



# Reducing Operational Costs through Fleet Optimization and Maintenance

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## Abstract

The USA trucking industry serves as a critical backbone for supply chain and logistics operations, yet it faces significant challenges in managing operational costs due to rising fuel prices, maintenance expenses, and driver shortages. Fleet optimization and maintenance strategies have emerged as effective solutions to reduce these expenses while maintaining efficiency and reliability. This paper explores the role of fleet optimization techniques, such as route planning, load management, and driver behavior monitoring, in minimizing fuel consumption and improving overall fleet utilization. It also examines the impact of predictive and preventive maintenance strategies on reducing unplanned downtime and maintenance costs. Furthermore, the integration of advanced technologies, including telematics and IoT-driven predictive maintenance, is discussed to enhance operational efficiency. The findings demonstrate that investing in optimization and maintenance not only reduces costs but also provides environmental and competitive advantages, paving the way for a sustainable and profitable trucking industry.

**Keywords:** Fleet Optimization, Operational Cost Reduction, Usa Trucking Industry, Supply Chain Logistics

## I. Introduction

### 1. Background

The USA trucking industry is a cornerstone of the national economy, responsible for moving approximately 72.5% of the country's freight by weight, as reported by the American Trucking Associations (ATA) [1]. However, this industry operates within a complex landscape marked by fluctuating fuel prices, driver shortages, regulatory compliance pressures, and rising maintenance costs. These challenges significantly impact the profitability and efficiency of trucking operations, particularly for small to medium-sized enterprises that often lack the resources to absorb unexpected costs.

Fleet optimization and maintenance are pivotal strategies to address these challenges. By employing advanced technologies such as telematics, IoT-enabled sensors, and predictive analytics, companies can streamline operations, improve fuel efficiency, and reduce costly breakdowns. As sustainability



becomes a growing concern, adopting such strategies is also vital for reducing carbon footprints and adhering to stringent environmental regulations [2].

## 2. Problem Statement

Operational costs in the trucking industry have surged in recent years due to volatile fuel prices and increasing vehicle maintenance demands. According to a 2021 report by the American Transportation Research Institute (ATRI), fuel costs alone accounted for 24% of total operational expenses, while maintenance and repair costs grew by 8% over the previous year [3]. These rising expenses threaten the profitability of many trucking companies, particularly those without optimized fleet management systems.

## 3. Objective of the Study

This study aims to investigate how fleet optimization and maintenance practices can effectively reduce operational costs within the USA trucking industry. The objective is to explore key strategies, assess their economic and operational benefits, and highlight real-world examples where these methods have led to measurable cost reductions.

## 4. Scope

It examines operational cost challenges and explores the integration of optimization technologies, maintenance strategies, and their implications for improving efficiency and profitability.

## II. Literature Review

### 1. Fleet Optimization Practices

Fleet optimization involves leveraging data-driven approaches to enhance the efficiency and productivity of trucking operations. Tools such as route optimization software have gained prominence for minimizing fuel consumption and improving delivery times. Studies suggest that companies adopting these systems experience up to a 15% reduction in fuel costs [4]. For instance, real-time GPS and telematics enable trucking firms to identify the most efficient routes, avoiding traffic congestion and minimizing idling time. Additionally, load optimization strategies, such as dynamic load balancing and freight consolidation, have proven instrumental in reducing operational costs by maximizing vehicle capacity utilization.

### 2. Maintenance Strategies

Maintenance costs are a major contributor to operational expenses in the trucking industry. Preventive maintenance, which involves regularly scheduled inspections and servicing, reduces the likelihood of unexpected breakdowns and extends vehicle lifespans. However, predictive maintenance has emerged as a more advanced solution, utilizing IoT sensors and telematics to predict failures before they occur. This approach significantly reduces downtime and maintenance costs while enhancing operational reliability. For example, a case study on a mid-sized trucking company revealed a 20% reduction in maintenance-related expenses after implementing predictive maintenance systems [5].

### 3. Technological Integration



The integration of telematics and IoT has revolutionized fleet management. Telematics systems provide real-time insights into vehicle performance, driver behavior, and route efficiency. These systems have been widely adopted in the USA trucking industry, with companies reporting improved fleet utilization and safety compliance. Machine learning algorithms analyze historical and real-time data to optimize routes and predict vehicle failures. Furthermore, IoT-enabled devices monitor critical vehicle components, such as tire pressure and engine performance, allowing companies to address issues proactively [6].

