

Article

Road Safety Management in Brazilian Logistics Companies: An Empirical Study of Practices, Motivators, and Barriers

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Abstract

This study explores how Brazilian logistics companies manage road safety by identifying key practices, motivators, and barriers. While traffic safety has been widely studied, few investigations adopt an organizational perspective, especially in the logistics sector. Addressing this gap, we applied a mixed-methods approach combining expert input (qualitative phase) and a structured survey of industry professionals (quantitative phases). The findings reveal that practices such as infrastructure development, driver training, and compliance monitoring are perceived as most effective. Motivators include operational planning and economic incentives, while major barriers involve lack of internal motivation, awareness, and resource constraints. Factor analysis confirmed the structure of practices, motivators, and barriers, while a SWOT framework provided strategic insights into internal strengths and external challenges. This study offers practical recommendations for integrating safety into strategic planning, improving training, and strengthening collaboration with public actors. By aligning safety efforts with long-term business goals, logistics providers can enhance both operational performance and social responsibility. These results contribute to global discussions on sustainable logistics by supporting key Sustainable Development Goals, including SDG 3.6 (road safety), SDG 8.8 (safe working environments), SDG 9.1 (sustainable infrastructure), and SDG 11.2 (safe and accessible transport).



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1. Introduction

Traffic accidents represent a critical public health challenge worldwide, responsible for approximately 1.3 million deaths and 20 to 50 million injuries each year. Vulnerable populations, including children, adolescents, and individuals in developing countries, are disproportionately affected [1]. In Brazil, heavy vehicles represent approximately 5% of the total fleet but are involved in a substantial proportion of traffic accidents and fatalities, accounting for nearly 47% of deaths on federal highways [2]. This highlights the significant role of logistics operations, particularly those involving trucks and trailers, in traffic safety outcomes on these roadways. These accidents generate not only human suffering but also substantial economic losses due to vehicle downtime, cargo damage, insurance claims, and reputational risks for logistics providers [3,4].

While road safety has been a global priority for decades, research focused specifically on road safety management within logistics companies remains limited. Most studies

prioritize individual driver behavior [5], environmental conditions such as weather [6], or public policy and technological infrastructure [7,8]. In parallel, international standards such as ISO 45001:2018 and ISO 39001:2012 [9,10] highlight the importance of structured safety management systems, providing organizations with frameworks to systematically reduce risks, strengthen corporate accountability, and enhance road safety performance in transport and logistics operations; however, in many developing countries, awareness and adoption of these standards remain less widespread [7,8]. This leaves an important gap in understanding how logistics companies, as organizations, manage road safety within their internal strategies, and highlights the relevance of examining how companies in Brazil approach road safety management, providing insights into both local challenges and opportunities for aligning with international best practices.

Despite the recognition of road safety as part of broader corporate social responsibility (CSR) and sustainability frameworks [11], companies in the logistics sector often overlook its strategic value. Integrating safety into logistics operations can enhance performance, reduce costs, and align with global goals such as the United Nations Sustainable Development Goals (SDGs) [12]. Nonetheless, recent studies indicate that road safety management is a crucial aspect of socially responsible logistics and can safeguard operational integrity, enhance value, and improve customer loyalty [13,14].

This study aims to fill the existing research gap by developing and validating a conceptual model to identify and analyze the key practices, motivators, and barriers that influence road safety management in Brazilian logistics companies. The objective is to understand how these factors shape safety performance and to provide actionable strategies for improvement. To achieve this, we adopted a mixed-methods approach: first, we collected qualitative insights from academic experts, and then we validated these findings through a quantitative survey with logistics professionals from across Brazil. The results generate both theoretical contributions, by advancing the understanding of road safety management in the logistics sector, and practical implications, offering evidence-based guidance to enhance safety outcomes and align logistics operations with broader sustainability and social responsibility goals.

2. Theoretical Background

Traffic safety has become a central concern for businesses, society, and public policymakers, as road accidents generate social, economic, and health impacts on a global scale. The increasing frequency of accidents involving food delivery drivers, for example, has sparked debates about the corporate social responsibility (CSR) of digital platforms. In response, some of these companies have begun adopting specific strategies, such as extending delivery times under the platform's own responsibility or through consumer empowerment, in addition to requiring workers' compensation insurance. However, questions remain regarding the effectiveness of these measures in effectively reducing risks to drivers. Research based on the Hotelling model suggests that differentiated CSR strategies, such as offering extended delivery times, can reduce risks without compromising profitability and generate collective benefits for consumers, workers, and businesses [15].

In the technological field, advances related to autonomous vehicles have been identified as promising alternatives for improving efficiency, safety, and sustainability. The integration of computer vision systems, such as YOLOv8 for real-time pothole detection, has proven capable of reducing accidents, minimizing infrastructure maintenance costs, and aligning with CSR principles. This innovation highlights the synergy between technology, corporate responsibility, and road safety, paving the way for ethical and resilient transportation [16].

The economic dimension of accidents is also noteworthy. Research conducted in Poland between 2014 and 2020 demonstrated that work incapacity resulting from road accidents generates significant losses for companies, even outside the transportation sector. The costs, which reached PLN 1.6 million, reveal that the effects of lost productivity impact different sectors of the economy, reinforcing the need for occupational health policies and corrective instruments that align social costs and collective benefits. In this sense, strategies such as life insurance and initiatives to support worker recovery are identified as central elements of corporate CSR [17].

