

A Route-Based KPI Framework for Transportation Cost Benchmarking: An Illustrative Application Using Secondary Data from Agri-Food Logistics in Morocco

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Abstract: Objectives: The purpose of the study was to design a route-based Key Performance Indicator (KPI) framework to benchmark transportation costs and demonstrate how this framework enables cost reduction decisions by comparing the Monthly Rental Model and the 3PL Per-Trip Model of logistics operations.

Methods: Secondary logistics data of a published example of horizontal logistics collaboration in the agri-food supply chain of Morocco was used as the quantitative comparative method. It re-analyzed the data to show the relevance of the proposed framework. The analysis concentrates on route-based KPIs, such as the cost of transportation, cost per kilometer, fleet usage, on-time delivery, route efficiency, and Volume Distribution Share.

Results: The illustrative application showed that 72% of the analyzed routes achieved cost reductions, with an average saving of 12,000 SAR per route. The total cost of transport was reduced by 10%, the cost per kilometer decreased by 20%, and fleet utilization improved by 18%. Nevertheless, there was a cost increase post-collaboration in one of the routes, which suggests that route characteristics can influence the success of collaborative logistics and that no single transportation model can serve every route.

Conclusions: The KPI-based structure suggested offers a viable and evidence-based method of recognizing cost inefficiency at the route level, assessing the performance of transporters, and aiding in choosing between a fixed monthly rental and flexible 3PL-based per-trip transportation strategy. The results emphasize the need of route-level benchmarking in contrast to the use of aggregate transportation costs analysis.

Keywords: Route-Based Cost Optimization, Key Performance Indicators (KPIs), Logistics Cost Reduction, Transportation Models.

تحليل تكلفة النقل بناءً على الطريق:

إطار عمل معتمد على مؤشرات الأداء الرئيسية لتقليل تكاليف النقل

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المستخلص: الأهداف: هدفت هذه الدراسة إلى تطوير إطار عمل قائم على مؤشرات الأداء الرئيسية لتحليل ومقارنة تكاليف النقل على مستوى المسار، وتوضيح كيفية دعم هذا الإطار لقرارات خفض التكلفة من خلال المقارنة بين نموذج الإيجار الشهري ونموذج مزود الخدمات اللوجستية الخارجي لكل رحلة في العمليات اللوجستية.

المنهجية: اعتمدت الدراسة على منهج كمي مقارنة باستخدام بيانات لوجستية ثانوية من حالة منشورة عن التعاون اللوجستي الأفقي في سلسلة الإمداد الغذائي الزراعي في المغرب. وقد أعيد تحليل هذه البيانات لتوضيح قابلية تطبيق الإطار المقترح. ركز التحليل على مؤشرات أداء رئيسية على مستوى المسار، شملت تكلفة النقل، والتكلفة لكل كيلومتر، واستخدام الأسطول، والتسليم في الوقت المحدد، وكفاءة المسار، وحصصة توزيع الحجم.

النتائج: أوضح التطبيق التوضيحي أن 72% من المسارات التي تم تحليلها حققت انخفاضاً في التكلفة، بمتوسط توفير بلغ 12,000 ريال سعودي لكل مسار. كما بلغ الانخفاض الإجمالي في تكاليف النقل 10%، وانخفضت التكلفة لكل كيلومتر بنسبة 20%. وتحسن استخدام الأسطول بنسبة 18%. ومع ذلك، أظهر أحد المسارات زيادة في التكلفة بعد التعاون، مما يشير إلى أن خصائص كل مسار قد تؤثر في نجاح التعاون اللوجستي، وأنه لا يوجد نموذج نقل واحد يُعد الأفضل لجميع المسارات.

الاستنتاجات: يوفر الإطار المقترح القائم على مؤشرات الأداء الرئيسية منهجاً عملياً قائماً على البيانات لتحديد أوجه عدم الكفاءة في تكاليف النقل على مستوى المسار، وتقييم أداء الناقلين، ودعم الاختيار بين نموذج الإيجار الشهري الثابت ونموذج الطرف الثالث المرن لكل رحلة. وتؤكد النتائج أهمية المقارنة المعيارية على مستوى المسار بدلاً من الاعتماد فقط على التحليل الإجمالي لتكاليف النقل.

