

# **Circular Supply Chain Optimization for Sustainable Packaging: Insights, Methods, and Emerging Research Directions**

**Amirjon Atoev**

Student, BS in Industrial Engineering  
Mechanical and Industrial Engineering Department  
RIT Dubai, Dubai Silicon Oasis, Dubai United Arab Emirates  
aa8266@rit.edu, atoevamir1@gmail.com

**Dua Weraikat, PhD**

Assistant Professor & MEIE Department Coordinator  
Mechanical & Industrial Engineering Department  
RIT Dubai, Dubai Silicon Oasis, Dubai United Arab Emirates  
dxwcad@rit.edu

## **Abstract**

This systematic literature review investigates circular supply chain (CSC) optimization approaches in the context of sustainable packaging by analyzing ten key studies that reflect current research trends. A comprehensive search of three academic databases (the Web of Science, IEEE Xplore, and PubMed) identified 20 peer-reviewed studies published between 2018 and 2025. PRISMA 2020 guidelines were implemented, resulting in a final dataset of 10 studies. The review highlights a wide range of optimization models, including mixed-integer linear programming (MILP) for returnable packaging networks, Stackelberg game models for packaging recycling, multi-objective optimization for closed-loop supply chains, and agent-based modeling for recycling logistics. Key application areas include automotive returnable packaging, express delivery packaging recycling, food packaging efficiency assessment, and plastic waste management. The review highlights contributions in integrating circular economy (CE) principles with advanced optimization methods. It also sheds light on policy implications and the role of technology-enabled solutions such as IoT and fuzzy evaluation models. However, critical research gaps remain, including limited dynamic assessment frameworks, insufficient cross-industry methodology transfer, and robust real-world validation. Overall, the findings provide comprehensive insights into existing optimization approaches and outline promising directions for future research on circular packaging systems.

## **Keywords**

Circular Supply Chain, Sustainable Packaging, Circular Economy Optimization Methods, Literature Review.

## **1. Introduction**

The global transition toward circular economy (CE) principles has created extraordinary demand for sustainable packaging solutions that minimize environmental impact while maintaining operational efficiency (Guillard et al. 2018; Li and Wang 2023). Traditional linear supply chain models, characterized by take-make-dispose patterns, have proven inadequate for addressing the complex challenges of packaging waste management and resource optimization (Tseng et al. 2019; Wu et al. 2021). This has driven researchers and practitioners to develop sophisticated optimization

approaches for circular supply chain (CSC) systems that integrate forward and reverse logistics operations (Li et al. 2022; El Boudali et al. 2022).

CSCs in packaging contexts involve complex networks of stakeholders including manufacturers, suppliers, consumers, recycling facilities, and government agencies (Tronnebati et al. 2024; Shen and Zhou 2023). These systems require the optimization of multiple conflicting objectives such as cost minimization, environmental impact reduction, resource efficiency maximization, and service level maintenance (Wu et al. 2021; Li and Wang 2023). The complexity is further amplified by uncertain return flows, varying packaging quality levels, policy interventions, and technological integration requirements (Wu et al. 2021; Li and Wang 2023).

Recent research has demonstrated significant advances in optimization methodologies for circular packaging systems, ranging from traditional mathematical programming approaches to innovative agent-based modeling and game-theoretic formulations (Li et al. 2022; Tseng et al. 2019; Shen and Zhou 2023). These developments reflect the growing sophistication of CSC optimization and the increasing recognition of packaging sustainability as a critical research domain requiring rigorous analytical approaches (Chavhan and Dutta 2025; Tanksale et al. 2021).

This review article synthesizes existing optimization approaches for CSCs in sustainable packaging and evaluates their applications across multiple sectors. It identifies methodological advances and practical contributions while exposing critical gaps in dynamic modeling, cross-industry transferability, and empirical validation. By integrating insights from diverse optimization techniques with CE principles, the article establishes a foundation for both theoretical development and practical implementation. Together, these contributions outline a clear agenda for advancing research and practice in sustainable packaging systems.

