



# Safety management systems in road transport: Opportunities and challenges in shared mobility

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## Abstract

Safety Management Systems (SMS) have long been applied in high-risk sectors such as aviation and rail, but their adaptation to road transport remains underexplored. This paper examines the potential of SMS as a proactive framework for improving safety in road transport, with particular attention to shared vehicles and car sharing. It traces the origins and principles of SMS, evaluates its benefits and limitations, and analyses case studies from public transit, shared mobility platforms, and international experiences. The findings show that SMS can strengthen safety culture, enhance hazard identification, and support continuous monitoring, yet challenges such as fragmented governance, inconsistent driver practices, and technological barriers limit its effectiveness. The paper argues that stronger policy commitment, regulatory oversight, and institutional coordination are essential for successful implementation, alongside platform-level measures such as driver training, fatigue management, and data-driven monitoring. The distinctive contribution of this study lies in extending SMS from traditional high-risk sectors into the fragmented, rapidly evolving context of road transport and shared mobility, clarifying both the opportunities and the systemic challenges of such adaptation for policymakers, regulators, and platform operators.

**Keywords:** Safety Management Systems (SMS), Road transport safety, Shared vehicles, Car sharing, Policy and decision-making, Risk management, Digital mobility platforms.

## 1. Introduction

Over the past few decades, safety has become a central concern in road transport, not only for policymakers but also for operators and users. Mauriño (2017) explains that a Safety Management System (SMS) should not be seen as a simple regulatory requirement. Instead, it represents a comprehensive managerial approach that embeds safety into all organisational processes. This includes identifying hazards, assessing risks, developing safety policies, providing staff training, and continuously evaluating safety performance (Al-Mahamid et al., 2025; Mauriño, 2017).

The OECD/ITF further stresses that the successful implementation of SMS in the road transport sector depends on strong institutional commitment, clear policies, sufficient financial resources, and the active involvement of stakeholders, including governments, service providers, and road users. When these conditions are met, safety is no longer treated as a costly burden but as an added value that improves overall performance and reduces human and economic losses from accidents (OECD/ITF, 2018). Despite continuous progress in vehicle design and infrastructure, road traffic crashes remain one of the world's most pressing safety challenges. Each year, an estimated 1.19 million people lose their lives, and up to 50 million are injured, with vulnerable road users such as pedestrians, cyclists, and motorcyclists representing more than half of the victims. Beyond the human suffering, crashes impose a heavy economic burden, costing countries approximately 3% of their GDP annually (WHO, 2023). Recognising this challenge, the United Nations has included in its Sustainable Development Goals the ambitious target of reducing global road traffic deaths and injuries by 50% by 2030. (United Nations, 2015)



The roots of Safety Management Systems (SMS) go back to the aviation sector, where the International Civil Aviation Organisation (ICAO) began developing the concept in the late 1990s and early 2000s, particularly with the release of the Global Aviation Safety Plan (ICAO, 2013) and the adoption of a proactive approach to risk management. This framework was later adopted by other high-risk sectors, including railways and maritime transport, demonstrating its flexibility and effectiveness in reducing accidents and improving safety performance. (Mauriño, 2017).

In recent years, there has been a growing interest in applying Safety Management System (SMS) principles to the road transport sector. The increasing complexity of road environments drives this shift, as does the diversity of road users and persistently high accident rates. Agencies such as the U.S. Federal Transit Administration (FTA) have launched pilot programs to implement SMS in public transportation systems, including projects with the Chicago Transit Authority (CTA) and Maryland's Ride On bus service, aiming to enhance proactive safety performance and risk mitigation (FTA, 2020). Additionally, the National Transportation Safety Board (NTSB) has recommended adopting SMS across all modes of transportation, including road transport, emphasising its value in identifying hazards early and implementing preventive measures – regardless of the size or scope of the organisation (NTSB, 2023). These initiatives reflect a broader shift toward systematic and anticipatory safety management, moving beyond reactive approaches and fostering a stronger safety culture on the roads.