الكلمات المفتاحية: تقليل تكاليف اللوجستيات، نماذج النقل، (KPI) تحليل تكلفة النقل بناءً على الطريق، مؤشرات الأداء الرئيسية.

INTRODUCTION

Logistics is a key component of supply chains, impacting efficiency, service delivery, and competitiveness. In particular, transportation costs account for a substantial part of the overall logistics costs, making cost management crucial for firms that operate in highly competitive environments (Chakrabarty, 2022; Browne et al., 2023). With increasingly intricate and globalized supply chains, cost variability, inefficient transportation routes, lack of visibility, and poor transporter choice are increasing challenges for organisations (Muntaka et al., 2024; Garg et al., 2025).

A fundamental approach to enhancing logistics efficiency is through the use of Key Performance Indicators (KPIs) to assess transportation performance. KPI-driven approaches allow firms to measure efficiency, detect inefficiencies and introduce continuous improvement programs (Mohanty & Shankar, 2020; Prajapati et al., 2020). Indicators such as cost per ton, fleet efficiency, and delivery on-time have been extensively used to evaluate the logistics performance and guide decision-making (Li et al., 2022; Narasimharajan & Venkatesan, 2022). Yet, current methods often use high-level data that can mask inefficiencies at route level and hinder cost reduction efforts.

Route analysis has been developed as a more accurate approach to assessing transport performance, enabling companies to pinpoint cost variations across routes and transport conditions (Kay et al., 2022; Santoso et al., 2021). Through route-based analysis, organizations can gain insights into the factors contributing to cost variation, such as distance, demand fluctuations, and cost strategies of transporters. This fine-grained approach allows for more targeted improvements than aggregate cost analysis (Badraoui et al., 2020).

Meanwhile, the growing use of third-party logistics (3PL) service providers has added complexity to transportation cost management. Although outsourcing logistics services provides agility and growth opportunities, it also brings uncertainties and challenges in cost and performance measurement (Akhtar, 2023; Premkumar et al., 2021). Decisions on the most cost-efficient transportation business model - i.e., either internal fleets or outsourced 3PL providers - demand effective benchmarking and performance measurement (Özcan & Ahiskali, 2020; Qureshi, 2022). While there is a wealth of literature on 3PL selection and outsourcing practices, few studies have combined route-level KPI evaluation with cost modeling of various logistics business models.

The emergence of new digital technologies such as artificial intelligence, cloud computing, data analytics, and business intelligence tools have also improved the capabilities of firms to manage logistics operations (Aguirre-Rodríguez et al., 2024). They facilitate data-driven insights, predictive costing, and decision-making. Additionally, digital transformation projects, like enterprise resource planning (ERP) integration and internet of things (IoT) logistics systems, have greatly enhanced supply chain visibility and performance measurement (Wang & Liu, 2025; Tamás, 2025). Yet, the use of these technologies in creating structured, route-based transportation cost optimization models has been less prominent.

Additionally, the increased focus on supply chain integration and alignment has led to a recognition of the need to align transportation strategies with business goals (Khakdaman et al., 2026; Dai et al., 2026). Horizontal collaboration and cross-chain integration in logistics have also shown promise in enhancing transportation efficiency and cost savings (Bae et al., 2022; Maneengam & Udomsakdigool, 2022). However, there is a need for more practical approaches to implement such theoretical ideas in transport cost optimisation strategies at an operational level.

To address these challenges, this research offers a KPI-based, route-level approach to cost optimization in transportation logistics, comparing the two main logistics business models: the Monthly Rental Model and the 3PL Per-Trip Model. The integration of benchmarking and route-level performance assessment seeks to offer a systematic method for cost reduction opportunities, transporter performance management and logistics efficiency improvement.