From an organizational perspective, recent studies on logistics service providers in Brazil analyze road safety management from three dimensions: safety practices (formal and informal actions, such as driver training, vehicle monitoring, and infrastructure investments), drivers (economic incentives, regulatory compliance, customer expectations, and corporate values), and barriers (financial constraints, institutional limitations, and inflexible operational structures). Understanding these elements is crucial, as the logistics sector relies heavily on road transportation and faces high accident risks. Furthermore, safety practices in the sector directly contribute to the Sustainable Development Goals (SDGs), particularly SDG 3.6 (reduction in road traffic deaths and injuries), SDG 8.8 (safe and secure working environments), and SDG 11.2 (safe and sustainable transport). Investments in innovation and infrastructure align with SDG 9.1, while strategic partnerships to promote safety reinforce SDG 17.17.

From a global perspective, unintentional injuries, including traffic accidents, remain a leading cause of disability and death. Although the SDG agenda recognizes road safety in specific targets, its relevance is cross-cutting and connects to broader challenges, such as urbanization, population displacement, and environmental sustainability. Therefore, injury prevention needs to be integrated into diverse sectoral policies, strengthening the “Injury Prevention in All Policies” approach. In this context, road safety and corporate social responsibility become strategic elements not only to protect lives and reduce costs, but also to align organizations with the global sustainable development goals.

In this context, this study adopts an organizational perspective to analyze road safety management in Brazilian logistics providers. We build on three core analytical dimensions:

- Safety practices: Defined as formal or informal actions, systems, and policies adopted by logistics companies to reduce traffic risks in their operations—including driver training, vehicle monitoring, infrastructure investment, and compliance measures [5].
- Motivators: Internal or external factors that encourage companies to adopt safety practices, such as economic incentives, regulatory compliance, customer expectations, or corporate values [18,19].
- Barriers: Organizational, financial, or institutional factors that hinder the implementation of effective road safety measures—including lack of resources, limited awareness, or inflexible operational structures [20].

Road safety research focused on logistics companies is essential to reduce accidents, save lives, and increase operational efficiency, while contributing to the achievement of several Sustainable Development Goals (SDGs). In the context of logistics, where road transport is intensive and accident risks are high, safe practices directly impact SDG 3.6 (reduction in road traffic deaths and injuries), SDG 8.8 (safe and secure working environments), and SDG 11.2 (access to safe, accessible, and sustainable transport systems). Furthermore, investments in infrastructure and technological innovation align with SDG 9.1, while strategic partnerships to improve safety are part of SDG 17.17. Thus, understanding the sector’s specific drivers, practices, and barriers not only strengthens companies’ competitiveness and social responsibility but also aligns corporate actions with global sustainable development goals [1].

3. Method

This research adopted a sequential mixed-methods design, combining qualitative and quantitative techniques to gain a comprehensive understanding of road safety management in logistics operations. The use of mixed methods is well established in organizational and operations management studies, as it allows for the integration of in-depth expert perspectives with empirical validation in real-world contexts [21].

3.1. Phase 1: Qualitative Expert Survey

The first phase aimed to identify potential practices, motivators, and barriers related to road safety in logistics companies. A semi-structured questionnaire was developed based on previous literature on road safety, sustainable logistics, and CSR [22–24], and included open-ended questions organized into three main categories:

- (i) Road safety practices observed or recommended in logistics;
- (ii) Motivational factors leading companies to adopt such practices;
- (iii) Perceived barriers limiting implementation.

The survey was pre-tested with three logistics scholars to ensure clarity and relevance. Data were collected using Google Forms from 18 academic experts affiliated with Brazilian universities and research institutions. These experts were selected using purposive sampling, based on their publication record and technical expertise in logistics, safety, and sustainability. Importantly, their role was consultative and did not influence the research design or results.

Responses were analyzed using the ATLAS.ti software (version 9.0.24), following a conventional content analysis approach [25]. Two independent coders carried out iterative coding cycles. Coding consistency was ensured through comparison and consensus meetings. As a result, 43 relevant variables were identified (13 practices, 15 motivators, and 15 barriers). These were transformed into 62 clear statements for the quantitative phase, capturing nuances and expanding on the original expert input.

3.2. Phase 2: Quantitative Survey with Industry Professionals

The second phase aimed to validate the identified variables through a structured online questionnaire distributed to logistics professionals across Brazil. The 62 statements were grouped by dimension (practices, motivators, and barriers) and rated on a five-point Likert scale, ranging from 1 (“Strongly Disagree”) to 5 (“Strongly Agree”).

The questionnaire was hosted on the QuestionPro platform and pre-tested by seven researchers in logistics and safety management. After refinement, it was distributed via industry associations, LinkedIn, and professional networks. Although the survey was not open to the public, participants were recruited through professional channels with an emphasis on individuals in decision-making or safety-related roles, such as logistics managers, safety officers, and operational directors.

The analyses were performed in three separate blocks: motivators (14 variables), barriers (14 variables), and practices (13 variables). For each block, a separate exploratory factor analysis was performed, with a sample of 104 responses for each block, complying with the formality of 5 responses per variable [26].

The questionnaires used in phase 1 and phase 2 are presented in the Supplementary Material.

3.3. Data Analysis

Descriptive statistics (means, standard deviations) were calculated for all variables. Sampling adequacy was tested using the Kaiser–Meyer–Olkin (KMO) test, with all three dimensions showing high adequacy (practices = 0.876, motivators = 0.905, barriers = 0.875) [27]. Internal consistency was assessed through Cronbach’s alpha, with

results above 0.89 for all dimensions, indicating strong reliability all within the acceptable range of 0.70–0.95 [28].

Spearman's correlation coefficients were calculated to explore relationships between variables [26]. Subsequently, an Exploratory Factor Analysis (EFA) using Principal Component Analysis with Varimax rotation was performed. Factors were retained based on the eigenvalue > 1 criterion and factor loadings ≥ 0.5 . Communalities averaged 0.527, within acceptable ranges (0.4 to 0.7) for factor retention [29]. The goal was to reduce dimensionality and identify latent constructs underlying each group of variables. The statements representing 43 core variables were grouped by theoretical category (practices, motivators, barriers). Of the extracted variables, 13 relate to practices, 15 to motivators, and 15 to barriers. Factor analyses were performed by each category individually, making them suitable for factor analysis given the sample size [30]. Ref. [31] presents a study on a minimum sample size for factor analysis, ranging from approximately 5 (five) to 20 (twenty) respondents per analysis variable. However, they emphasize that case-by-case adequacy is appropriate and that additional adequacy tests, such as Cronbach's Alpha, should be used to estimate the reliability of the questionnaire items [26,32].

