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Assessment of Factors Influencing Driver Training Fleet Maintenance - A Review

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***Abstract*:** A key role in transport education is providing students with practical learning experience through driver training fleets. These fleet vehicles are subjected to intense usage, a diverse operational environment, and unpredictable driving behavior, which all contribute to complex maintenance issues. This review paper examines the key factors that influence the maintenance of driver training vehicles. The five key areas identified through the review include operational, organizational, human, technological, and environmental factors. Each factor has a distinctive influence on fleet maintenance performance, from the usage and service of vehicles to the administration of resources and personnel. The paper is also keen on how issues such as bad driving practice, limited budgets, lack of skilled staff, and extreme weather can increase vehicle wear and lead to higher maintenance costs. Understanding these challenges helps institutions and policymakers to develop better strategies for maintaining vehicle safety, reliability, and cost-efficiency. In summary, good fleet maintenance calls for a comprehensive consideration of technical, managerial, and human aspects. This paper recommends regular training, adequate funding, and advanced technology incorporation to improve efficiency in maintaining fleets as well as ensure operational reliability.

Key words - Driver training fleet, vehicle maintenance, operational efficiency, maintenance strategy, transport education, human factor, fleet management, predictive maintenance

1. Introduction

Maintaining driver training vehicles is essential for keeping transport training institutions running smoothly, safely, and effectively. These vehicles often undergo more stress than typical commercial fleets because they are operated by students who are still learning basic driving skills (Hs, 2024). According to Muir et al., (2020), such use leads to an increased risk of wear and tear, unplanned downtime, and even safety incidents. Well-maintained training vehicles help to protect both students and instructors and also ensure the institution to follow safety and environmental regulations. According to Seniwoliba & Awuni. (2023) add that good maintenance practices also help to reduce vehicle downtime, lower repair costs over time, and improve the overall learning experience for students.

Around the world, there is growing recognition of how important fleet maintenance is not just for road safety, but also for supporting the economy and protecting the environment (Mena et al., 2024). In contrast, Crespo del Castillo & Parlikad, (2024) advocate for predictive and workload-balanced maintenance approaches that consider component criticality and Remaining Useful Life (RUL).

Muir et al., (2020) identifies that in training institutions poor maintenance can lead to unexpected vehicle breakdowns, interrupted lessons, and increased safety risks. These problems are especially common in developing countries, where limited budgets, older vehicles, and inconsistent maintenance routines make the situation more difficult. The objective of this review is to assess the key factor that influence the maintenance of driver training vehicles and to suggest the strategic improvement that can enhance their operational efficiency.

2. Operational Characteristics of Driver Training Fleets

Driver training vehicles are exposed to unique operational demands. Mikulić et al. (2020) emphasize that constant braking, gear shifting, and short-distance trips result in quicker degradation of key components like brakes and clutches. Widiarto et al. (2024) also highlight the critical role of operator skill and spare parts availability in sustaining operational efficiency. Compared to commercial vehicles, training fleets often follow rigid timetables, disregarding the actual intensity of use. Crespo del Castillo & Parlikad (2024) propose that fleet managers should dynamically adjust servicing schedules based on real-time operational data and component stress levels. For example, while Salonen & Deleryd, (2011) advocates more frequent brake checks in mountainous terrain, Sindhu et al. (2013) points out that even urban use marked by congestion and short stops demands attention to cooling and transmission systems. A comparison of these views underscores the need for localized, context-aware maintenance scheduling

3. Key Factors Influencing Fleet Maintenance

Maintaining driver training vehicles can be quite challenging due to many different factors involved. These fleets face unique demands compared to regular transport vehicles, as they are often used by learners who drive unpredictably, stop and start frequently, and generally put more strain on the vehicles. Because of this, maintenance must be carefully planned and flexible enough to respond to changing needs (Knight et al., 2011). Based on current research and practical experience in fleet management, several important factors have been identified that influence how well these vehicles are maintained. These include the technical condition of the vehicles, the skills and attitudes of maintenance staff, how the vehicles are used, available funding, institutional policies, and the use of technology to support maintenance. These factors are all connected when one area is weak, it can affect the others. For driver training institutions to keep their vehicles safe, reliable, and cost-effective, they need to understand how these factors work together (Haider et al., 2015). The sections that follow take a closer look at each of these areas and summarize what the current research says about them.

3.1 Operational related factors

Since the frequency and intensity of use influence the need for maintenance, vehicle operations must be serviced more frequently. High-mileage fleets must be serviced more frequently to avoid breakdowns and maximize efficiency. Research has also established that fleets more active in operations experience more degradation and, therefore, need routine maintenance strategies to ensure vehicles remain in optimal condition (Andrén, 2013). Mikulić et al. (2020) emphasize that constant braking, gear shifting, and short-distance trips result in quicker degradation of key components like brakes and clutches. For instance, vehicles used in mountainous areas need more frequent brake inspections because the areas put much pressure on the braking systems. In contrast, vehicles used in urban or flat lands may require more attention to the cooling and transmission systems (Salonen, 2012). Failure to align maintenance with vehicle usage intensity mostly leads to delayed servicing, breakdown, and costly downtime. Preventive maintenance performed at specified intervals helps to reduce unexpected breakdowns compared to corrective maintenance done after a breakdown (Virca et al., 2015).