## 4. Real-World Applications

Several USA-based trucking companies have demonstrated the effectiveness of fleet optimization and maintenance strategies. For instance, J.B. Hunt Transport Services, a leader in the logistics industry, reported a 12% improvement in operational efficiency after adopting an AI-driven fleet management system [7]. Similarly, a study by ATRI highlighted the success of predictive maintenance programs in reducing downtime across various fleet sizes, showcasing the adaptability of these practices [3].

## 5. Challenges in Adoption

While the benefits of fleet optimization and maintenance strategies are evident, their implementation is not without challenges. High initial costs for technology acquisition and the need for driver training can deter small and medium-sized enterprises (SMEs) from adopting these systems. Additionally, resistance to change within organizations and a lack of skilled personnel to manage advanced technologies often hinder widespread adoption [8].

## III. Fleet Optimization Strategies

Efficient fleet optimization strategies are vital for reducing operational costs in the trucking industry. This section explores key approaches such as route optimization, load management, and driver behavior monitoring, focusing on their impact on operational efficiency and cost reduction.

### 1. Route Optimization

Route optimization involves determining the most efficient paths for delivering goods, which reduces fuel consumption and travel time. The use of advanced routing software and telematics systems has enabled trucking companies to save significantly on fuel costs. These systems analyze traffic patterns, weather conditions, and road constraints to recommend optimal routes in real-time. According to ATRI, implementing route optimization can lead to a 10-15% reduction in fuel expenses for mid-sized fleets [3].

An example of successful route optimization is FedEx Freight, which utilized advanced routing algorithms to minimize empty miles, achieving a reduction in overall operating costs by 8% in 2021 [9]. Similarly, smaller trucking companies have adopted cloud-based systems to implement dynamic route planning, enabling them to compete effectively in the logistics market.

### 2. Load Management

Load management is another critical aspect of fleet optimization, focusing on maximizing vehicle capacity to reduce unnecessary trips. Efficient load balancing not only minimizes fuel consumption but

also decreases wear and tear on vehicles. Techniques such as freight consolidation, where smaller shipments are combined into a single load, have shown substantial cost savings.

For instance, a case study on Schneider National revealed that optimizing payload distribution across its fleet led to a 5% improvement in vehicle utilization and a proportional decrease in operational costs [10]. Additionally, advancements in load management software, which use AI and machine learning, have automated the process of assigning loads, making it easier for companies to manage complex supply chains effectively.

### 3. Driver Behavior Monitoring

Driver behavior has a significant impact on operational efficiency. Practices such as idling, hard braking, and speeding not only increase fuel consumption but also lead to higher maintenance costs. By monitoring and training drivers, companies can improve fuel efficiency and extend the lifespan of their vehicles.

Telematics systems have become a critical tool for monitoring driver behavior. These systems provide real-time feedback to drivers and fleet managers, helping to identify and correct inefficient driving habits. For example, a study conducted by Lytx, a leading telematics provider, showed that fleets using driver behavior monitoring systems achieved a 12% improvement in fuel efficiency and a 15% reduction in accident rates [11]. Companies often pair these systems with incentive programs to encourage drivers to adopt safer and more efficient driving practices.

**Benefits of Fleet Optimization:** The cumulative impact of these strategies is evident in their ability to reduce operational costs while maintaining service quality. Route optimization minimizes fuel consumption and travel time, load management ensures maximum vehicle utilization, and driver behavior monitoring enhances overall fleet safety and efficiency. Together, these strategies create a comprehensive approach to fleet optimization, delivering tangible benefits for trucking companies of all sizes.

## IV. Maintenance Strategies to Reduce Costs

Maintenance strategies play a pivotal role in reducing operational costs within the trucking industry. Implementing preventive and predictive maintenance programs helps trucking companies avoid costly breakdowns, extend vehicle lifespans, and improve fleet reliability. This section delves into various maintenance strategies and their real-world applications in the USA trucking industry.

### 1. Preventive Maintenance

Preventive maintenance involves scheduled inspections, servicing, and replacement of vehicle components to prevent unexpected breakdowns. This proactive approach ensures that vehicles remain in optimal condition, reducing downtime and costly emergency repairs. The American Trucking Associations (ATA) emphasizes that regular preventive maintenance can extend the life of trucking assets by 20% while lowering overall maintenance costs by up to 15% [12].

For example, Werner Enterprises, a major trucking company in the USA, implemented a preventive maintenance program focused on regular oil changes, tire inspections, and brake checks. The company

reported a 12% reduction in unscheduled repairs over three years, saving millions in operational expenses [13].