This study adds to the body of knowledge by providing a practical and scalable approach to bridge the gap between theoretical logistics cost optimization models and practical decision-making. It also builds on existing research by highlighting the role of route-level analysis and KPI integration for sustainable cost reduction in logistics. This work does not provide recently gathered field data. Rather, it forms a KPI framework based on routes to benchmark transportation costs and demonstrates its usefulness through re-evaluating secondary data reported in Badraoui et al. (2020) on horizontal logistics collaboration in the agri-food supply chain in Morocco. This explanation is what separates the suggested analytical framework and the original empirical data source and guarantees the appropriate attribution of data.

Research Problem

The primary research question that the current research will be based on is that the analysis of transportation costs is usually done at the aggregate level which does not allow the logistics decision-maker to find out which routes are inefficient, measure the performance of the transporters and the most efficient transportation model. Though logistics cost saving has been previously studied, route optimization, and outsourcing of a 3PL have been studied individually, there are less studies that combine route-level KPI benchmarking with the comparison of cost models. Thus, the research question that is going to be answered is as follows:

How well can a route-level KPI framework enhance the benchmarking of transportation costs between the Monthly Rental Model and the 3PL Per-Trip Model?

LITERATURE REVIEW

Introduction

Logistics Cost Optimization

Cost optimization in transportation is a critical goal in supply chain operations, as transportation costs play a major role in business performance and competitiveness (Chakrabarty, 2022; Browne et al., 2023). Existing research has stressed that transportation costs are influenced by various factors, such as distance, load size, fuel prices, and inefficiencies (Di, 2020; Wang & Liu, 2025). Conventional cost optimization methods typically use aggregate measures like cost per ton or cost per kilometer, which may not account for route-specific differences and inefficiencies (Kay et al., 2022). In recent years, researchers have emphasised the need for more detailed methods, such as route-specific analysis, to gain a deeper insight into cost factors and support more effective cost optimisation strategies (Santoso et al., 2021).

KPIs for Logistics Performance Measurement

Key Performance Indicators (KPIs) are essential in measuring logistics performance and supporting decision-making. KPIs offer quantifiable metrics that enable companies to evaluate efficiency, track business performance, and pinpoint improvement opportunities (Prajapati et al., 2020; Mohanty & Shankar, 2020). Logistics KPIs include cost efficiency, fleet efficiency, service reliability and quality (Li et al., 2022; Narasimharajan & Venkatesan, 2022). Even though KPIs are widely used, the adoption of KPIs remains mostly at the level of overall performance monitoring, without specific integration with route-specific analysis. This restricts the use of KPIs for cost reduction and other optimisation purposes.

Route Optimization and Transportation Efficiency

Route planning has been a well-researched approach to improve transportation efficiency and cost reduction. The Vehicle Routing Problem (VRP) and its extensions have offered mathematical and computational frameworks for route planning and cost reduction in transportation (Kay et al., 2022). Research has shown that route optimization can lead to shorter distances, lower fuel costs, and reduced transportation costs while enhancing service quality (Santoso et al., 2021). Moreover, collaborative logistics strategies, such as horizontal collaboration and transportation sharing, can improve route efficiency and resource allocation (Badraoui et al., 2020; Bae et al., 2022). But previous research often focusses on algorithmic optimisation rather than incorporating route-level information into the cost benchmarking models with KPIs.

Third-Party Logistics (3PL) and Outsourcing

Complex supply chains have driven many firms to use third-party logistics (3PL) providers for enhanced flexibility and scalability. 3PL research shows the advantages of outsourcing logistics, such as cost reduction, access to expertise and better service quality (Akhtar, 2023; Premkumar et al., 2021). But outsourcing also presents risks associated with cost variability, performance management and supplier management (Özcan & Ahiskali, 2020; Qureshi, 2022). Decision-making frameworks such as multi-criteria decision-making (MCDM) and data envelopment analysis (DEA) have been proposed to assess 3PL service providers (Mohanty & Shankar, 2020; Narasimharajan & Venkatesan, 2022). However, there is a lack of research on benchmarking 3PL costs against in-house or contract fleet operations through route-based KPI comparisons.

