Circular Economy Frameworks (Geissdoerfer et al., 2017; Kirchherr et al., 2018)	Resource circularity, reuse prioritization, and closed-loop system thinking.	Positions RPCs as core assets in CE logistics, enabling material reuse, lower emissions, and life cycle efficiency.

Source: compiled by the author based on theoretical and empirical literature.

offering a structured view of how conceptual frameworks inform real-world RPC implementation. This integrative synthesis illustrates the complementary roles of diverse theoretical approaches in addressing the multifaceted challenges and opportunities associated with sustainable packaging systems.

This theoretical mapping underscores the need for an integrated, hybrid approach to managing reusable packaging systems. Classical theories such as those of Taylor, Fayol, and Weber provide structural clarity, process discipline, and rule-based governance—essential for designing standardized and scalable logistics operations. At the same time, contemporary frameworks—including institutional theory, contingency theory, network governance, and circular economy principles expand the analytical scope by incorporating environmental adaptability, regulatory alignment, stakeholder collaboration, and systemic sustainability. In summary, each theory complements the others, providing a multi-layered understanding of RPC operations in complex food supply chains. Table 1 demonstrates that operational efficiency drawn from classical theories must be integrated with the adaptive governance mechanisms emphasized in contemporary frameworks. This synergy is critical for effective RPC implementation, enabling both technical performance and systemic sustainability. The next section reviews recent empirical studies to illustrate how these theoretical dimensions play out in practice, particularly through life cycle assessments (LCA), stakeholder experiences, and case-based performance outcomes. This transition from conceptual analysis to real-world insights allows for a more grounded and actionable understanding of RPC system performance and implementation challenges.

Insights from recent empirical studies

Empirical evidence from recent academic and industry studies reinforces the theoretical linkages outlined earlier, while also highlighting the practical complexities of implementing reusable packaging systems in food logistics. These studies provide validation for the proposed conceptual model by demonstrating how its core dimensions—such as design optimization, governance coordination, and organizational adaptability—manifest in real-world applications.

A consistent empirical finding is the environmental superiority of RPCs over single-use packaging. Life Cycle Assessment (LCA) studies show that RPC systems can significantly reduce greenhouse gas emissions and overall environmental impacts, particularly when crates are circulated at high rotation rates in closed-loop networks (Albrecht et al., 2022; Ratay et al., 2024; Zambujal-Oliveira et al., 2024). However, researchers also note that fully closing the material loop remains challenging in practice. Losses due to crate contamination, improper returns, and other leakage issues still occur, limiting the realization of circular economy benefits in operational settings (Zambujal-Oliveira et al., 2024; Albrecht et al., 2022). This gap between theoretical potential and actual performance underscores the importance of robust system design and management strategies, as emphasized in the model's sustainable design component.

Another key insight relates to the governance of RPC systems. Empirical studies show that successful reusable packaging initiatives often employ hybrid governance models that blend formal contracts with informal, trust-based collaboration (GIZ, 2024; Betts et al., 2022). Such "combination governance" arrangements provide accountability through clear agreements while preserving the flexibility needed to coordinate among multiple supply chain partners. This evidence aligns with the model's multi-level governance component, confirming that strict top-down control alone is insufficient for managing a multi-actor, inter-organizational system. Indeed, overly rigid, bureaucratic controls can inhibit innovation, reinforcing the need to hybridize classical management principles with more adaptive approaches (Coelho et al., 2020). In practice, governing RPC networks extends beyond the authority of any single organization, requiring decentralized coordination and shared responsibility across stakeholders.

In addition to structure and governance, technological and cultural factors emerge as critical enablers of RPC system performance. High digital maturity—exemplified by the use of RFID, IoT sensors, and other traceability tools—significantly improves crate tracking and reverse logistics efficiency (Mahmoudi & Parviziomran, 2020; Pajula & Sundqvist-Andberg, 2022). However, uneven implementation of these technologies across regions reveals a gap between the available digital tools and their actual utilization in practice. Equally important is the human element: a strong organizational culture of trust and collaboration among supply chain partners consistently correlates with better RPC outcomes (Ratay et al., 2024; Kudrenko & Hall, 2024). Shared logistics infrastructure and cooperative norms allow stakeholders to achieve performance gains collectively that would be unattainable by any single firm acting alone. These insights correspond to the model's emphasis on organizational adaptability, indicating that both advanced technology and social capital are essential to translating the model's theoretical benefits into practice.