3.2 Organizational related factors

Organizations play a significant role in determining maintenance outcomes. Vassallo & Izquierdo (2002) argue that financial constraints often delay necessary servicing, leading to higher long-term costs. Hamzi et al. (2015) extend this discussion by identifying the complexities involved in managing mixed-technology fleets such as internal combustion, hybrid, and electric vehicles, these setups demand specialized tools and strategies. Randeniya (2022) suggests aligning maintenance planning with institutional strategy and investing in digital systems that support real time fleet tracking and resource allocation. Comparing these insights reveals a common thread when maintenance is treated as a strategic priority supported by competent leadership and adequate budgeting, improve performance substantially. Organizations must also choose between in-house servicing or third-party vendors, each offering trade-offs in cost, control, and service responsiveness (Vassallo & Izquierdo, 2002).

3.3 Human related factors

Humans especially drivers and technicians are at the heart of effective fleet maintenance. Mong et al. (2019) argue that poor driving behaviors, such as abrupt braking or prolonged idling, accelerate wear. Rawat & Lad

(2017) show that training can reduce such behaviors, lowering maintenance costs and boosting productivity. Cortez et al. (2008) emphasize the importance of a safety and maintenance culture where early fault detection becomes part of daily routines. Comparing these viewpoints, it's evident that human behavior can either amplify or mitigate mechanical stress. Institutions that invest in frequent and hands-on training for both drivers and maintenance staff experience fewer breakdowns and lower repair costs. Moreover, empowering drivers to report faults early, rather than waiting for scheduled servicing, can be a game-changer.

3.4 Technologically related factors

Integrating telematics and Internet of Things (IoT) technologies enables real-time vehicle monitoring for predictive maintenance and early fault identification. This approach minimizes downtime and improves the reliability of the vehicles (Vujanović et al., 2012). Technology has redefined maintenance possibilities. D. Vujanović et al. (2012) demonstrate how integrated maintenance management systems improve energy efficiency and reduce unexpected failures. Denton (2020) discusses how onboard diagnostics and real-time alerts reduce unnecessary repairs and enable timely interventions. Cui et al. (2024) and Katreddi et al. (2023) present machine learning models that predict failure points based on sensor data, allowing for better planning. However, Crespo del Castillo & Parlikad (2024) caution that predictive models must be customized to reflect real-time usage, environment, and operational goals. Thus, while tech tools offer immense potential, their success depends on integration with practical operations and informed human oversight.
More and more fleets are using electric and hybrid vehicles, which pose new challenges in battery management, high-voltage component service, and software updates. These special skills and tools are required for such vehicles, which adds complexity to fleet maintenance (Martinez et al., 2017).

3.5 Environmental related factors

The environment in which training fleets operate directly affects their performance and maintenance schedules. Zang et al. (2019) point out that high heat accelerates tire wear, while cold weather compromises battery function. Krishnamoorthi et al. (2019) add that poor fuel quality increases engine wear, leading to frequent maintenance needs. Snelder & Calvert (2016) quantify how adverse weather affects road performance, suggesting the need for adaptive servicing. Comparing these insights reveals that environmental stressors demand flexible and responsive maintenance frameworks tailored to local conditions. Ignoring these variables can lead to mechanical failures that compromise safety and inflate costs.

4. Maintenance Strategy Integration and Digitalization

Traditional calendar based maintenance systems are increasingly giving way to hybrid strategies that incorporate real-time data and predictive analytics. Crespo del Castillo & Parlikad (2024) propose a dynamic framework that integrates workload distribution with component criticality and predictive failure models. Lemes & Hvam (2019) support this approach through the use of KPIs and balanced scorecards, which help monitor fleet health and identify inefficiencies. Syed (2024) discuss how fleet analytics platforms now offer actionable insights into driver behavior, fuel consumption, and service patterns. When comparing these approaches, it becomes clear that maintenance planning should evolve from a static routine to a fluid, data-informed strategy capable of adapting to changing operational demands.

5. Conclusion and Recommendations

5.1 Conclusion

This review highlights that maintaining driver training vehicles involves more than just regular servicing. It is a complex task shaped by how vehicles are used, who manages and drives them, and the environment in which they operate. Operational patterns like frequent braking and rough terrain increase wear, while organizational issues such as limited funding and inadequate planning can delay essential maintenance. Human behavior including driver habits and the skill levels of maintenance staff also plays a big role. Technology, such as vehicle diagnostics and telematics, offers promising solutions but requires investment and training to use effectively. Environmental conditions like heat, cold, and fuel quality further add to the challenges. For training institutions to ensure safe, reliable, and efficient fleets, a deeper understanding of all these factors is necessary.

5.2 Recommendations

To improve the maintenance of driver training fleets, institutions should prioritize regular training for both drivers and maintenance staff to encourage responsible vehicle use and enhance technical skills. Adopting preventive and predictive maintenance strategies, rather than relying on reactive repairs, can help reduce breakdowns and long-term costs. Investment in modern technologies such as telematics and diagnostic tools can support early fault detection and better decision-making. Clear maintenance policies, supported by proper budgeting, are essential for consistency and accountability. Maintenance planning should also consider local environmental conditions, such as extreme temperatures and fuel quality, which affect vehicle performance. Finally, promoting a strong culture of safety and proactive maintenance across the organization can lead to more reliable operations and improved overall fleet efficiency.

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