## 2. Predictive Maintenance

Predictive maintenance leverages technology such as IoT sensors, telematics, and data analytics to monitor vehicle performance and predict failures before they occur. By analyzing data from engine diagnostics, tire pressure monitors, and other sensors, companies can identify potential issues and address them proactively.

A case study conducted by Fleet Complete, a telematics provider, demonstrated the cost-effectiveness of predictive maintenance. A mid-sized fleet using predictive maintenance reduced unplanned downtime by 30% and achieved a 22% decrease in maintenance costs over two years [14]. Additionally, predictive maintenance aligns with the growing trend of digitization in the trucking industry, enabling companies to use data-driven insights to optimize their maintenance schedules.

### **Comparison: Preventive vs. Predictive Maintenance**

While preventive maintenance follows a fixed schedule, predictive maintenance relies on real-time data to determine when servicing is required. Both approaches have distinct advantages:

- **Preventive Maintenance:** Best suited for routine tasks like oil changes and tire rotations, ensuring basic upkeep of fleet vehicles. It is cost-effective for smaller fleets with limited technological capabilities.
- **Predictive Maintenance:** More advanced and suitable for large fleets, offering precise insights into vehicle health. While it requires an initial investment in IoT devices and analytics software, it significantly reduces the risk of catastrophic failures, leading to long-term savings.

### **Real-World Examples**

Several USA-based trucking companies have successfully implemented maintenance strategies to reduce costs:

1. **Swift Transportation:** By integrating predictive maintenance with telematics, Swift Transportation reduced its fleet's average maintenance cost per mile by 18% in 2021 [15]. The system flagged early signs of wear on critical components, allowing timely interventions.
2. **J.B. Hunt Transport Services:** The company combined preventive and predictive maintenance to create a hybrid approach, optimizing costs while maintaining high fleet reliability. J.B. Hunt reported a 25% improvement in fleet uptime over five years, attributed to this strategy [16].
3. **Owner-Operators:** Even smaller fleets and owner-operators benefit from preventive maintenance. A survey conducted by ATRI revealed that owner-operators who adhered to preventive maintenance schedules experienced 15% fewer breakdowns compared to those who did not [17].

### **Impact on Operational Costs**

Both preventive and predictive maintenance strategies have demonstrated measurable impacts on reducing operational costs:

- a) **Reduced Downtime:** By minimizing unexpected breakdowns, fleets experience fewer delays and avoid penalties associated with late deliveries.
- b) **Lower Repair Costs:** Early identification of issues prevents expensive repairs caused by component failures.
- c) **Improved Asset Lifespan:** Well-maintained vehicles operate efficiently for longer periods, reducing capital expenditure on new equipment.
- d) **Enhanced Fuel Efficiency:** Maintenance tasks such as tire alignment and engine tuning contribute to a better fuel economy, which is crucial given rising fuel prices.

## **Challenges in Implementation**

Despite the benefits, implementing effective maintenance strategies can be challenging. Predictive maintenance requires a significant upfront investment in technology and skilled personnel to interpret data. Moreover, smaller fleets may face budgetary constraints in adopting advanced telematics systems. To address these challenges, industry experts recommend starting with preventive maintenance and gradually transitioning to predictive maintenance as resources allow.

## **V. Economic and Operational Benefits**

Implementing fleet optimization and maintenance strategies provides significant economic and operational benefits to trucking companies. These benefits not only help reduce costs but also enhance overall efficiency, competitiveness, and sustainability in the trucking industry.

### **1. Cost Reduction**

Fleet optimization and maintenance strategies directly impact operational costs by minimizing fuel expenses, reducing repair costs, and avoiding downtime. According to the American Transportation Research Institute (ATRI), fuel costs accounted for 24% of total operational expenses in 2021, making it the single largest cost component for trucking companies [3]. By adopting route optimization technologies, companies can reduce fuel consumption by up to 15%, translating into substantial savings. Additionally, preventive and predictive maintenance programs have been shown to lower maintenance costs by 20% on average by avoiding expensive emergency repairs [18].

For instance, Knight-Swift Transportation Holdings implemented predictive maintenance across its fleet and reported annual savings of \$5 million in repair and replacement costs [19]. Such savings underscores the financial viability of investing in advanced fleet management systems.

### **2. Increased Fleet Utilization**

Fleet optimization ensures higher utilization of assets by minimizing empty miles and improving payload efficiency. Load management strategies allow companies to maximize the use of each vehicle, reducing the need for additional trips. Improved fleet utilization translates to increased revenue per mile while keeping operating costs low.