Other goodness-of-fit tests performed included the Kaiser–Meyer–Olkin test, Bartlett's test of sphericity, and consequently, communalities and eigenvalues to verify the suitability of the data for factor analysis and the correlation of variables within the population (e.g., [33]). In studies by [34] on factors that affect the quality of factor solutions in exploratory factor analysis, communality is closely related to the quality of factor extraction. In agreement with the propositions of [35], they argue that a high number of communalities can maintain the quality of factor extraction even with small samples.

In addition to the limits proposed by [26], other authors, such as Schreiber (2021) [27], point to greater confidence in the Kaiser–Meyer–Olkin (KMO), whose values between 0.8 and 0.9 are considered meritorious, and values above 0.9 are considered excellent. This includes the data from this study, both for practices (KMO 0.876), motivators (KMO 0.905), and barriers (KMO 0.875), all with significant Bartlett's test. According to [26], KMO is particularly suitable for a low relationship between observed cases and variables.

According to [28], the alpha coefficient was developed to provide a measure of the internal consistency of a test or scale and is frequently calculated in medical education research in situations that require measurement of items that comprise a concept or construct. The values calculated for this study are considered adequate by the authors, since they show that values between 0.70 and 0.95 are acceptable values

All statistical analyses were conducted using IBM SPSS v.27.

The SWOT analysis was carried out by integrating the answers to the open questions from the first phase of the questionnaire with the statistical results of the questionnaire applied in the second phase. Internal strengths and weaknesses were identified based on reported motivators, practices, and barriers, while external opportunities and threats were derived from environmental factors such as partnerships and resource availability. This framework synthesized key elements like economic incentives and implementation challenges, complementing the empirical findings. The analysis helped contextualize factors relevant to road safety management in logistics and informed practical recommendations aligned with the study's results.

4. Results

The qualitative survey analysis resulted in a coding system representing key concepts provided by academic experts. The road safety management practices with the highest mentions included promoting educational actions, training, and awareness measures for road safety (P11), followed by adopting new technologies and vehicle automation

(P1). The motivator element with the most references was the avoidance of economic and material damage and operational improvement (M7), followed by educational and awareness campaigns (M2). The barriers with the highest mentions were related to high implementation costs (B1), followed by a lack of information and awareness (B6).

4.1. Descriptive Statistics

The quantitative survey results revealed an average score of 3.792 across all variables, with a range from 3.519 to 4.029. The variance was 1.072, and the standard deviation was 1.023, with a minimum value of 0.858. The relatively higher mean values suggest a stronger consensus among respondents regarding the variables, given the 5-point Likert scale used, where 1 indicates strong disagreement and 5 indicates strong agreement.

The results described in Table 1 are directly related to the reality of companies and logistics professionals, as they reflect central aspects of operations and risk management in road transportation. The emphasis on evidence-based practices and infrastructure strengthening (P5, P6, P9) demonstrates that data-driven strategic decisions and targeted investments in critical highway points can reduce accidents, optimize routes, and increase delivery reliability. The highest-rated motivators, such as external incentives (M10), workforce readiness (M11), and proper cargo handling (M13), reveal the importance of policies and training that prepare drivers and crews to handle complex operational demands, preserving both the integrity of goods and the safety of all involved. On the other hand, the identified barriers—resource limitations (B9), lack of incentives (B13), and concerns about operational flexibility (B12)—indicate that, even when aware of the benefits, companies face financial and operational constraints that hinder the full adoption of safety measures. Therefore, understanding and overcoming these barriers is essential for logistics managers to align operational efficiency and road safety, strengthening competitiveness and compliance with national and international standards.

Table 1. Descriptive statistics of the variables.

Code	Variable	Mean	Standard Deviation	Variance
B9	Lack of resources and infrastructure	4.029	0.939	0.883
P5	Developing studies and research	3.971	0.980	0.960
P6	Development of infrastructure and services at strategic points on the highway	3.971	1.009	1.019
P9	Implementing a well-structured road safety system	3.971	1.019	1.038
B13	Lack of incentives for implementation	3.962	0.858	0.736
M10	External incentives such as tax benefits and standardization	3.952	0.969	0.939
B12	Loss of flexibility	3.942	0.868	0.754
P2	Adopting practices focused on driver rest and occupational safety	3.933	1.026	1.054
P11	Promoting educational actions, training, and awareness measures for road safety	3.933	0.958	0.918
P10	Public policies and regulations for road safety	3.913	0.956	0.915
P8	Ensuring and monitoring compliance with legislation and traffic rules	3.904	0.961	0.923
B5	Lack of enforcement and monitoring	3.894	0.913	0.833
B2	Lack of safety culture and prevention	3.885	1.017	1.035
P4	Assessing driver risk profiles	3.875	1.030	1.062
P1	Adopting new technologies and vehicle automation	3.856	0.980	0.960
B6	Lack of information and awareness	3.837	1.089	1.187
B7	Lack of long-term perspective	3.837	0.977	0.954
B8	Lack of public policies aligned with technology and the market	3.837	0.996	0.992
P12	Using or publishing environmental, accident, and/or road safety performance indicators	3.827	0.999	0.999
M11	Motivated, well-prepared, and trained drivers and employees	3.827	0.950	0.902
M13	Concern for cargo, wear and maintenance	3.827	1.161	1.348
B10	Lack of governance systems and appropriate guidelines	3.808	0.986	0.972
M2	Educational and awareness campaigns	3.798	1.144	1.308
M9	The existence of systems and culture focused on road safety	3.798	0.969	0.939
M12	Proper planning of time and route	3.798	1.028	1.056
B4	Lack of support for driver rest	3.798	1.037	1.075
M6	Avoiding legal and political costs (such as damage to the company's image)	3.788	1.146	1.314
M3	Demand for punctuality	3.76	1.057	1.116
M7	Avoiding economic and material damage and improving operations	3.721	1.127	1.271