Collectively, the empirical findings reinforce the need for a holistic, multifaceted approach to improving RPC systems. They demonstrate the importance of balancing structural control with contextual flexibility, technological capabilities with human factors, and formal institutional governance with adaptive collaboration. In sum, this evidence base supports the integrative conceptual model presented in the next section, validating that a combination of classical and contemporary management elements is crucial for achieving more effective, resilient, and sustainable RPC outcomes in food supply chains.

Conceptual model and results

To translate diverse theoretical perspectives into a practical systems framework, this study proposes an integrative conceptual model that connects classical and contemporary management theories with the operational realities of reusable plastic crate (RPC) systems in food logistics. The model builds on foundational management theories—Taylor's (1911) scientific management, Fayol's (1949) administrative principles, and Weber's (1947) bureaucracy theory—as well as contemporary frameworks including Scott's (2008) institutional theory, Lawrence and Lorsch's (1967) contingency theory, Powell's (1990) network governance, and circular economy principles (Geissdoerfer et al., 2017; Kirchherr et al., 2018).

Empirical insights from recent studies further ground the model in practice, highlighting key adoption barriers and performance challenges in RPC systems across European food supply chains (Albrecht et al., 2022; Mahmoudi & Parviziomran, 2020; Ratay et al., 2024; Zambujal-Oliveira et al., 2024).

Model development rationale. The model integrates six core theoretical frameworks with demonstrated applicability to RPC system management. The selected theories were chosen based on two criteria: (1) conceptual leverage across three model dimensions—design, governance, and adaptation—and (2) empirical validation in recent RPC and logistics sustainability research. Classical theories provide tools for process efficiency, standardization, and formalized control within firms (Zimmermann & Hauschke, 2024; Mahmoudi & Parviziomran, 2020). Institutional and network governance theories (Scott, 2008; Powell, 1990) offer explanatory power for inter-organizational coordination, legitimacy pressures, and governance alignment (Betts et al., 2022; GIZ, 2024). Contingency theory and circular economic principles support contextual fit, lifecycle integration, and responsiveness to external variability (Albrecht et al., 2022; Zambujal-Oliveira et al., 2024).

Collaborative network (Inter-firm Governance). This meso-level layer links multiple supply chain actors through formal and informal coordination mechanisms. Drawing on W. R. Scott's (2008) institutional theory, it highlights how coercive, normative, and mimetic pressures shape organizational behavior. W. W. Powell (1990) network governance theory further underscores the role of trust-based collaboration, shared resource management, and interoperable infrastructure in building resilient, efficient RPC loops.

Inter-firm contracts and Trust Mechanisms: Formal agreements establish clear roles, responsibilities, and performance metrics for manufacturers, pooling providers, carriers, and retailers. Such contracts specify return rates, cleaning standards, and penalties for non-compliance, thereby reducing uncertainty and aligning incentives (Betts et al., 2022). At the same time, informal trust-building activities—such as joint training workshops and regular multi-partner forums—complement contractual safeguards by fostering a shared commitment to system objectives and by facilitating conflict resolution (Zambujal-Oliveira et al., 2024).

Interoperable IT systems: Real-time visibility across the RPC network is enabled by RFID tags, IoT sensors, and blockchain platforms. These technologies allow stakeholders to track crate locations, monitor usage cycles, and proactively detect sanitation issues. For example, blockchain-based traceability can increase transparency and stakeholder confidence in shared logistics and help reduce disputes among partners (Saberi et al., 2019). Integrated dashboards that consolidate data from multiple actors enable analytics-driven decision-making (e.g., dynamically reallocating crates to high-demand regions or scheduling preventive maintenance).