To achieve these outcomes, the review is guided by the following research objectives. First, it examines current optimization methods applied to CSCs in sustainable packaging, identifying their effectiveness, limitations, and industry applications. Second, it explores how emerging technologies and policy considerations are being integrated into these optimization approaches, highlighting both opportunities and challenges. Third, it identifies critical research gaps, particularly in dynamic modeling, cross-industry transferability, and empirical validation, and proposes directions for future investigation. Finally, the review aims to provide comprehensive insights that can guide both researchers and practitioners in advancing circular packaging optimization within supply chain systems.

## **2. Review Methodology**

The review process began with a broad search in major databases, namely, Web of Science, IEEE Xplore, and PubMed. This article did not cover the grey literature (e.g. Ellen MacArthur Foundation & etc.) on the topic. The databases PubMed, IEEE Xplore, and Web of Science were chosen for their extensive and high-quality indexing of peer-reviewed literature spanning sustainability, engineering, and management disciplines. Their comprehensive coverage supports the exploration of key themes related to circular supply chain optimization, sustainable packaging solutions, and emerging data-driven research methods. The Boolean string used contained the following keywords:

*((*"circular economy"* OR *"circular supply chain"* OR *"closed-loop supply chain"* OR *"reverse logistics"*)  
AND (*"optimization"* OR *"multi-objective optimization"* OR *"mathematical model"* OR *"operations research"* OR  
*"heuristic"* OR *"simulation"* OR *"decision model"*)  
AND (*"sustainable packaging"* OR *"green packaging"* OR *"eco-packaging"* OR *"environmentally friendly packaging"*  
OR *"recyclable packaging"*)  
AND (*"systematic literature review"* OR *"literature review"* OR *"systematic review"* OR *"review paper"* OR  
*"bibliometric analysis"* OR *"state of the art"*))*

After retrieving only one article from the Web of Science using the above-mentioned search string containing the term “systematic literature review”, the string was refined by removing this component. The revised search strings combined keywords related to circular economy, supply chain optimization, and sustainable packaging. This adjustment yielded 22 articles across the three selected databases.

From this initial pool, two duplicates were removed, and the remaining records were screened by title and abstract for thematic relevance. Only studies explicitly addressing both optimization and sustainable packaging within CSC

contexts were retained. As illustrated in Figure 1, this process resulted in ten primary sources, comprising six journal articles and three conference papers that form the basis of the analysis presented in the following sections.