Table 1. *Cont.*

Code	Variable	Mean	Standard Deviation	Variance
B3	Low availability of specialized road safety companies	3.721	0.970	0.941
B11	Loss of operational efficiency	3.721	1.047	1.096
B14	Pressure for punctuality	3.712	1.030	1.062
P3	Adopting monitoring systems	3.673	1.110	1.232
M4	Availability and studies on renewable fuels	3.663	1.048	1.099
B1	High implementation costs	3.644	1.114	1.241
P7	Promoting shared use and non-motorized modes of transportation	3.625	1.054	1.110
M8	Existence of legislation, public policies, and regulation	3.625	1.054	1.110
M14	Promoting good practices, sustainability, and social responsibility	3.625	1.054	1.110
B15	Complex or overly bureaucratic processes	3.596	1.057	1.117
M15	Conducting evaluation, monitoring, and using road safety indicators	3.587	1.076	1.157
M1	Enhancing the integration of the company	3.558	1.022	1.045
P13	Using renewable fuels and eco-driving	3.519	1.166	1.359
M5	Avoiding costs of employee training due to accidents	3.519	1.043	1.087

These findings directly address the research objectives by identifying the most salient practices, motivators, and barriers impacting road safety management in logistics companies, thus providing a targeted basis for improving sustainability and social responsibility in this sector.

4.2. Correlation Analysis

Among the seventy-eight correlations tested across variables, most were statistically significant—sixty-four at $p < 0.01$ and nine at $p < 0.05$ —while five were not significant. Despite this high significance, only a limited number of correlations reached moderate strength (r between 0.4 and 0.69, by [31]), indicating that although many factors are related, they often operate somewhat independently.

Within road safety management practices, two moderate correlations stand out. The first is between implementing a well-structured road safety system (P9) and supportive public policies and regulations (P10), with $r = 0.516$, underscoring the critical role of regulatory frameworks in practice adoption. The second is between enforcement efforts (P8) and education and awareness measures (P11), with $r = 0.503$, highlighting the interdependence of compliance and training initiatives.

Regarding motivators, five correlations exceeded 0.5. Educational and awareness campaigns (M2) correlated moderately with the existence of legislation and public policies (M8, $r = 0.526$) and with proper planning of time and route (M12, $r = 0.564$). The latter (M12) also correlated with motivated and well-trained drivers and employees (M11, $r = 0.506$). Additional moderate correlations include the relationship between the existence of systems and a culture focused on road safety (M9) and concern for cargo, wear, and maintenance (M13, $r = 0.522$), as well as between promoting good practices, sustainability, and social responsibility (M14) conducting evaluation, monitoring, and use of safety indicators (M15, $r = 0.504$).

Among the barriers to road safety management, two moderate correlations were notable. The absence of safety culture and prevention (B2) correlated both the lack of information and awareness (B6) and operational efficiency loss (B11). Furthermore, operational efficiency loss (B11) showed a moderate correlation with pressure for punctuality (B14), reflecting how organizational pressures can affect safety culture and operational performance as shown in Table 2.

Table 2. Correlation matrix of variables related to Road Safety Management Practices, Motivators and Barriers.