Co-Investment structures: Shared infrastructure—such as centralized washing centers and pooled transport fleets—requires significant capital outlay. Co-investment agreements distribute these costs across network participants, reducing individual firm risk and generating economies of scale (GIZ, 2024). In European food supply chains, for example, collaborative financing of washing facilities has been shown to lower per-crate capital costs and increase asset utilization, compared to firms investing in separate proprietary systems (Betts et al., 2022; GIZ, 2024).

Regulatory alignment and legitimacy: Institutional pressures from public–private partnerships, ESG reporting mandates, and Extended Producer Responsibility (EPR) schemes create both coercive and normative motivations for network participation (DiMaggio & Powell, 1983; Albrecht et al., 2022). Harmonizing external requirements with internal governance rules is critical: where top-down policies lack stakeholder buy-in, compliance remains superficial and innovation is hindered (Coelho et al., 2020). Conversely, networks that actively engage regulators in co-designing deposit–return frameworks and reuse targets achieve higher legitimacy and adoption rates (Domenech & Bahn-Walkowiak, 2019).

Environmental context (Circularity and Adaptation). This macro-level layer situates the RPC system within the broader external environment, integrating Lawrence and Lorsch's (1967) contingency theory with circular economy principles (Geissdoerfer et al., 2017; Kirchherr et al., 2018) to support long-term system resilience and resource efficiency.

Contextual adaptation: Contingency theory emphasizes that system configurations must align with external variables such as geographic context (urban vs. rural density), product perishability, and seasonal demand fluctuations. For example, operations in low-density regions may require more dynamic routing and backhaul planning to reduce empty runs (Mani et al., 2017), whereas high-rotation urban circuits demand faster turnaround times to maintain freshness in perishable produce.

Design for durability and reparability: Circular economy tenets prioritize engineering products for extended use cycles. Durable materials and modular crate designs facilitate part-level replacement, thereby extending the functional life of crates by approximately 20% compared to conventional packaging and reducing material inputs and end-of-life waste (Pajula & Sundqvist-Andberg, 2022). Additionally, standardized crate components significantly simplify repairs and maintenance, reducing downtime and lowering the overall environmental footprint of the RPC pool (Ratay et al., 2024).

Incentive mechanisms (Deposit–Return Systems and Fees): Financial incentives align stakeholder behavior with circular economy objectives. Well-designed deposit–return schemes can dramatically reduce crate losses from typical rates of 10–15% down to as low as 5% by internalizing the cost of crate leakage and contamination (Zambujal-Oliveira et al., 2024). Similarly, eco-modulated fee structures reward high return rates and penalize excessive losses, reinforcing closed-loop performance and improving overall stakeholder compliance.

Monitoring and feedback loops: IoT-enabled sensors and digital platforms continuously monitor key performance metrics—such as loss rates, cycle counts, and contamination events—and provide real-time feedback to both governance bodies and operational teams. These data streams support dynamic adjustments to routing protocols, cleaning schedules, and incentive programs as conditions change, thereby linking environmental performance back to operational and governance decisions.

Further Figure 1 presents the integrative conceptual model.

In this way, circular economy and contingency theory principles are operationalized through practical management tools and technologies, ensuring adaptive flexibility and long-term sustainability.

Integrative conceptual model is presented as three concentric layers—Intercompany (Operational Core), Collaborative Network, and Environmental Context—encircled by bidirectional "Operation ↔ Governance" feedback loops that ensure continuous alignment between internal efficiency, inter-firm coordination, and system-level adaptability. Each layer plays a distinct but interdependent role in the system.