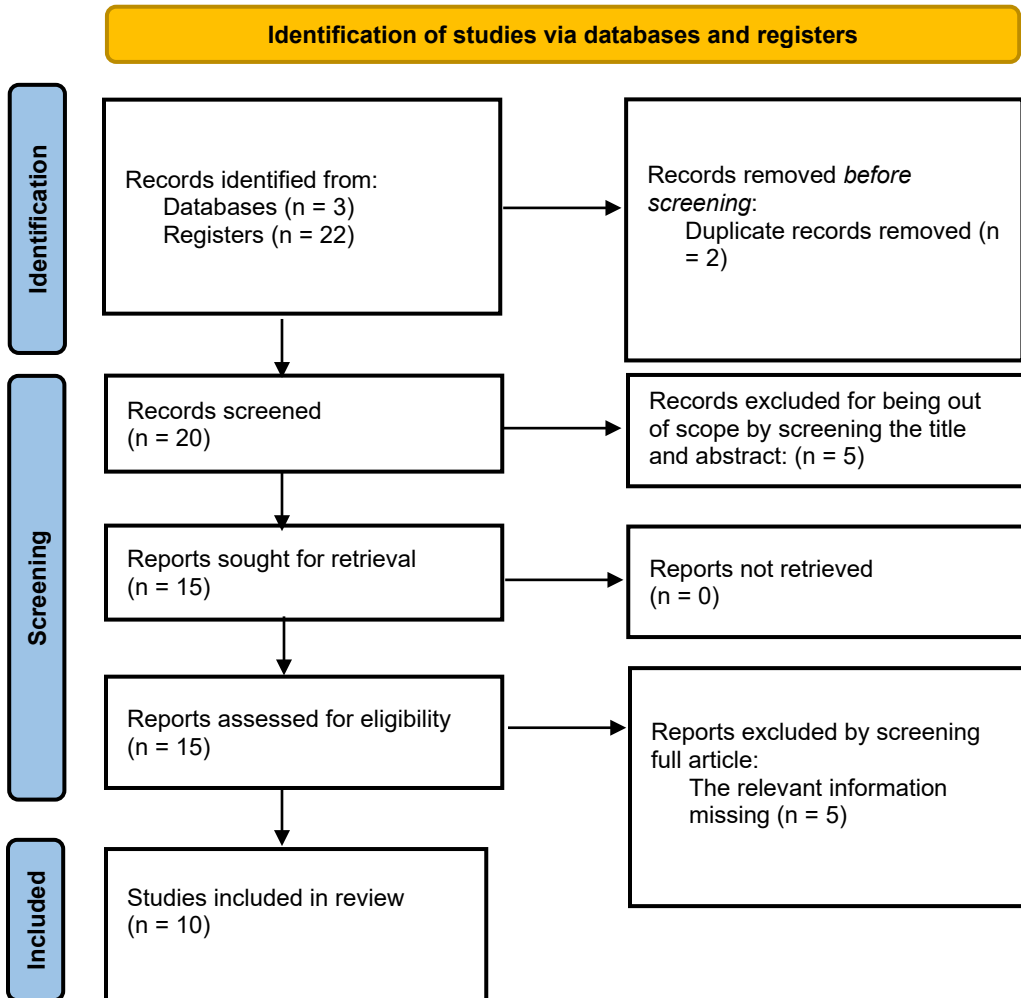


Figure 1. PRISMA 2020 Flow Diagram adapted from PRISMA website (PRISMA 2020 flow diagram, 2024)

The literature on CSC optimization for sustainable packaging encompasses diverse methodological approaches and application contexts. Mathematical programming techniques, particularly mixed-integer linear programming (MILP), have been extensively applied to optimize returnable packaging networks in automotive supply chains, focusing on minimizing transportation and shortage costs while ensuring adequate packaging availability at supplier locations (El Boudali et al. 2022).

Game-theoretic approaches emerged as valuable tools for modeling stakeholder interactions in packaging recycling systems, with Stackelberg game models effectively capturing the dynamics between carton factories and express delivery enterprises under policy support mechanisms (Wu et al. 2021). These models address the complex decision-making processes involved in packaging recovery scenarios and optimal reward structures for encouraging recycling participation.

Multi-objective optimization methodologies have gained prominence in addressing the inherent trade-offs between economic, environmental, and social objectives in circular packaging systems. The application of methods such as the

Augmented  $\epsilon$ -constraint Method (AUGMECON) has enabled the generation of Pareto-optimal solutions that balance cost minimization with environmental impact reduction in closed-loop supply chain networks (Tanksale et al. 2021).

Agent-based modeling has emerged as an innovative approach to capturing complex social behaviors and interactions within packaging recycling systems (Shen & Zhou, 2023). These models simulate the decision-making processes of multiple stakeholders, including consumers, government agencies, enterprises, and recycling facilities, thereby providing insights into policy effectiveness and system performance under different scenarios.

This review analyzes ten key research papers representing state-of-the-art approaches in CSC optimization for sustainable packaging. The selected studies encompass diverse methodological approaches, application contexts, and geographical regions, providing comprehensive coverage of the research domain. Each study was examined in detail with respect to its optimization approach, problem formulation, solution technique, application area, findings, and limitations

To enable systematic comparison, studies were categorized by primary optimization methodology, including mathematical programming, game theory, multi-objective optimization, agent-based modeling, and hybrid techniques. They were evaluated across multiple dimensions such as problem complexity, solution quality, computational efficiency, real-world applicability, and contribution to the circular economy literature. This analysis identifies recurring themes, methodological patterns, and research gaps, thereby offering consolidated insights into current practice and potential directions for future research.