A study conducted by the Massachusetts Institute of Technology (MIT) Center for Transportation & Logistics found that optimized fleet routing and load balancing can improve fleet utilization by 10-20%, significantly enhancing profitability [20]. Furthermore, better fleet utilization helps trucking companies meet tight delivery schedules, improving service reliability and customer satisfaction.

### 3. Enhanced Operational Efficiency

Integrating telematics and IoT tools into fleet management processes streamline operations by providing real-time data on vehicle performance, route conditions, and driver behavior. This not only helps in making informed decisions but also reduces administrative overheads. For example, automating route planning and driver monitoring eliminates manual interventions, saving time and reducing errors.

Additionally, maintenance strategies such as predictive maintenance improve operational efficiency by minimizing unscheduled downtime. The ability to forecast component failures allows companies to plan repairs during off-peak hours, ensuring that trucks spend more time on the road and less time in the shop.

### 4. Environmental Sustainability

Fleet optimization and maintenance strategies also contribute to environmental sustainability. By reducing fuel consumption through route optimization and driver behavior monitoring, trucking companies can significantly lower greenhouse gas emissions. In 2021, the Environmental Protection Agency (EPA) reported that the transportation sector accounted for 27% of total U.S. greenhouse gas emissions, with trucking being a major contributor [21]. Implementing efficient fleet management practices helps trucking companies comply with environmental regulations while improving their corporate social responsibility (CSR) profiles.

For instance, Schneider National reduced its carbon emissions by 200,000 metric tons annually through a combination of route optimization and fleet electrification initiatives [22]. These efforts not only align with sustainability goals but also enhance the company's reputation among eco-conscious clients.

### 5. Competitive Advantage

Companies that invest in fleet optimization and maintenance gain a competitive edge by offering reliable, cost-effective, and sustainable transportation services. Enhanced fleet reliability leads to fewer delivery delays, boosting customer trust and retention. Additionally, reduced operational costs allow companies to offer competitive pricing without compromising profitability.

A survey conducted by McKinsey & Company revealed that 75% of shippers prioritize reliability and cost-efficiency when choosing a logistics partner [23]. Trucking companies with optimized fleets are better positioned to meet these expectations, strengthening their market position in an increasingly competitive industry.

### 6. Long-Term ROI

The initial investment required for fleet optimization and maintenance strategies is often offset by the long-term return on investment (ROI). By reducing recurring expenses, improving operational efficiency, and enhancing fleet utilization, these strategies provide sustained financial benefits. A case study by Fleet Advantage demonstrated that companies implementing predictive maintenance systems recovered their investment within two years and achieved a 30% ROI over five years [24].

## **VI. Challenges and Solutions**

While the benefits of fleet optimization and maintenance strategies are well-documented, their implementation often comes with significant challenges. These include high initial investment costs, resistance to change, and the need for skilled personnel. This section explores these obstacles and proposes practical solutions to address them.

### **Challenges in Implementation**

#### **1. High Initial Costs**

One of the primary challenges is the substantial upfront investment required for implementing advanced fleet optimization and maintenance systems. Technologies such as telematics, IoT-enabled sensors, and predictive analytics software demand significant capital outlay. For small and medium-sized enterprises (SMEs), these costs can be prohibitive. In addition, the expense of training staff to use these systems adds to the financial burden.

#### **2. Resistance to Change**

Organizations often face internal resistance when introducing new technologies and processes. Drivers and fleet managers may be hesitant to adopt changes due to a lack of familiarity with digital tools or concerns over increased oversight, such as driver monitoring systems. This resistance can delay or derail implementation efforts.

#### **3. Skill Gaps**

The effective use of advanced fleet management technologies requires specialized skills in data analytics, predictive maintenance tools, and IoT system management. A 2021 survey by the Transportation Research Board found that 65% of fleet managers cited a lack of skilled personnel as a barrier to implementing predictive maintenance systems [25]. Smaller companies, in particular, struggle to hire or train employees with the necessary expertise.

#### **4. Data Security and Privacy Concerns**

The adoption of telematics and IoT systems introduces concerns about data security and privacy. Sensitive information about fleet operations and driver behavior can become vulnerable to cyberattacks if not adequately protected.