Table 2 outlines the theoretical foundations and core structural elements of each layer, mapping classical and contemporary theories to the Operational Core, Collaborative Network, and Environmental Context and highlighting the

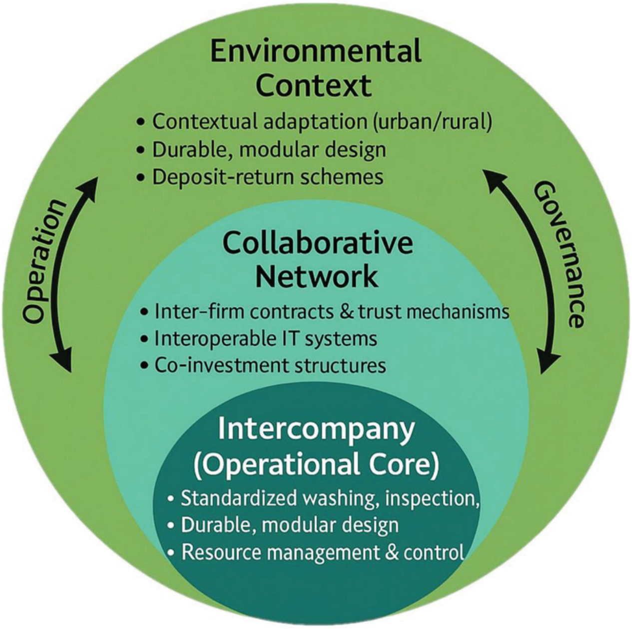

Fig. 1. **Conceptual model for enhancing RPC systems in food supply chains**

Source: Compiled by the author based on theoretical literature.

Table 2. **Theoretical contributions to understanding conceptual model**

Layer	Theory	Core Elements	Primary Flow
Intercompany (Operational Core)	Taylor (1911); Fayol (1949); Weber (1947)	Standardized washing/ inspection; resource control; hygiene compliance	**Operation → Governance: performance data**
Collaborative Network	Scott (2008); Powell (1990)	Inter-firm contracts; interoperable IT; co-investment	**Governance → Operation: regulatory mandates**
Environmental Context	Lawrence & Lorsch (1967); Geissdoerfer et al. (2017); Kirchherr etal. (2018)	Contextual adaptation; modular design; deposit-return schemes	Context → All Layers: environmental data

Source: compiled by the author based on theoretical literature.

primary flows of information or incentives between layers.

Summary presented in Table 2 highlights how bidirectional flows of information and incentives—including performance data, regulatory mandates, and environmental feedback—support the dynamic integration of all three layers.

Main Flows and Feedback Loops. The model operates through multiple bidirectional feedback loops interconnecting operational performance, governance mechanisms, and circular outcomes. These flows ensure dynamic alignment across the three layers:

Operational → Governance: Standardized procedures at the Operational Core generate performance data (e.g., throughput rates, quality metrics) that inform higher-level governance bodies, leading to adjustments in contracts, incentive schemes, and compliance protocols.

Governance → Operational: Institutional mandates and network agreements (from the Collaborative Network layer) set process standards and data-sharing requirements, guiding operational teams to refine workflows to meet compliance and responsive expectations.

Governance → Circularity: Policy levers (e.g., deposit–refund systems, EPR quotas) and inter-firm agreements initiated at the governance level enable return loops, fund traceability tools, and align stakeholder incentives, thereby facilitating circular flows.

Circularity → Governance: Environmental feedback—such as crate loss rates, contamination incidents, and reuse-cycle data—flows back to regulatory and network governance actors, prompting revisions to standards, incentives, and oversight practices.

Circularity → Operational: Insights from life-cycle assessments and changing external conditions drive design or process modifications at the operational level (e.g., new crate materials or adjusted cleaning and routing schedules).

Operational → Circularity: Efficiency improvements in operations (e.g., optimized washing routines or logistics routing) directly reduce per-cycle environmental impacts and extend crate lifespans, thereby improving the overall circularity and scalability of the system.

Empirical results mapped to the model

The following findings from recent studies provide real-world validation for each layer of the conceptual model. The evidence is organized by model layer, beginning with the Intercompany (Operational Core) and proceeding through the Collaborative Network to the Environmental Context.

Operational Core findings:

RFID-Enabled traceability reduces crate losses: Implementing RFID tags in automated crate cleaning lines led to a 20% reduction in crate loss, as real-time tracking enabled quick identification of misplaced or damaged units and triggered corrective actions (Mahmoudi & Parviziomran, 2020).