#### **4. Results and Discussion**

The analysis of the selected research papers (Table 1) identified diverse geographical contexts, including Morocco, China, Germany, Tunisia, and other regions, underscoring the global relevance of packaging sustainability challenges.

The studies span multiple application domains such as automotive returnable packaging systems, express delivery packaging recycling, food packaging efficiency assessment, plastic waste management, and general circular packaging distribution networks. This diversity demonstrates the breadth of circular packaging optimization research and its applicability across industries.

Each study was examined using a standardized framework that captured research objectives, employed methodologies, optimization techniques, application contexts, quantitative results, key findings, and reported limitations. Applying this structured approach enabled consistent comparison across studies and facilitated the identification of overarching trends and methodological patterns within the research domain.

Table 1. Selected Studies and Research Focus Areas

<b>Study</b>	<b>Databases</b>	<b>Authors</b>	<b>Geographical contexts</b>	<b>Primary Focus</b>	<b>Application Context</b>
Designing the reverse logistics network for returnable packaging	IEEE Xplore	El Boudali et al. (2022)	Morocco	Returnable packaging network design	Automotive industry
Research on the Optimal Strategy of Delivery Packaging Recycling Under Policy Support	IEEE Xplore	Wu et al. (2021)	China	Packaging recycling optimization	Express delivery
Green supplier selection criteria in automotive industry	IEEE Xplore	Tronnebati et al. (2024)	Morocco	Green supplier selection	Automotive packaging
Analysis and Research on Express Packaging Recycling Logistics System Based on Netlogo	IEEE Xplore	Shen and Zhou (2023)	China	Packaging recycling logistics	Express delivery systems
Heuristic column generation for designing an express	Web of Science	Li et al. (2022)	China	Circular packaging distribution	General packaging

circular packaging distribution network					
Unpacking the role of primary packaging material in designing green supply chains: An integrated approach	Web of Science	Tanksale et al. (2021)	Not addressed in the paper.	Closed-loop supply chain design	Plastic packaging
Green packaging materials design and efficient packaging with Internet of Things	Web of Science	Li and Wang (2023)	China	Packaging efficiency assessment	Food packaging
Redesigning quick commerce fresh and short food supply chains: circular economy strategies for sustainable last-mile operations	Web of Science	Chavhan and Dutta (2025)	India	Circular economy practices	Food supply chains
Considering JIT in Assigning Task for Return Vehicle in Green Supply Chain	Web of Science	Tseng et al. (2019)	Not addressed in the paper.	Green supply chain optimization	General packaging
The Next Generation of Sustainable Food Packaging to Preserve Our Environment in a Circular Economy Context	Web of Science & PubMed	Guillard et al. (2018)	France / European Union	Sustainable packaging integration	Food packaging

#### **4.1 Numerical Results**

In terms of publication outlets, journals accounted for six of the selected studies (60%), while conference proceedings represented four (40%), as represented in Figure 2. Journals such as Sustainability, Operational Research, and the International Journal of Production Economics emphasize methodological rigor and theoretical contributions, whereas conference papers (LOGISTIQUA, ICEIB, IEEM) tend to focus on applied approaches and industry-driven problem-solving. This distribution reflects the dual nature of research in this field, with journals providing conceptual depth and conferences offering case-specific validation. However, conference papers also remain significant in driving forward practical case applications. This suggests that sustainable packaging optimization is still an evolving area, with theory and practice progressing hand-in-hand.

The selected studies report diverse quantitative outcomes, demonstrating the effectiveness of different optimization approaches across packaging contexts. In automotive returnable packaging, mixed-integer linear programming achieved notable cost reductions, with weekly transport costs of €86,340 for returning empty packaging across multiple supplier regions in Morocco (El Boudali et al., 2022).

