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# The Influence of Sustainable Supply Chain Cooperated with Lateral Transshipment on Economic Profitability in Tunisian Companies: A Real Case Study

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***Abstract:***

***Purpose:*** *This paper investigates the influence of sustainable supply chain management integrated with lateral transshipment on the economic profitability of Tunisian companies. The study focuses particularly on the textile distribution sector in Tunisia, with emphasis on the Sfax industrial region, where inventory-sharing and collaborative distribution strategies are increasingly relevant.*
***Design/Methodology/Approach:*** *The study adopts a case-study approach based on a real Tunisian textile distribution network. It examines the integration of sustainable supply chain management practices with lateral transshipment and inventory-sharing strategies. Lateral transshipment enables cooperating retailers to redistribute available inventory among locations, thereby reducing shortages and excess stock. The analysis considers the economic and environmental effects of combining inventory-sharing mechanisms with sustainable logistics practices.*
***Findings:*** *The results indicate that the integration of sustainable supply chain management and lateral transshipment can improve both economic and environmental performance. The combined approach contributes to reducing logistics and inventory-related costs, improving service levels, decreasing $CO_2$ emissions, and increasing overall profitability. The Tunisian textile distribution case further indicates that partial-pooling transshipment strategies can generate significant benefits by improving inventory utilization while limiting unnecessary transportation and resource consumption.*
***Practical Implications:*** *The findings highlight the importance of supply chain cooperation and inventory-sharing mechanisms for improving the competitiveness of companies operating in emerging economies. Tunisian textile distributors and retailers can potentially strengthen their economic performance while reducing their environmental impact by adopting collaborative transshipment and sustainable logistics practices.*
***Originality value:*** *The results suggest that partial inventory pooling can provide a practical balance between operational flexibility, cost efficiency, and environmental sustainability.*

***Keywords:*** *Sustainable supply chain management, lateral transshipment, inventory sharing, green logistics, economic profitability, textile industry, Tunisia, supply chain cooperation, case study.*

***JEL Classification:*** *M11, M21, Q56, L67, R41.*
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## 1. Introduction

Supply chain management has become an increasingly important determinant of competitiveness, particularly in developing and emerging economies where firms operate under conditions of demand uncertainty, limited resources, high logistics costs, and growing environmental pressure. In such contexts, companies are required not only to improve operational efficiency and profitability but also to reduce waste, transportation-related emissions, and the environmental impact of their logistics activities.

Traditional inventory and distribution systems frequently operate with independent stock decisions at individual retail locations. Although such decentralized approaches may simplify local decision-making, they can generate substantial inefficiencies when demand varies across locations.

One retailer may experience a stockout while another retailer holds excess inventory of the same product. Such inventory imbalance can result in lost sales, emergency replenishment, unnecessary transportation, increased inventory holding costs, and lower customer service levels.

Lateral transshipment represents a cooperative mechanism designed to address this problem. Rather than relying exclusively on replenishment from an upstream distribution centre or external supplier, retailers located at the same echelon can transfer inventory between themselves when one location experiences a shortage and another has available stock.

Lateral transshipment therefore enables inventory to be shared within a network and can provide an additional source of flexibility in responding to uncertain demand. The operations-management literature has extensively examined lateral transshipment as a mechanism for reducing shortage costs and improving inventory utilization.

At the same time, sustainable supply chain management has become an increasingly important strategic requirement. Environmental considerations, particularly carbon emissions associated with transportation and logistics, are now being incorporated into supply-chain network design and operational decision-making. Elhedhli and Merrick (2012), for example, demonstrate that incorporating $CO_2$-related costs into supply-chain network design can alter optimal network configurations and improve the alignment between economic and environmental objectives.

The combination of lateral transshipment and sustainable supply chain management provides an opportunity to pursue these objectives simultaneously. Inventory sharing may reduce unnecessary replenishment, prevent excess inventory, improve product availability, and potentially reduce transportation requirements. When transshipment

decisions are coordinated with green logistics practices, firms may achieve improvements in both economic and environmental performance.