In the context of road transport governance, several studies emphasise that road safety can be managed through structured institutional systems and measurable strategic objectives. For example, Čabarkapa et al. (2016) highlight that effective road safety management requires coordinated institutional functions, policy implementation mechanisms, and clearly defined safety indicators embedded within national strategies. However, while SMSs have been widely adopted in aviation, rail, and maritime sectors, their adoption in road transport remains limited. In particular, the growing field of carsharing presents unique challenges – such as decentralised driver structures, platform-based operations, and limited regulatory oversight – that are not adequately addressed in existing literature. This paper seeks to fill this gap by exploring how SMS principles can be integrated into road transport and shared mobility systems, highlighting both the opportunities and the barriers to implementation.

## **2. Concept of Safety Management Systems (SMS)**

While the introduction highlighted the historical evolution and growing relevance of SMS in road transport, this section delves deeper into its conceptual foundations. Safety Management Systems are more than abstract frameworks; they represent structured managerial processes that translate safety objectives into operational practices. To understand their application in road transport, it is essential to examine the formal definitions, the core components, and the way SMS has been institutionalised across different transport modes.

### **2.1. Definition and framework**

According to the International Civil Aviation Organisation (ICAO), SMS is “a systematic approach to managing safety, including the necessary organisational structures, accountabilities, policies and procedures” (IATA, n.d.). Mauriño (2017) emphasises that SMS should be understood as a managerial system comparable to other management systems, such as financial or quality management, but with safety as its central focus. Stolzer (2008) further highlights that SMS operationalises safety objectives into practical processes by emphasising risk identification, mitigation, and continuous monitoring. Reason (1997) introduced the concept of “organisational accidents,” which underpins SMS by stressing that accidents result not only from human errors but also from latent failures embedded within systems. Later, Hollnagel et al. (2015) expanded this view through the concepts of Safety-I (minimising things that go wrong) and Safety-II (maximising things that go right), framing SMS as a dynamic system of learning and adaptation. Together, these perspectives establish SMS as a structured framework that not only addresses risks reactively but also anticipates and manages them proactively, making it particularly relevant for complex sectors such as road transport.

### **2.2. Core components of SMS**

The International Civil Aviation Organisation identifies four core components of a Safety Management System: (i) safety policy and objectives, (ii) safety risk management, (iii) safety assurance, and (iv) safety promotion. These



components form the backbone of SMS and provide a structured means to embed safety into organisational practice (ICAO, 2013).

Safety policy and objectives establish the organisation's overall commitment to safety, defining roles and responsibilities, and allocating resources. A safety policy is more than a formal declaration; it serves as a guiding framework for operationalising safety goals throughout the organisation. Safety risk management (SRM) is the heart of SMS. It involves the systematic identification of hazards, the assessment of associated risks, and the development of mitigation strategies (Mauriño, 2017). This proactive process ensures potential threats are addressed before they cause accidents. Safety assurance constitutes the monitoring and evaluation dimension of the Safety Management System. According to ICAO's Safety Management Manual (Doc 9859), it provides the mechanisms to verify whether risk controls perform as intended through activities such as internal audits, performance monitoring, and continuous improvement processes (ICAO, 2013). In practice, the ACI–ICAO SMS Handbook (ACI, 2016) further details these activities, highlighting audits and inspections, safety performance monitoring, surveys, and documentation as core tools of safety assurance. Similarly, within the European railway context, Regulation (EU) 2018/762 and the ERA (European Union Agency for Railways) guidance require operators to establish structured procedures for monitoring, auditing, and feedback, ensuring that the implemented safety measures remain effective and are continuously improved (ERA, 2022). Safety promotion focuses on fostering a strong safety culture by ensuring effective communication, training, and continuous learning. Together, these four elements ensure that SMS functions as a living system: one that not only reacts to incidents but continuously evolves to prevent future risks and enhance organisational safety performance.