In express delivery packaging recycling, agent-based modeling enhanced recycling rates by simulating policy scenarios, thereby identifying optimal government interventions to maximize participation (Shen & Zhou, 2023). Similarly, game-theoretic models determined effective recovery reward structures that balanced economic incentives with environmental objectives (Wu et al., 2021).

Multi-objective optimization in closed-loop supply chain design highlighted trade-offs between economic and environmental objectives. For instance, increased recycling activities were associated with higher costs but yielded significant environmental benefits, with AUGMECON generating Pareto-optimal solutions that allow decision-makers to balance priorities effectively (Tanksale et al., 2021).

In food packaging applications, IoT-enabled fuzzy comprehensive evaluation facilitated dynamic efficiency assessments. Results indicated that certain packaging types outperformed others across multiple sustainability dimensions, including environmental impact, economic efficiency, and resource utilization (Li & Wang, 2023).

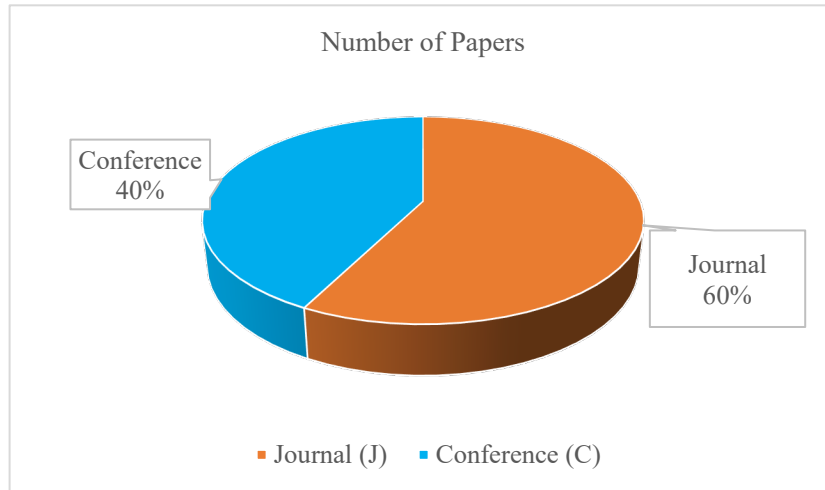


Figure 2. Percentage of articles covered in this study

The distribution of optimization methodologies across the selected studies reveals multi-objective programming as a prevalent approach, followed by agent-based modeling and game-theoretic formulations. This reflects the inherent complexity of circular packaging systems, which require advanced analytical tools to accommodate multiple stakeholder perspectives and conflicting objectives. Table 2 provides a comparative summary of the optimization methods, primary benefits, limitations, and computational performance or scalability characteristics of the ten studies analyzed in this review. The table highlights the methodological diversity within circular supply chain optimization for sustainable packaging, ranging from mathematical programming and multi-objective optimization to simulation-based and decision-analysis approaches.

Analysis of application contexts shows that automotive and express delivery systems are the most extensively studied. This trend reflects both the maturity of returnable packaging practices in the automotive sector and the rapid growth of e-commerce, which has intensified challenges in express delivery packaging. Research on food packaging is also expanding, driven by cold chain requirements and perishability concerns.

In addition, green supplier selection has emerged as a relevant stream of research. Studies employing the Analytic Hierarchy Process (AHP) have identified key criteria for sustainable packaging procurement, with “Sustainable Product Design” emerging as the most significant factor (0.164), followed by “Health and Security” (0.153) and “ISO 14001 Certification” (0.129) in automotive industry contexts (Tronnebati et al., 2024).

Table 2. Optimization Methods and Key Findings

Study	Method	Primary Benefits	Limitations	Computational Performance/Scalability
Designing the reverse logistics network for returnable packaging	MILP	Cost optimization for returnable packaging	Single region focus	Not addressed in the paper.
Research on the Optimal Strategy of Delivery Packaging Recycling Under Policy Support	Stackelberg Game	Policy-aware recycling optimization	Limited scenario coverage	Not addressed in the paper.
Green supplier selection criteria in automotive industry	AHP	Structured green supplier selection	Subjective weight assignment	Not addressed in the paper.
Analysis and Research on Express Packaging Recycling	Agent-based Model	Comprehensive stakeholder modeling	Computational complexity	Not addressed in the paper.