Road Safety Management Practices Correlation Matrix															
	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13		
P1	1														
P2	0.406 **	1													
P3	0.457 **	0.462 **	1												
P4	0.310 **	0.472 **	0.327 **	1											
P5	0.246 *	0.473 **	0.401 **	0.248 *	1										
P6	0.396 **	0.453 **	0.452 **	0.270 **	0.404 **	1									
P7	0.265 **	0.183	0.220 *	0.276 **	0.299 **	0.159	1								
P8	0.325 **	0.488 **	0.285 **	0.348 **	0.337 **	0.469 **	0.0125	1							
P9	0.497 **	0.420 **	0.477 **	0.240 *	0.458 **	0.325 **	0.259 **	0.422 **	1						
P10	0.433 **	0.460 **	0.326 **	0.383 **	0.378 **	0.420 **	0.397 **	0.461 **	0.516 **	1					
P11	0.411 **	0.431 **	0.446 **	0.410 **	0.408 **	0.447 **	0.241 *	0.503 **	0.353 **	0.377 **	1				
P12	0.320 **	0.392 **	0.368 **	0.442 **	0.289 **	0.286 **	0.276 **	0.314 **	0.355 **	0.477 **	0.260 **	1			
P13	0.472 **	0.356 **	0.246 *	0.199 *	0.222 *	0.185	0.240 *	0.152	0.346 **	0.254 **	0.312 **	0.333 **	1		
Road Safety Management Motivators Correlation Matrix															
	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	M13	M14	M15
M1	1														
M2	0.313 **	1													
M3	0.448 **	0.193 *	1												
M4	0.487 **	0.354 **	0.415 **	1											
M5	0.289 **	0.204 *	0.399 **	0.357 **	1										
M6	0.223 *	0.348 **	0.404 **	0.305 **	0.368 **	1									
M7	0.268 **	0.259 **	0.316 **	0.199 *	0.404 **	0.430 **	1								
M8	0.239 *	0.526 **	0.275 **	0.314 **	0.283 **	0.328 **	0.256 **	1							
M9	0.270 **	0.294 **	0.353 **	0.228 *	0.378 **	0.336 **	0.343 **	0.328 **	1						
M10	0.388 **	0.413 **	0.326 **	0.380 **	0.258 **	0.458 **	0.364 **	0.431 **	0.436 **	1					
M11	0.191	0.488 **	0.205 *	0.236 *	0.18	0.231 *	0.264 **	0.405 **	0.372 **	0.304 **	1				
M12	0.221 *	0.564 **	0.272 **	0.371 **	0.19	0.358 **	0.328 **	0.483 **	0.363 **	0.438 **	0.506 **	1			
M13	0.237 *	0.494 **	0.338 **	0.245 *	0.238 *	0.405 **	0.244 *	0.343 **	0.522 **	0.414 **	0.486 **	0.436 **	1		
M14	0.302 **	0.402 **	0.304 **	0.416 **	0.298 **	0.296 **	0.352 **	0.296 **	0.351 **	0.480 **	0.291 **	0.484 **	0.362 **	1	
M15	0.193 *	0.370 **	0.260 **	0.236 *	0.151	0.311 **	0.232 *	0.329 **	0.341 **	0.390 **	0.368 **	0.486 **	0.428 **	0.504 **	1
Road Safety Management Barriers Correlation Matrix															
	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12	B13	B14	B15
B1	1														
B2	0.246 *	1													
B3	0.379 **	0.344 **	1												
B4	0.370 **	0.341 **	0.156	1											
B5	0.169	0.391 **	0.322 **	0.240 *	1										
B6	0.310 **	0.502 **	0.329 **	0.322 **	0.318 **	1									
B7	0.337 **	0.445 **	0.237 *	0.338 **	0.304 **	0.300 **	1								
B8	0.248 *	0.214 *	0.444 **	0.201 *	0.230 *	0.310 **	0.398 **	1							
B9	0.333 **	0.363 **	0.438 **	0.379 **	0.381 **	0.439 **	0.511 **	0.333 **	1						
B10	0.324 **	0.404 **	0.294 **	0.251 *	0.244 *	0.348 **	0.286 **	0.353 **	0.298 **	1					
B11	0.374 **	0.507 **	0.386 **	0.314 **	0.359 **	0.249 *	0.406 **	0.334 **	0.217 *	0.284 **	1				
B12	0.213 *	0.324 **	0.392 **	0.284 **	0.206 *	0.256 **	0.294 **	0.329 **	0.330 **	0.450 **	0.322 **	1			
B13	0.283 **	0.545 **	0.344 **	0.311 **	0.377 **	0.448 **	0.382 **	0.206 *	0.518 **	0.271 **	0.464 **	0.205 *	1		
B14	0.383 **	0.420 **	0.448 **	0.270 **	0.444 **	0.307 **	0.348 **	0.251 *	0.341 **	0.413 **	0.525 **	0.392 **	0.356 **	1	
B15	0.291 **	0.226 *	0.217 *	0.379 **	0.309 **	0.252 **	0.339 **	0.217 *	0.394 **	0.352 **	0.459 **	0.376 **	0.338 **	0.464 **	1

* Significant correlation at $p < 0.05$ (two-tailed). ** Significant correlation at $p < 0.01$ (two-tailed).

4.3. Factor Analysis

An exploratory factor analysis (EFA) was conducted to identify latent variables and group related items within the dataset. The number of factors to be extracted was determined using the eigenvalue criterion [36]. To facilitate interpretation and simplify the factor structure, Varimax orthogonal rotation with Kaiser normalization was applied, a method widely recognized for its effectiveness [23]. Variables with factor loadings above 0.5 were retained for analysis. Table 3 shows the detailed factors loading for each variable grouped by practices, motivators, and barriers. Table 4 presents the values of communalities, KMO and Bartlett, and Alpha coefficient.

Table 3. Factor composition for each group of variables.

Code	Variable	Components		
		Factor 1	Factor 2	Factor 3
Practices				
P1	Adopting new technologies and vehicle automation	0.490	0.515	n.d.
P2	Adopting practices focused on driver rest and occupational safety	0.714	0.337	n.d.
P3	Adopting monitoring systems	0.634	0.293	n.d.
P4	Assessing driver risk profiles	0.591	0.292	n.d.
P5	Developing studies and research	0.638	0.254	n.d.
P6	Development of infrastructure and services at strategic points on the highway	0.758	0.035	n.d.
P7	Promoting shared use and non-motorized modes of transportation	0.071	0.682	n.d.
P8	Ensuring and monitoring compliance with legislation and traffic rules	0.787	−0.031	n.d.
P9	Implementing a well-structured road safety system	0.632	0.393	n.d.
P10	Public policies and regulations for road safety	0.623	0.388	n.d.
P11	Promoting educational actions, training, and awareness measures for road safety	0.673	0.237	n.d.
P12	Using or publishing environmental, accident, and/or road safety performance indicators	0.435	0.519	n.d.
P13	Using renewable fuels and eco-driving	0.127	0.760	n.d.
Motivators				
M1	Enhancing the integration of the company	0.110	0.183	0.789
M2	Educational and awareness campaigns	0.704	0.097	0.355
M3	Demand for punctuality	0.105	0.552	0.486
M4	Availability and studies on renewable fuels	0.234	0.169	0.770
M5	Avoiding costs of employee training due to accidents.	0.013	0.746	0.271
M6	Avoiding legal and political costs (such as damage to the company’s image)	0.328	0.674	0.124
M7	Avoiding economic and material damage and improving operations	0.282	0.671	0.099
M8	Existence of legislation, public policies, and regulation	0.598	0.255	0.254
M9	The existence of systems and culture focused on road safety	0.545	0.489	0.068
M10	External incentives such as tax benefits and standardization	0.455	0.320	0.455
M11	Motivated, well-prepared, and trained drivers and employees	0.753	0.150	0.015
M12	Proper planning of time and route	0.758	0.148	0.244
M13	Concern for cargo, wear and maintenance	0.710	0.282	0.053
M14	Promoting good practices, sustainability, and social responsibility	0.491	0.145	0.500
M15	Conducting evaluation, monitoring, and using road safety indicators	0.636	0.086	0.196
Barriers				
B1	High implementation costs	0.421	0.371	n.d.
B2	Lack of safety culture and prevention	0.710	0.298	n.d.
B3	Low availability of specialized road safety companies	0.413	0.477	n.d.
B4	Lack of support for driver rest	0.476	0.338	n.d.
B5	Lack of enforcement and monitoring	0.585	0.257	n.d.
B6	Lack of information and awareness	0.730	0.156	n.d.
B7	Lack of long-term perspective	0.564	0.387	n.d.
B8	Lack of public policies aligned with technology and the market	0.314	0.503	n.d.
B9	Lack of resources and infrastructure	0.677	0.316	n.d.
B10	Lack of governance systems and appropriate guidelines	0.246	0.619	n.d.
B11	Loss of operational efficiency	0.390	0.615	n.d.
B12	Loss of flexibility	0.056	0.763	n.d.
B13	Lack of incentives for implementation	0.781	0.141	n.d.
B14	Pressure for punctuality	0.318	0.673	n.d.
B15	Complex or overly bureaucratic processes	0.243	0.653	n.d.