### **2.3. Adaptation to road transport**

Adapting Safety Management Systems (SMS) to the road transport sector is both essential and challenging. The sector's complexity, the diversity of stakeholders, and persistently high road fatality rates make SMS implementation indispensable. At the same time, fragmented institutional responsibilities, uneven stakeholder awareness, and reliance on ad hoc interventions underscore the urgent need for systematic, evidence-based strategies (Mooren and Shuey, 2024; Stoma et al., 2021). Multiple studies emphasise that robust institutional frameworks and clear, enforceable policies are foundational for effective SMS. Countries with strong government commitment, regulatory clarity, and coordinated agencies achieve better road safety outcomes. Weak institutional readiness or fragmented policies limit system-wide improvements and the implementation of best practices (Khan and Das, 2024; Sakhapov and Nikolaeva, 2018). Practical applications have also begun to emerge. The U.S. Federal Transit Administration introduced an SMS framework for public transit agencies, requiring proactive identification of safety concerns, risk-based decision-making, and continuous monitoring (Spencer et al., 2015). The U.S. National Transportation Safety Board (NTSB) has encouraged the adoption of Safety Management Systems (SMSs) across various transportation modes, but its focus has primarily been on aviation and, more recently, commercial aerospace. In other sectors such as rail, public transportation, pipelines, and maritime transportation, evidence of their adoption is less clear, while surface transportation has not yet been explicitly included (Al-Mahamid, 2025; Teske and Adjekum, 2021). Together, these efforts reflect a gradual but critical shift in road safety management – from reactive crash response to proactive, systematic safety governance.

In summary, Safety Management Systems provide a structured and proactive framework for embedding safety into organisational processes. While their foundations were established in high-risk sectors such as aviation and rail, the adoption of SMS in road transport underscores both its necessity and complexity. The fragmented nature of road systems, combined with the diversity of users and environments, demands tailored strategies for successful implementation. These unique challenges form the basis of the next section, which examines the specific barriers and difficulties in advancing road safety through SMS.



### 3. Challenges in road transport safety

Road transport safety faces several interrelated challenges that complicate the implementation of structured systems such as SMS. Unlike aviation or railways, where safety responsibilities are highly centralised, road transport is influenced by human behaviour, infrastructure conditions, institutional fragmentation, and technological limitations. Human factors remain the most dominant challenge. The World Health Organisation (WHO, 2023) reports that speeding, drink-driving, distraction, and fatigue account for the majority of road traffic crashes worldwide. Studies and reviews report that human factors account for 77–90% of road traffic accidents, with some studies specifically citing 90% as the proportion attributable to human error (Agarwal et al., 2020; Ren, 2013; Singh et al., 2016) and underscoring the difficulty of managing road safety in an environment dependent on millions of individual drivers.

Infrastructure-related issues add another layer of complexity. In addition, infrastructure-related safety management in road transport should be viewed in the context of established engineering practices, such as geometric design consistency, pavement condition monitoring, traffic flow assessment, roadside hazard mitigation, and road safety audits, which provide an operational basis for identifying and reducing infrastructure-related risks. Poor road design, inadequate maintenance, and hazardous environments, such as sharp curves or poorly marked intersections, are strongly associated with higher crash risks. Research shows that poor infrastructure – such as unstable foundations, inadequate safety barriers, or substandard road design – can increase the likelihood of accidents, especially when combined with human errors, such as improper operation, inattention, or violations of safety protocols. For example, construction collapses are often linked to both unstable infrastructure and operational mistakes, illustrating how these factors compound risk. Empirical studies further confirm that road infrastructure elements – such as narrow lanes, deteriorated pavements, insufficient lighting, and roadside hazards – significantly affect crash occurrence (Pembuain et al., 2019). Recent empirical research further supports the importance of infrastructure condition indicators in crash analysis. For example, Al-Mahamid et al. (2025) demonstrate that traffic exposure (Annual Average Daily Traffic – AADT) and pavement roughness (International Roughness Index – IRI) are among the most influential predictors of crash frequency when developing Safety Performance Functions for road safety analysis.