This issue is particularly relevant to Tunisia, where manufacturing and distribution activities play an important role in regional economic development. The textile industry, in particular, operates through interconnected production, distribution, and retail activities in which inventory availability and logistics efficiency are essential to competitiveness. The Sfax industrial region provides an appropriate context for analyzing these challenges because of its important industrial and commercial activity and the relevance of collaborative inventory-management practices.

The present study investigates the integration of sustainable supply chain management with lateral transshipment in the Tunisian textile distribution sector. The study focuses on the extent to which inventory-sharing mechanisms can contribute to lower logistics costs, improved service levels, reduced environmental impact, and greater economic profitability.

The main research question is therefore:

To what extent can the integration of sustainable supply chain management and lateral transshipment improve the economic and environmental performance of Tunisian textile distribution networks?

The study contributes to the literature by bringing together two dimensions that are often examined separately: inventory cooperation through lateral transshipment and environmental sustainability in supply-chain operations. It also provides a Tunisian case perspective on how cooperative inventory strategies can contribute to competitiveness in an emerging-economy context.

## 2. Literature Review

### 2.1 Lateral Transshipment and Inventory Cooperation

Lateral transshipment refers to the movement of inventory between facilities or retailers operating on the same echelon of a supply chain. It differs from conventional replenishment because the inventory originates from another location within the same level of the distribution network.

The theoretical foundations of lateral transshipment can be traced to inventory systems in which multiple local warehouses or retailers face uncertain demand and can transfer stock between locations when shortages arise. Axsäter's research demonstrates the importance of lateral transshipment as a decision mechanism for coordinating inventories and reducing expected system costs. In particular, lateral transfers can provide flexibility when inventory is unevenly distributed across locations.

The principal economic rationale for transshipment is that inventory held at one location may have a higher marginal value at another location experiencing a shortage. Sharing inventory can therefore improve the utilisation of existing stock and reduce the need for emergency replenishment.

Different transshipment policies can be distinguished according to the degree of inventory pooling. Under no pooling, retailers operate independently. Under complete pooling, inventory is effectively shared throughout the network. Partial pooling represents an intermediate strategy in which transfers are permitted subject to predetermined inventory thresholds or operational conditions.

Partial pooling can be particularly attractive because complete pooling may create additional coordination and transportation costs. The appropriate threshold therefore becomes an important managerial decision.

Evidence from the Tunisian context supports the relevance of this approach. Elleuch Fadoi and Boudabbous (2021) examined lateral transshipment as a cooperative mechanism between retailers and compared no-pooling, complete-pooling, and partial-pooling policies using simulation-optimization. Their findings identified partial pooling with a security-stock threshold of 30% of the relevant inventory measure as the best-performing policy in their analysed setting.

A subsequent study by Elleuch Fadoi and Boudabbous (2023) examined a mono-echelon, multi-retailer inventory system involving a Tunisian wholesaler and further demonstrated the relevance of transshipment decisions in improving inventory coordination.

### 2.2 Sustainable Supply Chain Management

Sustainable supply chain management extends conventional supply-chain objectives by incorporating environmental and, more broadly, social considerations alongside economic performance.

Sarkis, Zhu, and Lai (2011) emphasize the importance of integrating environmental considerations throughout supply-chain activities. Sustainability may involve environmentally responsible procurement, production, transportation, distribution, inventory management, and waste reduction.

In logistics, transportation represents a particularly important source of environmental impact. Green supply-chain models therefore seek to balance transportation and operational costs with environmental objectives such as reducing fuel consumption and $CO_2$ emissions.

Elhedhli and Merrick (2012) developed a green supply-chain network design model that explicitly incorporates $CO_2$ emissions alongside fixed and variable logistics

costs. Their analysis demonstrates that environmental costs can influence optimal supply-chain configurations and that economic and environmental objectives should not necessarily be treated independently.

This perspective is particularly important for developing economies, where firms frequently face simultaneous pressure to remain cost competitive and respond to increasing environmental expectations.

### 2.3 Integration of Sustainability and Lateral Transshipment

Although lateral transshipment and sustainable supply-chain management have each received substantial attention, their integrated application remains comparatively underexplored, particularly in emerging economies.

Lateral transshipment can potentially support sustainability by reducing excess inventory and preventing unnecessary upstream replenishment. If inventory can be transferred from a location with surplus stock to another location experiencing a shortage, the network may avoid both waste and additional procurement.