Extraction based on principal component analysis. Varimax rotation with Kaiser normalization. n.d.: non determined.

Table 4. Values of communalities, KMO and Bartlett, and Alpha coefficient.

	Cod.	Commonalities	KMO	Bartlett (<0.001)	Alpha
Practices	P1	0.505	0.876	530.375	0.891
	P2	0.623			
	P3	0.488			
	P4	0.434			
	P5	0.472			
	P6	0.576			
	P7	0.47			
	P8	0.621			
	P9	0.554			
	P10	0.539			
	P11	0.509			
	P12	0.458			
	P13	0.594			

Table 4. *Cont.*

	Cod.	Commonalities	KMO	Bartlett (<0.001)	Alpha
Motivators	M1	0.668	0.905	581.033	0.896
	M2	0.632			
	M3	0.552			
	M4	0.676			
	M5	0.63			
	M6	0.577			
	M7	0.54			
	M8	0.487			
	M9	0.541			
	M10	0.517			
	M11	0.59			
	M12	0.655			
	M13	0.586			
	M14	0.512			
	M15	0.45			
Barriers	B1	0.314	0.875	576.883	0.895
	B2	0.593			
	B3	0.398			
	B4	0.341			
	B5	0.409			
	B6	0.557			
	B7	0.468			
	B8	0.351			
	B9	0.558			
	B10	0.443			
	B11	0.53			
	B12	0.586			
	B13	0.63			
	B14	0.555			
	B15	0.485			

4.3.1. Factors for Practice's Variables

Table 5 summarizes the formation of two main factors identified within the Practices group through exploratory factor analysis: Factor 1—Infrastructure of Operation and Factor 2—Innovation Aspects.

Table 5. Factors formation for Practices' variables.

Factor 1—Practices—Infrastructure of Operation		
Code.	Name	Load
P8	Ensuring and monitoring compliance with legislation and traffic rules	0.787
P6	Development of infrastructure and services at strategic points on the highway	0.758
P2	Adopting practices focused on driver rest and occupational safety	0.714
P11	Promoting educational actions, training, and awareness measures for road safety	0.673
P5	Developing studies and research	0.638
P3	Adopting monitoring systems	0.634
P9	Implementing a well-structured road safety system	0.632
P10	Public policies and regulations for road safety	0.623
P4	Assessing driver risk profiles	0.591
Factor 2—Practices—Innovation		
Code	Name	Load
P13	Using renewable fuels and eco-driving	0.760
P7	Promoting shared use and non-motorized modes of transportation	0.682
P12	Using or publishing environmental, accident, and/or road safety performance indicators	0.519
P1	Adopting innovative technologies and vehicle automation	0.515

The Infrastructure of Operation factor groups variables related to operational setup and safety compliance. Top contributors to this factor include ensuring compliance with legislation and traffic rules (P8), infrastructure development at strategic points (P6), and driver rest and occupational safety practices (P2). This factor also encompasses internal

management through education, training, and monitoring systems (P11, P5, P3), as well as structured road safety system implementation and public policies (P9, P10).

The Innovation Aspects factor emphasizes newer and environmentally oriented practices. The highest loading is on the use of renewable fuels and eco-driving (P13), highlighting environmental consciousness. It also includes promoting shared and non-motorized transport modes (P7), adopting vehicle automation (P1), and using performance indicators related to environment and safety (P12), connecting innovation to sustainability and data-driven management.

4.3.2. Factors for Motivator's Variables

Table 6 presents an overview of the three factors identified within the motivators category that influence road safety management among logistics providers. These factors represent the underlying dimensions driving these organizations to adopt effective safety practices, with each factor comprising specific variables whose loadings reflect their relative contribution.

Table 6. Factors formation for Motivators' variables.