Logistics System Based on Netlogo				
Heuristic column generation for designing an express circular packaging distribution network	Lagrangian Relaxation	Complete closed-loop system	Limited uncertainty consideration	The proposed algorithm's performance is validated through comprehensive experiments. It is compared with CPLEX and LocalSolver for efficiency. Results show the algorithm's scalability across different network sizes.
Unpacking the role of primary packaging material in designing green supply chains: An integrated approach	AUGMECON	Multi-objective trade-off analysis	High computational requirements	AUGMECON is implemented using GUROBI 8.0 with Python interface. Experiments conducted on a personal computer with Intel core i-3 processor. The model is scalable for large-scale supply chains. AUGMECON produces diverse non-dominated solutions efficiently.
Green packaging materials design and efficient packaging with Internet of Things	Fuzzy Evaluation	Real-time monitoring capability	Limited validation scope	The model requires improved data gathering for better performance. A data-driven framework enhances scalability in packaging efficiency assessments. Continuous assessment is vital for optimizing computational performance. The study emphasizes iterative optimization based on evolving data. The framework addresses limitations in existing computational approaches.
Redesigning quick commerce fresh and short food supply chains: circular economy strategies for sustainable last-mile operations	SEM	Comprehensive practice assessment	Industry-specific application	Scalability evaluates the potential for CE practices' widespread adoption. It examines replication across different contexts while maintaining effectiveness. The study identifies high-impact CE practices for improved scalability.
Considering JIT in Assigning Task for Return Vehicle in Green Supply Chain	Multi-objective	JIT integration with green logistics	Limited scalability analysis	Not addressed in the paper.
The Next Generation of Sustainable Food Packaging to Preserve Our Environment in a Circular Economy Context	Synthesis	Comprehensive sustainability framework	Conceptual focus	Not addressed in the paper.

## 4.2 Proposed Improvements

Based on the comprehensive analysis of the selected studies, several critical improvement areas emerge for advancing circular supply chain optimization in packaging applications. Integration of emerging technologies, particularly Internet of Things (IoT) sensors and real-time monitoring systems, shows significant potential for enabling dynamic optimization and adaptive decision-making in packaging systems (Li and Wang 2023).

Multi-stakeholder coordination mechanisms represent another crucial improvement area, with agent-based modeling approaches demonstrating effectiveness in capturing complex interactions between consumers, enterprises, government agencies, and recycling facilities (Shen and Zhou 2023). However, most current studies focus on bilateral relationships rather than comprehensive multi-party coordination frameworks.

Policy integration emerges as a critical consideration, with studies demonstrating that government incentives, regulations, and policy interventions significantly impact circular packaging system effectiveness (Wu et al. 2021). Explicit modeling of policy mechanisms within optimization frameworks rather than treating them as external constraints represents an important advancement opportunity.

Uncertainty management requires enhanced attention, with most current approaches assuming deterministic conditions despite the inherent variability in packaging return rates, demand fluctuations, quality variations, and supply disruptions. Robust optimization methodologies addressing these uncertainties represent a significant improvement opportunity (Li et al. 2022).

Based on the above-mentioned results, Table 3 discusses the significant research gaps and opportunities. For example, existing studies often lack dynamic assessment frameworks, as most optimization models remain static and fail to capture the real-time variability of packaging systems. Integrating IoT-enabled continuous monitoring and sensor-based data collection could enable adaptive and data-driven decision-making (Li and Wang 2023). Furthermore, policy integration remains insufficiently addressed; incorporating policy-aware optimization frameworks that explicitly model governmental incentives and regulatory impacts could improve system responsiveness and sustainability outcomes (Wu et al. 2021).