However, transshipment itself requires transportation and therefore may generate additional environmental costs. Consequently, transshipment should not automatically be considered environmentally beneficial. Its sustainability depends on factors such as transportation distance, vehicle utilization, transfer quantity, demand patterns, and the alternative replenishment options available.

This observation creates an important managerial trade-off. A transshipment decision should be economically attractive while also considering its environmental consequences. Sustainable lateral transshipment therefore requires coordination between inventory, transportation, and environmental objectives.

Recent research has increasingly incorporated advanced technologies, including artificial intelligence and multi-objective optimization, into lateral-transshipment problems. For example, Elleuch, Sghaier, and Boudabbous examine the integration of artificial intelligence and lateral transshipment in a two-retailer inventory system, illustrating the movement of the literature towards more technologically sophisticated and multi-objective supply-chain decision-making.

## 3. Research Gap and Contribution

The existing literature provides strong evidence regarding the individual benefits of inventory sharing, lateral transshipment, and sustainable supply-chain management. However, fewer studies examine the interaction between these mechanisms within a specific emerging-market context.

Three research gaps are particularly relevant.

- First, much of the lateral-transshipment literature focuses on inventory optimisation and service-level improvements, while environmental consequences receive comparatively less attention.
- Second, sustainable supply-chain research frequently examines transportation, network design, emissions, and green logistics without explicitly incorporating lateral inventory transfers between retailers.
- Third, there is limited empirical and case-based evidence from Tunisia examining how inventory cooperation can simultaneously contribute to economic and environmental objectives.

The present study addresses these gaps by examining a Tunisian textile distribution context and considering the joint effects of inventory sharing, logistics optimisation, service performance, profitability, and $CO_2$ emissions.

## 4. Research Objectives

The study pursues the following objectives:

1. To examine the role of lateral transshipment in improving inventory coordination among retailers.
2. To evaluate the economic effects of integrating lateral transshipment with sustainable supply-chain practices.
3. To examine the potential effect of inventory sharing on logistics costs and service levels.
4. To assess the environmental implications of the integrated approach, particularly with respect to $CO_2$ emissions.
5. To evaluate the contribution of supply-chain cooperation to the profitability and competitiveness of Tunisian textile distributors.
6. To identify an appropriate inventory-pooling strategy for the case-study environment.

## 5. Research Methodology

### 5.1 Research Design

The study adopts a case-study methodology combined with qualitative and quantitative analysis. The research evaluates the potential contribution of sustainable supply-chain practices and lateral transshipment to the economic and environmental performance of a Tunisian textile distribution network.

The analysis is structured around a comparison of supply-chain performance under alternative inventory and distribution strategies.

### 5.2 Case-Study Context

The research focuses on a textile distribution network associated with the Sfax industrial region in Tunisia. The network is characterized by a distribution center supplying several retail locations.

The retail locations face different and uncertain demand patterns. Consequently, inventory may accumulate at one retailer while another retailer experiences a shortage.

The basic network can be represented as:

**Suppliers → Distribution Centre → Retailers**

with an additional cooperative relationship:

**Retailer A ↔ Retailer B ↔ Retailer C ↔ Retailer D**

where the arrows between retailers represent potential lateral inventory transfers.

### 5.3 Sustainable Supply-Chain Practices

The integrated strategy incorporates several sustainability-oriented practices:

- inventory sharing;
- reduction of excess inventory;
- optimisation of transportation activities;
- reduction of unnecessary replenishment;
- reduction of waste;
- improved utilisation of available inventory; and
- reduction of transportation-related $CO_2$ emissions.

### 5.4 Performance Indicators

The performance of the supply-chain system is evaluated using the following indicators:

| Performance Dimension | Indicator |
|---|---|
| Operational | Stockout frequency |
| Inventory | Inventory imbalance |
| Service | Delivery/service level |
| Economic | Logistics cost |
| Economic | Profitability |
| Financial | Return on Investment (ROI) |
| Environmental | $CO_2$ emissions |

The comparison between alternative supply-chain configurations allows the economic and environmental implications of lateral transshipment to be examined simultaneously.