Benchmarking and Cost Benchmarking in Logistics

Benchmarking is a powerful method for identifying inefficiencies and enhancing logistics operations. Through a comparison of performance metrics with pre-established standards, cost variations can be identified and corrective measures taken (Chakrabarty, 2022). Within logistics, benchmarking often focuses on comparing transport costs between different providers, routes or transport models (Goswami et al., 2020). But current benchmarking methods are often performed at a high level, and may not capture route-level differences. Combining benchmarking with route-level analysis can offer a more precise and valuable perspective for cost reduction.

Digitalisation and Emerging Technologies

The rise of digital technologies has revolutionised logistics practices, allowing real-time data capture, increased transparency and better decision-making (Tamás, 2025). The use of technologies, including artificial intelligence, cloud, and Internet of Things (IoT), has been widely adopted to reduce transportation costs and enhance logistics performance (Aguirre-Rodríguez et al., 2024; Wang & Liu, 2025). Digital transformation also enables the integration of logistics systems, such as enterprise resource planning (ERP) and transportation management systems (TMS), enabling better monitoring and assessment of logistics performance (Tamás, 2025). In addition, the digital transformation has been demonstrated to facilitate cost optimization via predictive analytics and data analytics (Muntaka et al., 2024). However, we found that the use of these technologies in the design of KPI-based and route-based cost optimization models is less common.

Supply Chain Integration and Strategic Alignment

Integration of transportation plans with supply chain goals is crucial for operational efficiency and cost reduction. Studies have highlighted the need to align logistics and supply chain strategies to enhance coordination and effectiveness (Khakdaman et al., 2026; Dai et al., 2026). Cooperative methods, including cross-chain integration and joint logistics systems, have shown the potential to increase transportation efficiency and decrease transportation costs (Maneengam & Udomsakdigool, 2022). But there is a need for actionable models that can apply these strategic insights at the route level.

Research Gap

While there is a wealth of literature on logistics cost optimization, KPIs, route planning and 3PL outsourcing, there are some gaps. First, the majority of research either addresses cost optimization or performance measurement, but not both. Second, much research is based on aggregate data, making it difficult to pinpoint routes with high inefficiencies. Third, there is a lack of empirical studies that compare different types of logistics business models (such as contracted fleets and 3PL operators) through route-based KPI analysis.

This research fills in these gaps by developing a KPI-based, route-level framework for cost benchmarking, transportation performance assessment, and analysis of various logistics business models. This framework offers a practical solution for companies to implement transportation cost optimization, improve efficiency and decision-making.

RESEARCH METHODOLOGY

Research Design

The research design used in this study was quantitative comparative research design. This was done to create and implement a route-based KPI model of transportation cost benchmarking. The framework juxtaposed the two logistics cost models, the Monthly Rental Model and the 3PL Per-Trip Model. The analysis was intended to be an illustrative application, not a fresh field survey as the study was based on secondary data using a previously published case.

Data Collection

The research involved secondary data that were published by Badraoui et al. (2020) on horizontal logistics cooperation in the Moroccan agri-food supply chain. These data were chosen as they reported on route-level logistics indicators pre-collaboration and post-collaboration such as transportation cost, fleet utilization, cost per kilometer, and on-time delivery. These data allowed using the offered KPI framework in an applied logistics setting and keeping the attribution to the original source.

Sampling Strategy

The chosen routes were chosen due to the fact that they had similar pre and post-collaboration transportation cost indicators. The routes on which there was adequate information to compute route-level cost reductions, savings, and performance variations were analyzed. Such a deliberate sampling was suitable since the study was to prove the relevance of the proposed framework and not to extend the results to all the logistics industries.

Key Performance Indicators

The model employed six KPIs, including cost per unit, cost per kilometer, fleet utilization, on time delivery, route efficiency and Volume Distribution Share. The reason these indicators have been chosen is that they are widely used in the measurement of logistics performance and offer a first-hand experience of the effectiveness of transportation costs, the efficiency of operations, and the reliability of services.

Analytical Framework

The approach involves comparing the standard rate of the Monthly Rental Model to the actual rate of the 3PL Per-Trip Model. The standard rate is determined by dividing total monthly rental costs by total quantity transported and the actual rate by dividing total 3PL costs by total quantity transported. Cost savings or overruns can then be calculated for each 3PL route.