Table 3. Research Gaps and Improvement Opportunities

<b>Gap Category</b>	<b>Specific Issues Identified</b>	<b>Proposed Solutions</b>
Dynamic Assessment	Limited real-time optimization	IoT-enabled continuous monitoring
Policy Integration	Weak modeling of government role	Policy-aware optimization frameworks
Uncertainty Handling	Deterministic assumptions	Robust optimization methods
Cross-Industry Transfer	Limited generalizability	Adaptable frameworks across sectors
Validation Rigor	Few real-world tests	Industry partnership validations
Technology Integration	Underutilized smart technology potential	AI and blockchain integration
Scalability	Limited large-scale system optimization	Scalable algorithm development

In addition, many studies still rely on deterministic assumptions, overlooking the uncertainties inherent in packaging return flows, demand fluctuations, and material quality variations. This highlights the need for robust optimization methods that account for stochastic elements in circular packaging networks (Li et al. 2022). The generalizability of models across industries also remains limited, suggesting opportunities to develop adaptable frameworks applicable to various packaging sectors. Finally, enhancing validation rigor through industry partnerships and integrating AI and blockchain technologies could further improve scalability, transparency, and traceability across circular supply chain operations.

The findings of this review highlight several actionable directions for manufacturers, logistics operators, and policymakers engaged in sustainable packaging initiatives. By integrating IoT-enabled monitoring systems and AI-driven optimization techniques, industry actors can enhance real-time decision-making, improve packaging recovery efficiency, and strengthen traceability across supply networks (Li and Wang 2023). Policymakers can leverage these insights to design incentive-based regulatory frameworks that encourage collaboration among producers, recyclers, and technology providers (Wu et al. 2021). Furthermore, the limited number of studies identified in this domain indicates that circular supply chain optimization for packaging remains underdeveloped, presenting significant opportunities for industry–academic partnerships to pilot scalable solutions and establish standardized frameworks for sustainable packaging optimization (Li et al. 2022; Shen and Zhou 2023).

As this topic remains relatively new and underexplored, the limited number of studies identified in this review underscores the need for deeper academic and industrial engagement. The scarcity of comprehensive models and real-world validations indicates that circular supply chain optimization for sustainable packaging is still in its developmental stage, offering a valuable opportunity for future researchers to expand the theoretical foundations and practical applications of this emerging field. Consequently, continued investigation into advanced modeling techniques, cross-industry frameworks, and digital integration strategies can significantly contribute to the evolution of sustainable and circular packaging systems.

### **4.3 Validation**

Validation approaches across the analyzed studies reveal considerable variation in both rigor and comprehensiveness. Case study validation emerges as the most common method, particularly in automotive returnable packaging and express delivery contexts where real-world data availability facilitates practical model testing (El Boudali et al., 2022; Wu et al., 2021). Simulation-based validation is frequently employed in food packaging and plastic waste management research, where controlled experimental settings enable systematic evaluation of optimization outcomes (Li & Wang, 2023; Tanksale et al., 2021). By contrast, field experiments remain scarce, highlighting a critical gap between theoretical optimization models and their real-world applicability.

Computational performance assessments indicate that heuristic approaches generally achieve acceptable solution times in large-scale applications, whereas exact methods often demand substantial computational resources, particularly for complex multi-objective formulations (Li et al., 2022). This trade-off between solution quality and efficiency represents a central challenge for practical adoption.

Finally, sensitivity and robust analyses are incorporated in only a limited subset of studies, suggesting considerable scope to enhance validation rigor. Notably, statistical significance testing and confidence interval reporting are almost entirely absent, raising concerns about the reliability and generalizability of reported results.

## **5. Conclusion**

This systematic literature review has provided comprehensive insights into circular supply chain optimization for sustainable packaging, based on an in-depth analysis of ten key research studies that represent state-of-the-art approaches. The findings reveal considerable methodological diversity, ranging from mathematical programming and multi-objective optimization to agent-based modeling and game-theoretic formulations. Each of these approaches addresses different aspects of circular supply chain complexity, from cost reduction and efficiency improvements to behavioral dynamics and policy integration.