High reuse thresholds lower emissions: Life cycle assessment (LCA) studies indicate that achieving over 100 reuse cycles per crate under standardized washing and inspection protocols yields roughly a 30% reduction in greenhouse gas emissions compared to single-use packaging (Ratay et al., 2024).

Process automation boosts efficiency: Adopting conveyor-based crate washing and sorting systems improved throughput by 25% and reduced manual labor requirements by 18%, demonstrating the efficiency gains predicted by Taylor's time-motion principles and Fayol's coordination guidelines (Zimmermann & Hauschke, 2024).

These findings confirm that process standardization, real-time monitoring, and rigorous control mechanisms at the Operational Core are essential for achieving the efficiency, hygiene, and resource-use performance needed in RPC operations.

Collaborative Network findings:

Hybrid governance improves return rates: In European retail supply chains, a combination of formal pooling agreements and informal trust-building workshops yielded a 15% increase in RPC return rates. This illustrates the benefit of blending contractual safeguards with relationship-based governance strategies (Betts et al., 2022; Anwar et al., 2023).

Co-Financed infrastructure lowers costs: Shared investment in centralized washing facilities and transport fleets reduced capital expenditure per crate by about 25%, while increasing utilization rates by over 30% compared to standalone operations (GIZ, 2024; Betts et al., 2022).

Blockchain traceability reduces disputes: Deploying a blockchain-based traceability platform lowered inter-firm disputes over missing or damaged crates by roughly 10%, bolstering transparency and confidence among participants in the pooled system (Saberi et al., 2019).

Collectively, these findings substantiate that formal contracts, trust-based collaboration, and interoperable IT systems are key enablers of effective multi-firm governance in reusable packaging systems.

Environmental Context findings:

Dynamic routing cuts empty miles: Deploying real-time routing algorithms tailored to different density areas led to an 18% reduction in empty backhaul trips, reducing fuel usage and emissions in low-density distribution networks

(Mani et al., 2017; Kamble, Gunasekaran, & Gawankar, 2020).

Modular design extends crate lifespan: Reusable crates engineered with replaceable modular components achieved about a 20% longer service life, significantly reducing material consumption and waste generation (Pajula & Sundqvist-Andberg, 2022).

Deposit–return programs curb losses: Introducing structured deposit–return schemes cut crate loss rates from typical 10–15% ranges down to around 5% by providing direct financial incentives for returns and accountability (Anwar et al., 2023).

These findings validate the model's proposition that the Environmental Context layer—through adaptive operations, durable design, and incentive-aligned policies—is critical for closing the loop and ensuring long-term sustainability of RPC systems.

Implications for practice

The above results offer actionable guidance for stakeholders implementing or managing RPC systems in food supply chains. The key recommendations that align with the model's Collaborative Network and Environmental Context layers include:

Strengthen collaborative governance: Formalize inter-firm agreements with clear performance indicators and dispute resolution procedures. Invest in interoperable IT platforms to enable end-to-end traceability, data analytics, and real-time shared dashboards. Structure co-investment arrangements that distribute capital and operating costs equitably among partners, promoting high asset utilization and mutual accountability. Finally, engage policymakers via joint committees to align regulatory mandates (e.g., packaging standards, reporting requirements) with on-the-ground operational realities and innovation goals.

Enhance environmental adaptability: Tailor RPC and supply chain design elements (e.g., crate materials, ventilation features) to specific product categories and distribution environments for maximum effectiveness. Implement dynamic routing and sensor-based monitoring tools to continuously adjust logistics operations in response to demand variability and regional differences. Collaborate with regulatory bodies and industry partners to co-design deposit–return programs and related policies, ensuring they are practical for all stakeholders and effectively support circular economy goals.

By embedding these collaborative and adaptive practices within RPC systems, firms can leverage shared resources, reduce transaction costs, and improve overall resilience—ultimately achieving greater operational efficiency, stakeholder alignment, and circular performance. In summary, the evidence confirms that each layer of the conceptual model contributes uniquely to RPC system performance, and that improvements at one level reinforce progress at the others. Integrating internal process excellence, network governance, and environmental adaptability thus provides a robust foundation for sustainable and scalable reusable packaging programs. The next section discusses these findings in depth, with attention to managerial and policy implications.