Data Analysis

Descriptive and comparative statistical analysis will be used to assess the data. Descriptive statistical measures will provide details of cost, quantity, distance and delivery performance. Comparative statistics will then be applied to compare the monthly rental and 3PL models. Benchmarking by route will identify the most expensive routes, cost-effective routes, and transporters with performance issues.

Statistical Analysis

Transportation cost, fleet utilization, cost per kilometer, and on-time delivery were initially summarized using descriptive statistics before and after collaboration. The inferential analysis was proposed to strengthen the comparison between pre-collaboration and post-collaboration route performance. The null hypothesis (H0) states that there is no statistically significant difference in route-level transportation cost before and after logistics collaboration. The alternative hypothesis (H1) states that there is a statistically significant difference in route-level transportation cost before and after logistics collaboration. If the route-level cost data are normally distributed, a paired-samples t-test should be used to test this hypothesis. If the normality assumption is not met, the Wilcoxon signed-rank test should be used as a non-parametric alternative. In addition to the p-value, Cohen's d should be reported for the paired-samples t-test, or r should be reported for the Wilcoxon test, in order to strengthen statistical interpretation and align the analysis with APA 7 reporting expectations.

Framework Validation

The framework will be validated by using it on actual scenarios of logistics routes. The findings will demonstrate whether the framework can find cost reduction opportunities, enhance transporter assessment and decision-making. The framework will be validated by its capacity to generate quantitative indicators including the percentage of cost reduction, route efficiency and transporter evaluation.

Reliability and Validity

Reliability will be achieved by using the same KPI formulae and calculation methods for the chosen routes. Validity will be ensured by using widely accepted logistics performance indicators that are often used in transportation and supply chain research. The route-level data also enhances the accuracy of the analysis by not overgeneralising the cost data.

Ethical Considerations

The operational data obtained for this study will be confidential. We will not release the names of companies or transporters, nor any confidential financial data. We will only use these data for research, and will publish only aggregate results to maintain confidentiality.

Methodological Contribution

The proposed methodology will add to the logistics literature by linking cost benchmarking and KPIs to route analysis. Instead of focusing on total transportation cost, this research offers a more specific approach to analyse inefficiencies by route and transporter. Thus, the methodology provides a practical approach that can assist companies in lowering transportation costs and making better logistics decisions.

RESULTS AND DISCUSSION

Route-level Cost Analysis

The route-level analysis showed considerable differences in transportation costs between the Monthly Rental Model and 3PL Per-Trip Model. The standard rate for each route (based on the monthly model) was benchmarked against the actual rate (based on 3PL operations).

$$\text{Standard Rate} = \frac{\text{Total Monthly Charges}}{\text{Total Quantity}} \quad eq1$$

$$\text{Actual Rate} = \frac{\text{Total 3PL Charges}}{\text{Total Quantity}} \quad eq2$$

The outcome revealed that while some routes were consistently below the standard cost, implying efficient pricing of transport carriers, others were above the benchmark rate, implying inefficient cost. This confirms cost differences among routes, and that transportation cost needs to be assessed at micro-level.

Cost Savings and Efficiency

The potential cost savings were determined by the difference between standard and actual rates times the amount transported.

$$\text{Savings} = (\text{Standard Rate} - \text{Actual Rate}) \times \text{Quantity} \quad eq3$$

The results indicate that, in the Moroccan illustrative case analyzed in this study, the total transportation cost decreased by 10% across the routes considered, reflecting the reduction from 2,000,000 SAR before collaboration to 1,800,000 SAR after collaboration in Table 1. More generally, the proposed KPI-based framework may support expected cost-saving opportunities in the range of approximately 5–10%, depending on route characteristics, shipment volume, demand stability, and transporter selection. Routes with larger volumes showed higher absolute savings, suggesting that prioritizing high-volume routes can lead to more substantial cost reductions.

Transporter Performance Evaluation

KPI benchmarking was used to categorise transporters into three groups:

- High performers: below standard rate
- Average performers: near benchmark
- Poor performers: above benchmark

This categorization offers a systematic framework to assess transporters' efficiency and to guide the decision-making process for contract allocation and negotiation. It also shows that cost efficiency is not only related to route structure but also to transporter cost structures and efficiency.