In addition, systematic road-safety analysis methods have been developed to identify hazardous locations within road networks. For example, Nguyen et al. (2013) proposed a black-spot safety management approach based on the Safety Potential (SAPO) indicator, which evaluates accident costs and exposure in order to prioritise locations where safety improvements can generate the greatest benefits. Likewise, in the construction sector, accidents, including collapses and structural failures, are frequently attributed to a combination of poor infrastructure quality and unsafe human practices, underscoring the interplay between technical deficiencies and behavioural errors in shaping accident outcomes (Zang et al., 2025). Institutional and regulatory weaknesses also hinder progress. Fragmented responsibilities among agencies, unclear policies, and insufficient resources are major barriers to implementing SMS in the road sector. Without strong institutional leadership and coordination, safety initiatives often remain ad hoc and reactive, rather than systematic and preventive (Nævestad et al., 2021).

Finally, technological and operational challenges do limit the transition toward proactive safety management. The adoption of advanced technologies (e.g., AI, IoT, digital twins) for proactive safety management is often hindered by integration challenges with legacy systems, limited interoperability, and insufficient digital infrastructure – especially in developing regions (Adikwu et al., 2024). The high costs of new technologies, limited access to reliable internet, and expensive maintenance hinder widespread implementation, particularly for small and medium-sized organisations (Sakhapov and Nikolaeva, 2018). Concerns about data privacy, cybersecurity, and regulatory compliance present significant barriers to the adoption of real-time monitoring and data-driven safety solutions (Adikwu et al., 2024; Sakhapov and Nikolaeva, 2018). A lack of technical skills, insufficient training capacity, and resistance to change among employees and management impede the effective use of proactive safety technologies (Malomane et al., 2022). Similar risk-based approaches have also been proposed in other transport sectors. For instance, Nedeliaková et al. (2022) developed a methodology based on Failure Mode and Effects Analysis (FMEA) to systematically identify and evaluate safety risks in railway crossings, demonstrating how structured risk-identification frameworks can support



proactive safety management in complex transport systems. Together, these challenges – human, infrastructural, institutional, and technological – illustrate why implementing SMS in road transport is more complex than in other high-risk industries. At the same time, they reinforce the urgency of adopting systematic approaches that can integrate fragmented efforts into a coherent framework for improving road safety.

#### **4. Application of SMS in carsharing**

Carsharing, including ride-hailing, has become an increasingly important part of urban mobility. The rapid growth of carsharing presents both opportunities and risks for road safety. On the one hand, these services introduce new operational models that rely on decentralised drivers, dynamic demand, and digital platforms. On the other hand, this very complexity underscores the need for systematic approaches, such as SMS, to manage safety in a structured and proactive manner.

Variability in driver qualifications and working conditions is a major safety challenge in shared mobility services. Unlike traditional taxi drivers, many ride-hailing drivers operate as independent contractors without standardised or formal training, which leads to significant inconsistencies in safety awareness and practices (Mao et al., 2021). Studies have shown that factors such as crash history, driving hours, passenger ratings, and employment type (full-time or part-time) directly influence risky driving behaviours and risk awareness (Hou and Guan, 2020; Mahudin and Sakiman, 2018). To address these challenges, a Safety Management System (SMS) can be implemented at the platform level to enforce unified safety policies, including driver training, fatigue management, and behavioural monitoring. Additionally, technological tools can be developed to automatically verify driver qualifications and ensure compliance with safety standards (Lu et al., 2023).