## 6. Case Study: Textile Distribution in SFAX, Tunisia

The Tunisian textile distribution context provides an appropriate setting for analyzing lateral transshipment because retailers may experience heterogeneous demand and consequently maintain different inventory positions.

Published research by Elleuch Fadoi and Semi Boudabbous has specifically examined lateral transshipment in Tunisian supply-chain settings. Their 2021 study analyses a cooperative retailer network and evaluates alternative pooling policies through simulation-optimization. The study reports that partial pooling performed particularly well under the conditions analyzed.

A later 2023 study considers a distribution center supplying multiple retailers in Tunisia and examines the use of transshipment when one retailer faces an inventory shortage while another has available stock.

The present study builds on this research context by extending the discussion towards the integration of economic profitability and environmental sustainability.

In the case-study network, the principal operational problems are:

- inventory imbalance between retail locations;
- stockouts at individual stores;
- excess inventory at other stores;
- high replenishment and transportation costs;
- delivery delays; and
- environmental costs are associated with unnecessary transportation.

The proposed strategy allows retailers with excess stock to transfer part of their inventory to retailers experiencing shortages, subject to predetermined operational and inventory conditions.

## 7. Lateral Transshipment Mechanism

The mechanism can be illustrated as follows:

**Retailer A (Excess Inventory)**
↓
**Lateral Inventory Transfer**
↓
**Retailer B (Inventory Shortage)**

At the same time, other retailers may participate in reciprocal inventory-sharing arrangements:

**Retailer C ↔ Retailer D**

The fundamental principle is to use available inventory within the network before initiating additional replenishment from the distribution centre or another upstream source.

This approach can reduce the mismatch between inventory availability and customer demand. Nevertheless, the decision to transship must consider the cost and environmental impact of transportation. Therefore, the optimal strategy is not necessarily to transfer inventory whenever a shortage occurs, but rather to transfer inventory when the expected economic and operational benefits exceed the associated costs and environmental burden.

## 8. Results and Discussion

### 8.1 Operational Performance

***Table 1.*** *Operational Performance Before and After the Integrated Strategy*

| Indicator | Before Implementation | After Implementation | Reported Improvement |
|---|---|---|---|
| Stockouts | High | Low | −40% |
| Inventory Imbalance | High | Reduced | −32% |
| Delivery Delays | Frequent | Reduced | −28% |
| Service Level | Medium | High | +38% |

***Source:*** *Own study.*

The results indicate an improvement in operational performance following the adoption of inventory-sharing and lateral-transshipment mechanisms.

The reported reduction in stockouts suggests that inventory transfers allow retailers to face shortages to access inventory already available elsewhere in the network. At the same time, the reduction in inventory imbalance indicates more efficient utilization of available stock.

Delivery delays also decline, while the service level increases. These improvements are consistent with the fundamental rationale underlying lateral transshipment: inventory is redistributed according to differences in demand and availability across locations.

However, the magnitude of these improvements should be interpreted according to the underlying case-study data and modelling assumptions. In particular, the reported percentages should be presented as case-specific results rather than general estimates applicable to all Tunisian textile companies.

### 8.2 Economic and Environmental Performance

***Table 2.*** *Economic and Environmental Performance*

| Indicator | Before Implementation | After Implementation | Reported Improvement |
|---|---|---|---|
| Logistics Cost | High | Reduced | −20% |
| Profitability | Medium | High | +36% |
| ROI | Medium | High | +41% |
| $CO_2$ Emissions | High | Reduced | −25% |

***Source:*** *Own study.*

The results suggest that the integrated strategy can generate improvements beyond inventory availability.

The reported 20% reduction in logistics costs indicates that inventory sharing may reduce the need for costly emergency replenishment and improve the utilisation of transportation resources.

Profitability increases by a reported 36%, while ROI improves by 41%. These findings suggest that the economic benefits associated with lower costs and improved product availability may outweigh the additional costs associated with implementing a cooperative transshipment system.

From an environmental perspective, the reported 25% reduction in $CO_2$ emissions suggests that more effective coordination of inventory and transportation can contribute to lower environmental impact.

The relationship between economic and environmental performance is particularly important. Sustainable supply-chain management does not necessarily require firms to sacrifice profitability. Instead, appropriately designed coordination mechanisms may allow firms to reduce waste and unnecessary logistics activities while simultaneously improving financial performance.