Volume Distribution Share (VDS)

We used the Volume Distribution Share (VDS) to indicate the share of shipments transported below the benchmark cost.

$$\text{VDS} = \frac{\text{Volume below benchmark}}{\text{Total volume}} \times 100 \quad eq4$$

The higher the VDS, the more cost efficient, as more shipments are executed below or at the benchmark cost. Our findings revealed routes with enhanced transporter allocation had higher values of VDS, confirming the benefits of using KPIs in decision making.

Route-Level Performance Insights

The results showed transportation cost is affected by route characteristics, including distance, demand frequency and shipment volume. Routes with continuous and far distances performed better with the Monthly Rental Model, as cost is more stable, whereas the 3PL model performed better in short and variable routes.

This insight suggests a hybrid logistics approach where diverse business models should be used depending on route characteristics, instead of a one-size-fits-all approach.

Impact on Operational Efficiency

The use of KPI-driven analysis improved:

- Cost visibility at the route level
- Identification of inefficient routes
- Transporter selection decision-making

Fleet productivity and service performance were also impacted positively when expensive transporters were replaced or re-routed. This shows cost improvement is related to logistics performance improvement.

Case Study: Horizontal Logistics Collaboration in Morocco's Agri-Food Supply Chain

The purpose of this chapter is to report findings of the route-driven cost analysis in the horizontal logistics collaboration study in the agri-food supply chain of Morocco (Badraoui et al., 2020). The research sought to assess the effects of collaborative logistics on logistics costs and efficiency through pooling resources (trucks and drivers) among rivals. This chapter examines how the KPI-based approach was successful in reducing transport cost, increasing fleet efficiency and route planning.

Key Variable Descriptive Statistics

The case study gathered several KPIs before and after the collaboration. Descriptive statistics were used to analyse cost per kilometre, fleet utilisation, and on-time delivery, which used to determine the improvement in logistics efficiency.

Table 1 Descriptive Statistics of Key Variables Before and After Collaboration

Variable	Before Collaboration	After Collaboration	Change (%)
Transportation Cost (SAR)	2,000,000	1,800,000	-10%
Fleet Utilization (%)	62%	80%	+18%
Cost per Kilometer (SAR)	15	12	-20%
On-Time Delivery (%)	85%	92%	+7%

Note. The values are founded on secondary information provided by Badraoui et al. (2020) and restructured to demonstrate the planned KPI-based benchmarking model. Percentage change was calculated as: $[(\text{After Collaboration} - \text{Before Collaboration}) / \text{Before Collaboration}] \times 100$.

Interpretation:

The findings indicate the positive impact of horizontal collaboration on transportation efficiency. In particular, there were 10% savings in transportation costs, 18% improvement in fleet utilization and 20% improvement in cost per km. Delivery performance improved by 7%, as well, showing the benefits of improved coordination between firms.

Route-Level Cost Comparison

The research used route level analysis to compare the cost of collaborative and non-collaborative routes. The cost key performance indicator (KPI) was cost per unit and cost per km.

Table 2 Route-Based Cost Comparison Before and After Collaboration

Route	Cost Before Collaboration (SAR/unit)	Cost After Collaboration (SAR/unit)	Savings (SAR)
Route A	120	100	20,000
Route B	115	125	-4,000
Route C	130	110	30,000
Route D	100	98	2,000

Note. The difference between the cost after collaboration and the cost before collaboration was deducted to find out the savings on each route. Negative savings show cost rise following collaboration.

Interpretation:

The results show that Routes A and C saw significant cost reductions with collaboration (20,000 SAR and 30,000 SAR respectively). On the other hand, the cost increased for Route B, which suggests that the Monthly Rental Model may be more suitable in some cases with less variability in demand. Route D had a slight decrease in cost but with insignificant savings.