Another critical safety challenge in ride-hailing services is risk management within dynamic urban traffic environments, where drivers frequently interact with vulnerable road users such as pedestrians and cyclists. The absence of safety frameworks tailored specifically to these operating conditions has been shown to increase crash risks. Recent studies emphasise that algorithmic management – while improving efficiency – can also encourage risky driving behaviour due to income insecurity or pressure to complete more rides quickly (Lefcoe et al., 2023). However, risk can be mitigated by integrating safety technologies into the platform itself, such as hazard identification systems, risk visualisation tools, and spatial data algorithms that detect high-risk areas and issue real-time alerts (Fu et al., 2024; Niu et al., 2021; Zhang et al., 2025). Integrating such features into an SMS would allow platforms to proactively reduce exposure to crash-prone conditions by combining real-time data analysis, driver behaviour tracking, and predictive risk alerts.

Ensuring safety assurance is essential in ride-hailing platforms, especially given their ability to collect large-scale digital data on driver behaviours, trip characteristics, and traffic conditions. When leveraged effectively, these data streams can support continuous safety monitoring and performance evaluation – key components of an SMS. Studies have shown that platforms increasingly rely on algorithmic systems to track driver safety through rating systems, customer feedback, and real-time monitoring tools (Prabowo and Isbah, 2022). Feedback mechanisms, especially those tied to emergency response systems and user evaluations, have a measurable positive impact on overall safety performance (Afifudin et al., 2024). Additionally, studies propose that integrating objective, non-subjective trust systems – based on driver trajectory and behaviour data – can reduce bias and improve the accuracy of safety assessments (Tong et al., 2024). This approach reinforces the SMS principles of continuous improvement and proactive risk management through data-driven decision-making.

Finally, safety promotion can be advanced through transparent communication and user engagement. Platforms can strengthen the safety culture by informing passengers about safety measures, encouraging feedback, and promoting responsible driver behaviour. Such measures not only enhance public trust but also align with SMS objectives of building resilience and accountability. Thus, the application of SMS in carsharing represents a novel extension of



traditional safety management. By embedding SMS principles into the governance of digital mobility platforms, policymakers and operators can ensure that the benefits of shared mobility are realised without compromising safety.

## 5. Benefits and limitations

Implementing SMSs in road transport offers several clear advantages. Firstly, SMS provides a structured and proactive framework for hazard identification and risk mitigation, shifting the focus from reactive to preventive safety strategies. Research shows that involving all organisational levels in identifying and solving safety issues enhances safety culture and long-term effectiveness (Lappalainen, 2017). In the context of carsharing, SMS enables platforms to implement standardised driver training, fatigue management, and data-driven monitoring, thereby improving overall safety performance. Studies in multiple sectors highlight that SMS fosters continuous safety improvements by integrating monitoring, reporting, and policy feedback loops (Mauriño, 2017). Additionally, organisations that implement SMS report improved coordination, reduced accident rates, and better use of resources through structured safety audits and risk prioritisation (Geoffroy, 1993).

Despite these benefits, several limitations challenge the successful implementation of SMS in road transport. One major issue is institutional fragmentation and a lack of inter-agency coordination. Studies emphasise that without cross-sectoral cooperation and regulatory support, SMS initiatives often remain superficial or ineffective (Lappalainen, 2017). Kelly (2017) notes that SMS implementation has placed a heavy burden on regulatory authorities across all transport modes, especially in contexts where decentralisation and legacy systems complicate consistent oversight and enforcement. Furthermore, insufficient administrative and technological capacity – especially in low- and middle-income regions – hinders the collection and use of safety data for continuous monitoring (Steiner et al., 2009). In shared mobility services, the gig economy model further complicates SMS enforcement. Independent contractors often operate without standardised oversight, making it difficult to apply uniform safety policies or conduct safety audits (Anderson, 2003).

In summary, SMS offers a powerful and structured framework for improving road transport safety. However, its success hinges on overcoming systemic limitations such as fragmented governance, inconsistent driver regulation, and technological challenges. A coordinated, data-driven, and inclusive approach is essential to unlocking its full potential.