Discussion

This study's integrative conceptual model bridges classical management principles and contemporary organizational frameworks to address the sustainability imperatives of modern food logistics. The model is structured across three concentric layers—Operational Core, Collaborative Network, and Environmental Context—providing a comprehensive lens for understanding and designing sustainable reusable packaging systems (RPCs). This layered design underscores the need for a hybrid, multi-level approach in implementing RPC initiatives.

The findings affirm that no single theoretical perspective fully encompasses the operational, regulatory, and collaborative demands of RPC deployment. Classical management principles—exemplified by Taylorist process control and Weberian bureaucracy—enhance efficiency and accountability but can become overly rigid unless adaptive buffers are built into operations to handle variability (Morley et al., 2016). Likewise, institutional theory ensures compliance through regulatory and normative pressures, yet it may stifle innovation if enforced too rigidly (Coelho et al., 2020; Scott, 2008). These limitations highlight the importance of a hybrid governance approach: contemporary network-based frameworks emphasize trust, decentralized coordination, and shared infrastructure to build system resilience (Powell, 1990; Betts et al., 2022).

From a managerial perspective, the model offers several actionable insights for organizations seeking to implement or scale RPC systems. First, it emphasizes the importance of strategic alignment by embedding reusable packaging initiatives within broader corporate sustainability and ESG objectives (Zambujal-Oliveira et al., 2024). Second, it advocates digital process innovation through technologies such as RFID, IoT, and blockchain to enhance traceability, reduce crate losses, and enable data-driven monitoring (Kudrenko & Hall, 2024; Saberi et al., 2019). Third, the model supports ecosystem thinking by encouraging long-term, trust-based partnerships that co-invest in shared infrastructure and harmonize reuse protocols (GIZ, 2024). Finally, it underscores the value of data-informed adaptation, guided by life cycle assessment (LCA), to tailor RPC operations to local market conditions, product perishability, and reverse logistics constraints (Ratay et al., 2024; Zambujal-Oliveira et al., 2024).

At the policy and institutional level, our findings highlight the need to shift from voluntary initiatives to formal structural enablers of reuse. Governments can facilitate this transition by establishing enforceable reuse targets, providing fiscal incentives (e.g., tax credits or funding for reverse logistics), and implementing mandatory traceability regulations to ensure system-wide transparency and accountability (European Commission, 2022; Coelho et al., 2020). Additionally, Extended Producer Responsibility (EPR) frameworks should evolve beyond traditional recycling metrics to include reuse performance criteria. Institutional legitimacy—bolstered by consistent public procurement standards, regulatory alignment, and industry benchmarks—emerges as a critical success factor for scaling up RPC systems (Scott, 2008; Albrecht et al., 2022).

From a theoretical standpoint, this research contributes to the development of an integrated framework that reconciles operational efficiency, systemic resilience, and environmental circularity. It demonstrates the continued relevance of classical management theories in sustainability transitions when these principles are combined with modern constructs such as stakeholder alignment, digital governance, and networked collaboration. Notably, the study also identifies a gap in the literature regarding platform-based governance and ecosystem logic in circular logistics—contexts where pooled assets, shared accountability, and dynamic coordination are essential. Addressing this gap opens promising avenues for further research into multi-actor governance models, digital supply chain platforms, and adaptive capabilities in reusable packaging systems (Pajula & Sundqvist-Andberg, 2022; Ratay et al., 2024).

In sum, the success of RPC implementation hinges on a hybrid governance approach that deliberately integrates classical control mechanisms with adaptive, digitally enabled, and collaborative practices. This cross-disciplinary model not only supports effective RPC deployment but also serves as a strategic roadmap for advancing circular and resilient logistics in sustainable food supply chains.