Factor 1—Motivators—Planning, Awareness, and Organizational Support		
Code	Name	Load
M12	Proper planning of time and route	0.758
M11	Motivated, well-prepared, and trained drivers and employees	0.753
M13	Concern for cargo, wear and maintenance	0.710
M2	Educational and awareness campaigns	0.704
M15	Conducting evaluation, monitoring, and using road safety indicators	0.636
M8	Existence of legislation, public policies, and regulation	0.598
M9	The existence of systems and culture focused on road safety	0.545
Factor 2—Motivators—Economic and Financial Motivations		
Code	Name	Load
M5	Avoiding costs of employee training due to accidents	0.746
M6	Avoiding legal and political costs (such as damage to the company's image)	0.674
M7	Avoiding economic and material damage and improving operations	0.671
M3	Demand for punctuality	0.552
Factor 3—Motivators—Knowledge Sharing, Integration, and Sustainability		
Code	Name	Load
M1	Enhancing the integration of the company	0.789
M4	Availability and studies on renewable fuels	0.770
M14	Promoting good practices, sustainability, and social responsibility	0.500

Factor 1, labeled Planning, Awareness, and Organizational Support, captures the importance of structured planning, organizational commitment, and awareness-raising efforts in promoting road safety among logistics providers. The highest loading within this factor is proper planning of time and route (M12, loading 0.758), indicating that well-structured logistical management is essential for minimizing operational risks. Closely following is the motivator related to having motivated, well-prepared, and trained drivers and employees (M11, loading 0.753), which underscores the critical role of workforce capacity and preparedness in ensuring safe operations. Concern for cargo, wear, and maintenance (M13, loading 0.710) further highlights how operational and fleet management decisions contribute to safety outcomes. Educational and awareness campaigns (M2, loading 0.704) reinforce the significance of knowledge dissemination and promote a proactive safety culture within logistics firms. Additional motivators in this factor include conducting evaluation, monitoring, and using road safety indicators (M15, loading 0.636), emphasizing data-driven management practices, as well as the existence of legislation, public policies, and regulations (M8, loading 0.598), and a strong organizational culture focused on road

safety (M9, loading 0.545), both of which provide institutional support for implementing safety measures.

Factor 2, named Economic and Financial Motivations, reflects how economic considerations shape road safety management decisions among logistics providers. The highest loading in this factor is avoiding costs associated with employee training due to accidents (M5, loading 0.746), demonstrating that the financial implications of accidents extend beyond direct losses to include indirect costs such as additional training. Avoiding legal and political costs, such as damage to the company's image (M6, loading 0.674), and avoiding economic and material damage while improving operations (M7, loading 0.671) further underscore how risk management and operational efficiency are intertwined with safety investments. Although demand for punctuality (M3, loading 0.552) shows the lowest loading in this factor, it remains relevant, as punctuality influences customer satisfaction and competitiveness, indirectly affecting financial performance.

Factor 3, defined as Knowledge Sharing, Integration, and Sustainability, comprises motivators that reflect organizational integration, cross-functional collaboration, and sustainable development. The highest loading within this factor is enhancing the integration of the company (M1, loading 0.789), which indicates the importance of stimulating alignment across departments to strengthen safety practices. Availability and studies on renewable fuels (M4, loading 0.770) suggest that sustainability initiatives, such as the adoption of alternative energy sources, are increasingly embedded within road safety strategies of logistics providers. Promoting good practices, sustainability, and social responsibility (M14, loading 0.500), while having a relatively lower loading, still plays a significant role by emphasizing the broader context of corporate responsibility, which influences safety management by promoting a culture of shared responsibility and long-term planning.

In summary, the factor analysis of motivators reveals three core dimensions that drive the adoption of road safety management practices among logistics providers: planning, awareness, and organizational support, which emphasizes structured preparation and workforce development; economic and financial motivations, which highlight the importance of cost avoidance and operational efficiency; and knowledge sharing, integration, and sustainability, which reflect the integration of collaborative and environmentally responsible approaches into safety management. These findings provide a comprehensive understanding of the multifaceted drivers shaping effective safety strategies within the logistics sector.

4.3.3. Factors for Barriers' Variables

The factor analysis of barriers to road safety management among logistics providers revealed two distinct underlying factors, each consisting of multiple variables that hinder effective implementation of safety measures. Compared to the analysis of practices and motivators, where only one variable did not significantly contribute to factor formation, the barriers group showed a slightly different pattern, with three variables failing to contribute meaningfully, leading to a more balanced distribution of the remaining items (Table 7).

The first factor identified can be described as reflecting barriers related to motivation and organizational commitment to road safety. Within this factor, the variable with the highest loading is the lack of incentives for implementation (B13), with a factor loading of 0.781, highlighting how the absence of clear rewards or drivers for adopting road safety initiatives remains a substantial impediment for logistics providers. The next highest contributor is the lack of information and awareness (B6), with a loading of 0.730, which underscores that insufficient dissemination of knowledge about the benefits and requirements of safety practices negatively influences organizational decision-making and priority-setting processes. The lack of safety culture and prevention (B2), loading at 0.710, further reinforces the

challenge of embedding safety principles into organizational values and daily operations when a robust safety culture is absent.

Table 7. Factors formation for Barriers' variables.

Factor 1—Barriers—Motivation		
Code	Name	Load
B13	Lack of incentives for implementation	0.781
B6	Lack of information and awareness	0.73
B2	Lack of safety culture and prevention	0.71
B9	Lack of resources and infrastructure	0.677
B5	Lack of enforcement and monitoring	0.585
B7	Lack of long-term perspective	0.564
Factor 2—Barriers—Operational Responsiveness		
Code	Name	Load
B12	Loss of flexibility	0.763
B14	Pressure for punctuality	0.673
B15	Complex or overly bureaucratic processes	0.653
B10	Lack of governance systems and appropriate guidelines	0.619
B11	Loss of operational efficiency	0.615
B8	Lack of public policies aligned with technology and the market	0.503

Other variables contributing to this first factor include the lack of resources and infrastructure (B9), with a loading of 0.677, and the lack of enforcement and monitoring (B5), with a loading of 0.585. These results highlight that logistical and infrastructural limitations, alongside weak enforcement systems, undermine the ability to maintain consistent and effective safety practices. Additionally, the lack of a long-term perspective (B7), loading at 0.564, suggests that an overemphasis on short-term operational objectives limits the sustainability and continuous improvement of road safety management efforts among logistics providers.