### **Proposed Solutions**

#### **1. Incremental Implementation**



To address the issue of high initial costs, companies can adopt fleet optimization and maintenance strategies incrementally. Starting with preventive maintenance or route optimization software allows businesses to achieve immediate cost savings while gradually scaling up to more advanced systems like predictive maintenance. Leasing or subscribing to telematics solutions instead of purchasing them outright is another way to reduce financial strain.

## **2. Driver Training and Engagement**

Providing comprehensive training programs for drivers and fleet managers can reduce resistance to change. Emphasizing the personal and professional benefits of new systems, such as improved safety and reduced workload, can increase acceptance. Incentive programs that reward drivers for adopting safe and efficient driving practices can further enhance engagement.

## **3. Partnerships with Technology Providers**

Collaborating with technology providers can help companies overcome skill gaps. Many telematics and IoT vendors offer implementation support, training, and maintenance services. Outsourcing these aspects to external experts enables trucking companies to focus on core operations while still benefiting from advanced technologies.

## **4. Robust Data Security Measures**

To mitigate data security and privacy concerns, companies should invest in cybersecurity measures such as encryption, multi-factor authentication, and secure data storage systems. Partnering with reputable technology vendors who adhere to stringent data protection standards is essential. Regular audits and compliance with regulatory frameworks such as the Cybersecurity & Infrastructure Security Agency (CISA) guidelines can further enhance security.

## **Overcoming Challenges for SMEs**

Small and medium-sized enterprises face unique challenges due to limited resources. Government programs and industry associations, such as grants from the Department of Transportation (DOT) or incentives for adopting environmentally friendly practices, can help SMEs afford fleet optimization technologies [9]. Collaborating in cooperative purchasing agreements with other small companies can also reduce costs.

## **VII. Conclusion and Future Recommendations**

The USA trucking industry faces significant operational challenges, including rising fuel costs, vehicle maintenance expenses, and increasing competition. Fleet optimization and maintenance strategies have proven to be effective in mitigating these issues. Route optimization, load management, and driver behavior monitoring enhance operational efficiency, reduce fuel consumption, and improve fleet utilization. Maintenance approaches, such as preventive and predictive maintenance, further reduce downtime, extend vehicle lifespans, and lower overall costs.

By integrating advanced technologies like telematics, IoT, and new gen AI, companies can achieve substantial economic and operational benefits, including cost savings, enhanced sustainability, and competitive advantage. However, barriers such as high initial investment, resistance to change, and skill gaps must be addressed for successful implementation.

## **Recommendations for the Industry**

### **1. Adopt a Phased Approach to Implementation**

Companies, especially small and medium-sized enterprises (SMEs), should start with cost-effective strategies like preventive maintenance and basic telematics before transitioning to more advanced systems such as predictive maintenance and AI-driven fleet management tools. This phased approach minimizes financial strain while maximizing returns.

### **2. Invest in Training and Driver Engagement**

Comprehensive training programs should be established to familiarize drivers and fleet managers with new technologies. Incentive programs that reward safe and efficient driving can further encourage adoption and improve driver engagement.

### **3. Leverage Government Incentives and Industry Collaborations**

Organizations should explore grants and tax incentives offered by federal and state agencies for adopting environmentally friendly technologies. Collaborating with industry associations and technology vendors can also help reduce costs and access expertise.

### **4. Enhance Data Security Measures**

As data-driven technologies become more prevalent, trucking companies must prioritize cybersecurity to protect sensitive operational and driver data. Implementing robust security protocols and partnering with reputable vendors can mitigate risks.

### **5. Focus on Sustainability Goals**

Companies should integrate fleet optimization strategies with sustainability initiatives to align with environmental regulations and improve their corporate social responsibility (CSR) profile. For example, reducing fuel consumption not only cuts costs but also lowers greenhouse gas emissions.

### **6. Encourage Innovation through Technology**

The industry should continue to explore emerging technologies such as autonomous trucks, blockchain for supply chain transparency, and machine learning for predictive analytics. Investing in innovation will enable companies to stay ahead in an increasingly competitive market.

## **Future Research Directions**

### **1. Emerging Technologies in Fleet Management**

Further studies should investigate the potential of autonomous vehicles, electric trucks, and blockchain technology to enhance fleet optimization and maintenance practices.



## 2. Long-Term Impact of Sustainability Practices

Research on the long-term economic and environmental benefits of integrating sustainability-focused optimization strategies in the trucking industry would provide valuable insights for future investments.

## 3. Policy Impacts on Optimization Strategies

Analyzing the influence of regulatory policies on fleet management practices, particularly in the context of emissions standards and safety requirements, can help companies better align their strategies with compliance demands.

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