## 6. Examples

Case studies of SMS implementation in road transport and shared mobility illustrate both the opportunities and challenges of adapting this framework. These examples range from successful institutional applications to contexts where challenges persist. One notable example is the Chicago Transit Authority (CTA), which participated in the U.S. Federal Transit Administration (FTA) SMS Implementation Pilot Program in partnership with the Illinois Department of Transportation. As part of the pilot, CTA developed an SMS implementation plan, tested Safety Risk Management procedures in bus operations, and worked on developing Safety Assurance activities – demonstrating a practical application of structured SMS processes in a large-scale urban transit agency (FTA, 2018). By contrast, in the shared mobility sector, Uber has promoted practices resembling SMS, particularly its peer-to-peer rating system, to enhance driver and passenger safety. However, research shows that these ratings often pressure drivers into unsafe practices, such as carrying excessive passengers or speeding to avoid negative feedback. This indicates that, unlike formal SMS frameworks, car sharing safety remains largely voluntary and dependent on company policies rather than binding regulation (MacEachen et al., 2018).

The INESS project developed harmonised safety case processes within the European Rail Traffic Management System (ERTMS) to reduce costs, streamline certification, and strengthen cross-border interoperability. By standardising guidelines and promoting cooperation among national authorities, industry suppliers, and operators, the project demonstrated how coordinated SMS practices can significantly reduce fragmentation and improve oversight in complex, multinational transport systems (Mueller et al., 2010). Similarly, case studies in urban mass transit in cities such as Jakarta demonstrate the importance of embedding social and safety considerations into large-scale bus rapid



transit (BRT) and rail investments. Research shows that gendered travel patterns and risks, including overcrowding and sexual harassment, highlight the need for integrating equity and safety protocols into system design and operation to ensure long-term social sustainability (Turner, 2012).

Together, these examples demonstrate that SMS can be successfully adapted to complex, dynamic transport environments. However, they also underline that effectiveness depends on strong institutional oversight, mandatory integration of safety policies, and continuous use of operational data across both public transit and shared mobility platforms, especially in the context of road transport and carsharing.

## **7. Policy and decision-making implications**

Policy and decision-making play a central role in determining the effectiveness of Safety Management Systems (SMS) in road transport and shared mobility. Evidence shows that a tension between mobility and safety goals often shapes policy choices. For instance, Bates et al. (2010) demonstrate that while evaluations of graduated driver licensing (GDL) consistently show significant reductions in young driver crashes, policymakers may hesitate to adopt or strengthen such systems out of concern that restrictions on night driving or passengers could limit individual mobility. This illustrates how political priorities can both hinder and facilitate safety-focused reforms, depending on the balance struck between mobility and safety (Bates et al., 2010). Strong leadership and institutional coordination are also necessary for big, systemic change. May, Tranter, and Warn (2011) argue that transformational leadership is essential to move beyond “shallow” adaptive changes and toward integrated policies such as Vision Zero, which align transport with broader societal goals, such as sustainability and public health. Their research emphasises the need for inter-agency collaboration across energy, health, environment, education, and transport authorities to institutionalise safety culture. They further stress that a big change requires rethinking entrenched cultural practices and adopting holistic strategies such as mobility management, active and public transport, and even restructured societal time use (e.g., Slow Cities). Only through such integrated and cross-sectoral approaches can safety reforms achieve lasting impact (May et al., 2011).