Conclusions

This study developed a conceptual model integrating classical management theories, contemporary organizational frameworks, and circular economy principles to guide sustainable reusable packaging (RPC) implementation in food supply chains. By aligning operational efficiency, institutional legitimacy, stakeholder collaboration, and circularity objectives, the model provides a coherent and adaptable framework. The findings confirm that blending classical approaches with modern theories yields a robust, multi-dimensional system – balancing internal efficiency with external adaptability and grounded in stakeholder trust – thereby recontextualizing legacy concepts for contemporary sustainability goals.

Practically, the model guides decision-makers with clear strategies for RPC deployment. Key recommendations include embedding reusable packaging programs into broader corporate sustainability initiatives, investing in digital traceability and reverse logistics infrastructure, engaging in multi-stakeholder collaborations for asset pooling, shared governance, and performance monitoring, and aligning organizational practices with emerging regulatory frameworks (e.g., EU reusable packaging directives and Extended Producer Responsibility schemes). These actions ensure that operational improvements are reinforced by technological innovation and policy support.

Empirical evidence validates that reusable packaging systems can outperform single-use alternatives on life-cycle environmental metrics and long-term costs when reuse loops are tightly managed. However, persistent barriers – such as fragmented logistics networks, inconsistent consumer participation, and weak regulatory enforcement – still hinder the full potential of RPCs. Overcoming these challenges requires holistic system design, stronger public–private co-regulation, and context-sensitive adaptations to local conditions.

Ultimately, advancing reusable packaging in food supply chains demands more than technical fixes; it requires strategic integration of management theory with practical action. By combining operational excellence with institutional insight and collaborative governance, the proposed framework not only strengthens current practices but also lays a foundation for future research, guiding a transition toward more circular and resilient food logistics systems.

Future research directions

Building on the conceptual model presented in this study, future research should pursue four key directions to strengthen its empirical grounding and theoretical reach. First, there is a need to empirically validate the framework across diverse geographic and regulatory contexts. Examining the model in various supply chain configurations and product categories will help reveal how its operational, institutional, and behavioral components perform under different market conditions and policy regimes. Case-based studies and longitudinal research can test the model's transferability and pinpoint context-specific factors that influence the effectiveness of RPC implementations.

Second, further research should examine the role of digital governance and enabling technologies in scaling reusable packaging systems. Emerging tools such as IoT-based tracking, AI-driven reverse logistics optimization, and blockchain-enabled traceability could be investigated to understand how greater digitalization improves visibility, coordination, and lifecycle efficiency in RPC loops. Comparative field studies between networks with high and low digital maturity would shed light on the key enablers and obstacles of technology adoption in these circular systems.

Third, researchers should compare RPCs with alternative circular packaging solutions (e.g., compostable materials, modular designs) to evaluate their relative merits. This comparative approach could examine differences in life-cycle environmental impacts, consumer behavior, cost-effectiveness, and compliance with regulatory requirements. Insights from such studies would guide both industry and policymakers in selecting context-appropriate packaging strategies, accounting for varying sustainability priorities and local waste-management capacities.

Finally, more attention should be paid to the governance of distributed, multi-actor reuse platforms. This entails studying how decentralized stakeholders develop the dynamic capabilities, institutional innovations, and trust needed to jointly manage shared-use packaging infrastructure. In-depth qualitative research – for instance, ethnographic studies of pooling providers, consortia, or public–private partnerships – can illuminate the social norms, collaborative processes, and governance mechanisms that enable durable, platform-based RPC networks.

In summary, pursuing these four avenues will broaden the model's empirical scope and integrate evolving digital innovations. This will enhance its guidance

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The paper submitted: March 30, 2025
Prepared for publication: May 30, 2025

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TVARIŲ DAUGKARTINIO NAUDOJIMO PAKUOČIŲ MAISTO TIEKIMO GRANDINĖSE KONCEPCINIO MODELIO KŪRIMAS