Key contributions of existing research demonstrate that multi-objective optimization effectively manages trade-offs between economic, environmental, and social objectives, while agent-based models capture the role of stakeholders and behavioral interactions in recycling systems. Game-theoretic approaches provide valuable insights into competitive and cooperative decision-making across supply chain actors. The automotive industry shows the highest maturity in implementing returnable packaging optimization, whereas express delivery and food packaging applications highlight the emerging challenges of e-commerce growth and cold chain sustainability.

Despite these contributions, critical research gaps remain. Current studies often lack dynamic assessment frameworks, robust mechanisms for integrating policy into optimization models, and standardized metrics for evaluating sustainability performance. Furthermore, limited cross-industry transferability and insufficient real-world validation restrict the practical impact of these approaches.

Future research should therefore prioritize the development of integrated optimization frameworks that combine multiple methodologies, enhance real-world validation through industry partnerships, and create standardized sustainability assessment protocols. Addressing scalability challenges and embedding dynamic adaptability through emerging technologies such as AI and blockchain represent particularly promising avenues for advancing both theory and practice.

To consolidate these insights, Table 4 summarizes the key contributions of existing research and outlines future research directions across methodological, application, technology, policy, validation, and sustainability dimensions.

Table 4. Summary of Key Contributions and Future Directions

Research Area	Key Contributions	Future Research Directions
Methodological	Demonstrated diverse optimization models	Develop hybrid/multi-method approaches
Application	Solutions developed in automotive & food packaging	Cross-industry adaptation strategies
Technology	IoT and fuzzy methods used	AI, blockchain integration
Policy	Initial modeling of incentives	Comprehensive policy-embedded models
Validation	Case studies common	Rigorous field experiment validation
Sustainability	Multi-objective trade-off analysis	Standardized sustainability metrics

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## Biographies

**Amirjon Atoev** is an undergraduate student in Industrial Engineering at the Rochester Institute of Technology (RIT) Dubai. He has demonstrated a strong academic foundation and research interest in the areas of production systems, industrial operations, and economic development. During his studies, he gained valuable industrial experience through an internship at Tajikcement, the largest cement plant in Tajikistan, where he worked as an intern assistant at IT department. His responsibilities included troubleshooting production systems and monitoring operational processes to maintain efficiency and reliability. In addition, he completed an internship at the Ministry of Industry and New Technologies of the Republic of Tajikistan. This opportunity allowed him to expand his knowledge of industrial policies, innovative initiatives, and the role of technology in advancing national development. Amirjon’s research interests extend to the socio-economic dimensions of

industrial engineering, with a focus on cultural preservation and economic modernization in the Middle East. His academic work has reflected a multidisciplinary perspective, bridging engineering principles with broader development strategies.

**Dr. Dua Weraikat, Ph.D., Eng.**, is currently an Assistant Professor and MEIE Program Coordinator at the Rochester Institute of Technology, Dubai Campus. She brings a strong academic and research background in industrial engineering, with expertise in operations research, supply chain management, and sustainable reverse logistics. Prior to joining RIT Dubai in 2017, she held research and teaching positions at Concordia University, Canada, where she completed her Ph.D., and later served as a postdoctoral researcher at Université Laval, focusing on value chain coordination in the forest industry. With over 15 years of experience across academia and industry, Dr. Weraikat has contributed to several impactful publications, including journal articles and book chapters, in areas such as green supply chains and pharmaceutical logistics. She has also taught various courses including production planning, operations research, and project management. Her leadership is reflected in her current role on the Operations Research Division Board of the Institute of Industrial and Systems Engineers (IISE) for the 2025–2027 term. Fluent in English, Arabic, and French, Dr. Weraikat is passionate about integrating smart and sustainable solutions into engineering education and research, mentoring students, and fostering collaboration across academic and industrial platforms.