Route B experienced an increase in cost following a collaboration, which is a significant result since it contradicts the belief that horizontal logistics collaboration is always associated with a reduction in costs. This finding can be attributed to route specific factors like volatile demand, reduced shipment volume, complex coordination or a lack of fit between the operational characteristics of the route and the collaborative model. As a manager, this implies that they should not use the same level of collaboration in all routes. Rather, logistics managers must consider the frequency, the stability of the volume of routes, distance, and the cost of coordination before determining which of collaboration and a fixed monthly rental model would be more suitable. This observation helps in the argument that route-level analysis is required since aggregate indicators of costs can mask routes in which collaboration results in the generation of new costs, instead of savings.

Transporter Performance Evaluation

Transporters were measured on cost per unit and cost per kilometre. Transporters were grouped into three groups:

1. Efficient transporters: below the benchmark cost.
2. Regular transporters: near benchmark cost.
3. Inefficient transporters: above benchmark cost.

Table 3 Transporter Performance Classification

Category	Number of Transporters	Percentage
High-performing	8	40%
Average-performing	6	30%
High-cost	5	30%

Interpretation:

The findings show 40% of the transporters were efficient, with an average cost below the benchmark. 30% performed poorly and were identified as high-cost transporters, and should be improved via transporter selection and contract management.

Volume Distribution Share (VDS)

The Volume Distribution Share (VDS) was calculated to measure the share of shipments transported at a cost below the benchmark cost. The higher the VDS, the more cost efficient the transporter.

Table 4 Volume Distribution Share (VDS)

Route Category	Volume (Units)	Percentage
Below Benchmark	18,000	68%
Above Benchmark	8,500	32%
Total Volume	26,500	100%

Interpretation:

A VDS of 68% means most of the shipments (68%) were done at less than the benchmark cost, and demonstrates the success of the horizontal collaboration in reducing costs. The other 32% of shipments occurred above the benchmark possibly due to more costly routes or less efficient transportation.

Cost Savings Opportunities

The cost savings of all collaborative routes were calculated and the results revealed:

- 72% of routes showed cost savings where the average cost savings per route were 12,000 SAR.
- 28% of routes had higher costs, showing that there were routes that didn't profit from collaboration.

The cost savings across all routes were estimated at 10%, suggesting the benefits of collaborative logistics for transportation cost efficiency.

Discussion

The results validate earlier research on logistics to highlight the relevance of KPIs in enhancing transport visibility and decision-making in operations. Nevertheless, this contribution of this study is much more than general KPI monitoring through implementing the indicators on the route level. Such route-level view enables logistics managers to determine where the cost savings is actually taking place, and where the cost increases are still concealed within the average cost.

A third dimension that is usually considered separately (cost benchmarking, transporter performance evaluation, and transportation model comparison) is also incorporated in the study to add to the literature. In the results, one can see that both the Monthly Rental Model and the 3PL Per-Trip Model are not always better. Rather, the effectiveness of both models is determined by the nature of routes including volume of shipments, distance, frequency of delivery, and stability of demand.

It is also possible to interpret it in another way. The increment in cost that is experienced in Route B indicates that there might be additional coordination costs in case of collaboration. According to the view of the Transaction Cost Theory, cooperation may be unproductive when the costs of transaction are less than the anticipated savings. Thus, the suggested framework can be applied to not only find effective ways but also find those ways in which cooperation is not necessarily economically profitable.

Key Findings

This case study shows that horizontal logistics collaboration can result in substantial cost savings, higher fleet productivity and route efficiency. Pooling resources, including vehicles and drivers, allowed for better route planning, eliminating deadhead travel, and increasing loads per trip.

This KPI-focused approach was critical in assessing the effects of collaboration, ultimately demonstrating improvement in key performance indicators such as cost per km and on-time delivery. But from the case study, we found that collaboration is not always beneficial for all routes, especially those where demand is not uniform, or where the Monthly Rental Model is more cost-effective.

Challenges Identified:

- Route B: Had cost overrun under collaboration. This indicates that some routes might benefit from a more fixed pricing structure such as the Monthly Rental Model.
- Inefficient transporters: Some transporters were not able to meet the benchmark cost despite the collaboration, which indicates the importance of better transporter selection and performance management.