Santrauka

Daugkartinio naudojimo pakuočių (RPC) sistemos maisto tiekimo grandinėse yra svarbios mažinant atliekų kiekį ir laikantis žiedinės ekonomikos principų. Šių sistemų diegimą riboja įvairios vadybinės ir organizacinės kliūtys – didelės investicijos, sudėtinga grįžtamoji logistika, suinteresuotų šalių priešinimasis pokyčiams. Iškyla mokslinė problema: kaip įveikti šiuos barjerus ir paskatinti platesnį tvarių daugkartinių pakuočių sistemų diegimą? Tyrimo tikslas – sukurti vieningą koncepcinį modelį, integruojantį klasikinius vadybos principus ir šiuolaikines organizacines teorijas, padedantį sėkmingai įdiegti ir valdyti daugkartinio naudojimo pakuočių sistemas maisto tiekimo grandinėse, didinant veiklos efektyvumą, atsparumą ir mažinant poveikį aplinkai.

Modelis kurtas teorinės sintezės būdu, integruojant klasikinės vadybos principus (pvz., procesų standartizavimą, kokybės kontrolę) ir šiuolaikines organizacines teorijas (tinklaveikos valdymą, institucinę teoriją, žiedinės ekonomikos koncepcijas). Tyrimo metodologija – kokybinė, grindžiama teorinės literatūros (2015–2024 m.) ir praktinių šaltinių (logistikos atvejų, ES politikos dokumentų) analize, siekiant identifikuoti svarbiausius veiksnius, lemiančius daugkartinių pakuočių sistemų sėkmę. Remiantis šiomis įžvalgomis, dedukcinės analizės būdu suformuotas integruotas trijų lygmenų modelis.

Siūlomą modelį sudaro trys tarpusavyje susiję lygmenys: vidinių procesų, tarporganizacinio tinklo ir išorinės aplinkos. Vidinių procesų lygmuo orientuotas į įmonėje vykstančių operacijų efektyvumo didinimą ir standartizavimą, kad pakartotinio naudojimo procesai (surinkimas, plovimas, paskirstymas) vyktų efektyviai. Tarporganizacinio tinklo lygmuo pabrėžia koordinaciją – partnerystę tarp tiekimo grandinės dalyvių ir hibridines valdymo struktūras, leidžiančias pasidalyti kaštus ir kurti tarpusavio pasitikėjimą. Išorinės aplinkos lygmuo apima teisinio reguliavimo, rinkos normų ir ekonominių paskatų įtaką, skatinančią perėjimą prie žiedinės logistikos. Šių lygmenų dermė leidžia sistemiškai spręsti diegimo kliūtis ir gerinti pakartotinio naudojimo sistemos efektyvumą, atsparumą bei mažinti ekologinį pėdsaką.

Praktiniu požiūriu, sukurtas koncepcinis modelis suteikia įmonėms aiškias gaires, kaip diegti daugkartinio naudojimo pakuočių sistemas – nuo vidinių procesų optimizavimo ir sekimo technologijų (pvz., RFID) diegimo iki glaudesnio bendradarbiavimo su tiekimo grandinės partneriais. Laikydamosi modelio principų, įmonės gali lengviau įveikti diegimo kliūtis, optimizuoti kaštus ir didinti atsparumą. Politiniu požiūriu, tyrime pabrėžiama valstybinės / regioninės paramos svarba: siekiant platesnio tokių sistemų taikymo, rekomenduojama nustatyti privalomus daugkartinio pakavimo tikslus, taikyti fiskalines paskatas (mokesčių lengvatas, subsidijas grįžtamajai logistikai) ir sukurti vieningus standartus. Šios priemonės sudarytų palankesnes sąlygas verslui pereiti nuo linijinių prie žiedinių, tvarių tiekimo grandinių.

Šiame tyrime teikiamos praktinės rekomendacijos tiek verslui, tiek politikos formuotojams. Be to, siūlomas modelis gali būti taikomas kaip diagnostinis įrankis vertinant esamų daugkartinio pakavimo sistemų veikimą ir tobulinimo galimybes. Jį galima taikyti skirtingose geografinėse ir institucinėse aplinkose, taip užtikrinant platų praktinį pritaikomumą tiek verslo, tiek viešojo sektoriaus iniciatyvoms pereinant prie žiedinės ekonomikos modelio.