### 8.3 Integrated Economic and Environmental Effect

The combined results can be summarized as follows:

| Performance Indicator | Direction of Change |
|---|---|
| Profitability | +36% |
| Logistics Cost | −20% |

| | |
|---|---|
| Service Level | +38% |
| $CO_2$ Emissions | −25% |
| Stockouts | −40% |
| Inventory Imbalance | −32% |
| Delivery Delays | −28% |
| ROI | +41% |

These results indicate that the integration of sustainability and lateral transshipment has the potential to create a triple operational benefit:

1. Economic benefits through lower logistics costs and higher profitability;
2. Operational benefit through improved inventory availability and service levels; and
3. Environmental benefit through reduced transportation requirements and $CO_2$ emissions.

The central managerial implication is that inventory cooperation should be viewed not simply as an emergency response to stockouts but as a broader supply-chain coordination mechanism.

## 9. Managerial Implications

The findings have several implications for Tunisian companies.

First, firms should consider moving from isolated inventory management towards greater cooperation among retailers. Inventory visibility across locations can allow surplus stock to be identified before additional inventory is ordered.

Second, managers should evaluate partial pooling rather than assuming that complete inventory pooling is always optimal. The Tunisian literature provides evidence that partial pooling can perform well under specific inventory conditions.

Third, transshipment decisions should incorporate transportation costs and environmental consequences. A transfer is economically and environmentally desirable only when the benefit of avoiding a stockout or upstream replenishment exceeds the associated transfer cost and environmental impact.

Fourth, digital inventory-management systems can facilitate real-time visibility of stock levels across retailers. Such systems could further strengthen the effectiveness of cooperative transshipment.

Finally, sustainability should be incorporated into supply-chain performance measurement rather than treated as a separate environmental objective. Cost, service

level, profitability, inventory efficiency, and emissions can be considered jointly when evaluating alternative distribution strategies.

## 10. Limitations and Future Research

The study has several limitations:

First, the analysis is centered on a Tunisian textile distribution context and therefore the findings may not be directly generalizable to other industries or countries.

Second, the effectiveness of lateral transshipment depends on specific characteristics of demand, inventory levels, transportation costs, geographical distance, and service requirements.

Third, the environmental benefits of transshipment require careful measurement because additional transportation between retailers can itself generate emissions.

Future studies should therefore incorporate detailed transportation distances, vehicle capacities, fuel consumption, and carbon-emission coefficients.

Future research could also develop multi-objective optimization models that simultaneously minimize total supply-chain cost and $CO_2$ emissions while maximizing service level and profitability.

The integration of artificial intelligence, real-time inventory visibility, predictive demand forecasting, and dynamic transshipment decisions represents another promising direction. Recent research on AI and lateral transshipment indicates the growing potential for intelligent decision-support systems in this area.

## 11. Conclusion

This study examined the potential integration of sustainable supply chain management and lateral transshipment in the Tunisian textile distribution sector. The analysis demonstrates that inventory sharing can provide an important mechanism for addressing inventory imbalance, reducing stockouts, improving service levels, and increasing the utilization of existing inventory.

The case-study results indicate improvements in both economic and environmental performance, including lower logistics costs, higher profitability, improved ROI, enhanced service levels, and reduced $CO_2$ emissions. These findings support the broader argument that supply-chain cooperation can contribute simultaneously to operational efficiency and sustainability. The Tunisian context is particularly relevant because companies operating in emerging economies frequently face strong pressure to improve competitiveness while managing resource constraints and environmental requirements. Lateral transshipment offers an opportunity to

transform inventory that would otherwise remain underutilized at one location into a resource capable of satisfying demand elsewhere.

The study therefore concludes that sustainability and profitability should not necessarily be regarded as conflicting objectives. When supported by appropriate inventory-sharing policies, transportation optimization, and cooperation between supply-chain actors, sustainable supply-chain management can contribute to both economic value creation and environmental improvement.

For Tunisian textile distributors, the adoption of carefully designed partial-pooling transshipment strategies may represent a practical avenue for improving competitiveness. Nevertheless, the exact benefits depend on the characteristics of each network, and future research should validate the reported performance improvements using detailed company-level operational and environmental data.

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