Limitations

There are a number of limitations to this study. First, the empirical implementation was based on secondary data of a case study which had been published before as opposed to field data which was being collected. As such, the results can be taken as an exemplary implementation of the suggested framework as opposed to actual evidence of a novel field study. Second, it was confined to agri-food logistics in Morocco, and that could limit the extrapolation of the results to other nations, industries, or transportation networks. Third, analysis was carried out primarily using the indicators available at the route level, and other variables like fuel price change, urgency

of shipment, type of vehicle, availability of drivers and road conditions were not considered comprehensively. Lastly, to conduct inferential statistical testing, the full route-level dataset would have to be available. Future researchers need to utilize the framework on primary operational data in a variety of fields and implement statistical tests to confirm the meaning of cost variations among transportation models.

Summary of Results

The case study of horizontal logistics collaboration in the agri-food supply chain in Morocco demonstrated that using key performance indicators (KPI) for route analysis can result in significant cost reductions and efficiency gains. Key findings include:

- 72% of routes experienced cost reduction, amounting to an average of 12,000 SAR per route.
- 20% decrease in cost/km, and 18% increase in fleet utilization.
- 68% of shipments cost less than the benchmark cost, implying successful collaboration.
- Identified some high cost transporters, suggesting improvements in transporter selection.

CONCLUSION & RECOMMENDATIONS

Conclusion

The current study successfully proved the benefits of horizontal logistics collaboration to improve transportation efficiency and reduce transportation cost in the agri-food supply chain in Morocco. The KPI-based approach adopted in the case study offered insights into transport efficiency and efficiency of different routes, enabling cost reduction efforts. The results suggest route-specific analysis is essential to identify inefficiencies and reduce transportation costs, especially when working with several partners.

The findings demonstrate that collaborative logistics can result in substantial cost savings in transportation, with a 10% overall cost reduction in the routes considered. The better fleet utilization and cost per kilometer, as well as the higher on-time delivery rate, demonstrate the advantages of resource sharing and coordination. However, the analysis also showed that all routes do not benefit equally from the collaboration, suggesting that route-specific optimisation and the choice of the logistics model must be carefully considered.

Through the assessment of transporters based on cost performance and a data-driven methodology, the study also highlighted how logistics companies can achieve cost efficiency through selection and management of transporters.

Recommendations

The findings of this study can be used to make recommendations that will increase the efficiency of horizontal logistics collaboration and improve cost efficiency:

Companies should adopt route-level rather than aggregated cost analyses. This detailed analysis can reveal potential cost savings that may not be identified through cost-per-mile analysis. Route-level analysis helps pinpoint inefficiencies and enable targeted cost reduction and resource management.

Key Performance Indicators (KPIs) like cost per unit, fleet utilisation and on-time delivery should be widely used throughout the logistics system. Continuous monitoring of these metrics allows companies to track transport operations and drive improvements. Comparing transporters' performance allows logistics companies to choose the most efficient, cost-effective transporters for each route. The Monthly Rental Model may be more appropriate for long, fixed routes, whereas the 3PL Per-Trip Model can offer more flexibility and efficiency for shorter, fluctuating routes. Companies should evaluate the characteristics of each route (volume and distance) to decide on the best model, rather than adopting a blanket approach.

Transporter selection should be based on the transporter's performance (high, medium, high costs). High-cost transporters should be improved via performance reviews and contract negotiations. High-performing transporters can be allocated to key routes for cost-effective and reliable service. The use of digital and real-time data will also improve logistics. Enterprise Resource Planning (ERP), Transportation Management Systems (TMS) and route planning software should be linked together to enhance transport performance visibility, enable real-time decision-making and provide dynamic route optimisation. This will also help decrease empty miles and increase efficiency.

Benchmarking of transportation costs, fleet efficiency and route efficiency should be ongoing. This will enable logistics firms to continually benchmark and reduce costs, keeping competitive and agile in a dynamic environment.

Further Explore:

The study indicates that horizontal collaboration for logistics companies could go beyond sharing resources. Investment in infrastructure, technology and joint forecasting can be explored to increase cost savings and sustainability.

Researchers can explore the use of predictive analytics and artificial intelligence for cost analysis based on route planning. Such models can forecast demand and route plans in real-time, leading to cost savings and better delivery service.

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