The French experience further illustrates the importance of centralised, data-driven governance. Chapelon and Lassarre (2010) describe how national-level road safety policy in France has relied heavily on comprehensive information systems, including accident statistics, risk exposure data, speed measurements, and behavioural indicators such as mobile phone use. These datasets are integrated into risk management tools – such as monitoring, benchmarking, and policy refinement – that enable continuous oversight and evidence-based decision-making. Although challenges remain, this centralised model has enabled more systematic evaluation of risks and more effective safety interventions (Chapelon and Lassarre, 2010). For shared mobility, decision-making must also address integrating new mobility services into urban systems. Cieśla, Sobota, and Jacyna (2020) developed a multi-criteria decision-making model for metropolitan transport planning that incorporates factors such as safety, cost, environmental impact, and service quality. Their findings, based on application in the Silesian Metropolis in Poland, stress that policies guiding shared mobility adoption should balance user demand with broader systemic goals of safety and sustainability (Cieśla et al., 2020). Similarly, Teusch et al. (2023) review the role of advanced decision-support methods, particularly machine learning, in enhancing both safety and operational decisions in shared mobility platforms. Their systematic review highlights how supervised, unsupervised, and reinforcement learning approaches provide methodological solutions to challenges such as demand prediction, fleet management, and user experience optimisation – underscoring the growing importance of data-driven decision support in shared mobility (Teusch et al., 2023).

Finally, Muhlrاد (2006) stresses that road safety policies cannot exist in isolation. Effective decision-making requires embedding safety objectives into broader agendas such as urban planning, health, security, and transport policies. His analysis highlights that achieving this intersectoral integration demands profound organisational change, including shifting sectoral priorities, restructuring decision-making patterns, creating new professions, and fostering cultural and institutional change. This ensures that SMS adoption does not remain a narrow technical exercise but becomes part of systemic governance transformation (Muhlrاد, 2006).



## 8. Limitations and future research directions

This paper has certain limitations that should be acknowledged. First, the study is conceptual in nature and primarily builds on secondary literature, without original data collection, exposure-based crash analysis, or quantitative modelling of SMS in road transport or carsharing. Accordingly, the paper is intended to clarify the conceptual relevance and policy implications of SMS adoption rather than to provide a direct empirical assessment of crash-reduction effects. Second, the examples presented are illustrative rather than exhaustive, and therefore cannot fully capture the diversity of practices across different regions and mobility systems.

Future research should therefore move toward empirical investigations. Another important direction is to examine how SMS principles can be operationalised with established road safety engineering tools, such as Safety Performance Functions (SPFs), network screening approaches, roadway safety audits, and infrastructure condition-monitoring frameworks. One direction is the collection and analysis of large-scale operational and safety data from carsharing platforms to evaluate the real-world performance of SMS. Comparative studies across countries could further clarify how institutional frameworks and regulatory environments influence SMS outcomes in road transport. Another promising line of inquiry is the integration of emerging technologies – such as artificial intelligence, Internet of Things (IoT), and connected vehicle systems – into SMS frameworks, ensuring that safety management evolves in parallel with technological and organisational transformations in mobility.

## Conclusion and recommendations

This study has highlighted the importance of Safety Management Systems (SMS) as a structured, proactive framework for improving safety in road transport, with a particular focus on carsharing. By tracing the evolution of SMS from aviation to road contexts, examining its benefits and limitations, and analysing practical examples, the paper has shown that SMS can significantly strengthen safety culture, enhance hazard identification, and support continuous monitoring. At the same time, the findings underline that the fragmented and decentralised nature of road transport, combined with variability in driver behaviour and technological barriers, poses substantial challenges to its effective implementation.

Addressing these challenges requires a stronger commitment from policymakers and regulators to ensure that SMS principles are systematically embedded into national and urban transport systems. Shared mobility platforms must also take greater responsibility by institutionalising driver training, enforcing fatigue management, and leveraging digital tools for real-time monitoring and feedback. Investments in data infrastructure and advanced analytics are equally necessary to support proactive risk detection and continuous improvement. Most importantly, embedding safety as a cultural value across institutions, operators, and communities will be essential to achieving sustainable progress. The distinctive contribution of this study lies in extending the application of SMS principles from traditional high-risk sectors such as aviation and rail to the more fragmented and rapidly evolving domain of road transport and shared mobility. By highlighting both the opportunities and systemic challenges of this adaptation, the paper provides new insights for policymakers, regulators, and platform operators seeking to strengthen safety in decentralised transport systems.

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