The second factor derived from the analysis represents barriers related to operational responsiveness and efficiency within logistics organizations. The highest loading in this factor is observed for loss of flexibility (B12), with a factor loading of 0.763, indicating that operational rigidity, such as highly standardized or inflexible processes, acts as a significant barrier to integrating safety practices that require adaptive responses. Pressure for punctuality (B14), with a load of 0.673, emerged as the second most significant contributor, reflecting the tension between time-bound performance requirements and safety management, whereby prioritizing strict delivery schedules may compromise safety standards.

Complex or overly bureaucratic processes (B15), with a factor loading of 0.653, further illustrate operational constraints, as lengthy procedures and excessive formalities can hinder timely decision-making and slow the implementation of necessary safety interventions. Additional contributors to this factor include the lack of governance systems and appropriate guidelines (B10), loading at 0.619, which emphasizes how inadequate organizational structures and unclear safety protocols create gaps in accountability and execution, and the loss of operational efficiency (B11), with a loading of 0.615, highlighting the perceived or real trade-off between implementing safety measures and maintaining efficient operations. Finally, the lack of public policies aligned with technology and market needs (B8), loading at 0.503, indicates that misalignment between regulatory frameworks and the technological and operational realities of logistics providers limits the feasibility and effectiveness of adopting certain safety practices.

It is important to note that three variables did not contribute significantly to the formation of these two factors: high implementation costs (B1), low availability of specialized road safety companies (B3), and lack of support for driver rest (B4). Although these vari-

ables may still influence road safety management decisions, their lower factor loadings suggest they are not central barriers within the context of this study.

Overall, the two factors identified—motivation-related barriers and operational responsiveness barriers—capture the main challenges faced by logistics providers in implementing effective road safety management practices. Motivation barriers stem from the absence of incentives, limited information, and a weak safety culture, compounded by resource limitations and a lack of strategic vision. Responsiveness barriers arise from operational inflexibility, pressures for punctuality, bureaucratic complexities, and inadequate governance structures. Addressing both categories of barriers is essential to enabling logistics providers to adopt and sustain effective road safety measures that align with organizational goals, stakeholder expectations, and broader public safety objectives.

5. Discussion

The objective of this research was to identify key practices, motivators, and barriers influencing the development of road safety management within logistics providers. Although road safety has been recognized as a public health issue for nearly half a century [5] and promoted by multilateral organizations such as the [34] as well as major logistics companies like United Parcel Service in the EUA, concentrated studies on this topic from a management perspective remain scarce. This gap partly reflects the tendency of existing research to examine road safety from individual and collective perspectives, with limited focus on organizational approaches within logistics operations [6,37,38]. Moreover, dominant theories in Corporate Social Responsibility (CSR) and Sustainability have shifted attention towards environmental and social issues that rarely include road safety management [12–14,35], leaving this intersection underexplored.

The practices identified in this research can be broadly grouped into operational infrastructure and innovation. Practices related to operational infrastructure, such as ensuring compliance with legislation and traffic rules, developing infrastructure and services at strategic highway points, adopting driver rest and occupational safety practices, and promoting educational actions and training, reflect how logistics providers conceptualize infrastructure beyond physical road elements to include vehicles, services, standards, and organizational processes [39]. This aligns with [40], who examined road infrastructure from technical specifications to protective barriers, and with [41], who conceptualized infrastructure as a relational system supporting activities. The strong correlation between ensuring compliance with legislation (P8) and promoting road safety education (P11) supports the perspective of the legal standards are integral to effective training. Furthermore, the moderate correlation between implementing a well-structured road safety system (P9) and public policies and regulations (P10) emphasizes the relevance of open systems theory [42], which posits that systems interact with their environment to remain effective.

Innovation-related practices identified include adopting renewable fuels and eco-driving, promoting shared and non-motorized transportation modes, utilizing safety performance indicators, and implementing new technologies and vehicle automation. This finding is consistent with [43], who highlighted that innovation encompasses not only products but also management models and practices [5] explored the potential of systems like Vehicle of Things (VoT) and wireless sensor networks for affordable safety in autonomous vehicles, while [44], examined communication systems to improve transportation safety. Such innovations complement traditional infrastructure approaches, as demonstrated by Vision Zero in Sweden, which represents a radical policy transformation in road safety management [45]. Although innovation variables did not exhibit the same average and agreement values as infrastructure practices, their integration offers synergistic opportunities [46].

Motivators for adopting road safety management practices were grouped into planning, awareness, and organizational support; economic and financial motivations; and knowledge sharing, integration, and sustainability. The planning and organizational support factor highlights the importance of structured route planning, driver training, and operational care [47] emphasized that planning success is more influenced by organizational culture than by planning techniques, while ref. [48] argued that culture shapes planning behaviors. This study found strong correlations between well-prepared drivers (M11) and route planning (M12), and between planning and educational campaigns (M2), supporting [49], who suggested training and learning promote motivation and road safety.

The economic motivation factor reflects how avoiding costs associated with accidents, training, legal liabilities, and operational inefficiencies drives safety adoption. This aligns with [50] framework of economic performance dimensions, which includes sales growth, net income, and return on investment, and with studies such as [17,18], which highlighted the societal and economic costs of traffic accidents [51] further demonstrated the cost–risk relationship inherent in logistics operations, particularly under Just-in-Time (JIT) practices [17] noted that economic downturns increase accidents, suggesting that constrained budgets pose barriers despite the economic incentives for safety investment.

The third motivator factor, knowledge sharing, integration, and sustainability, highlights how promoting good practices, organizational integration, and renewable fuels influence road safety strategies [17] define structure as integrated operations including knowledge management, and ref. [52] linked responsible practices with performance indicator use, underscoring the importance of structural motivators for safety management.

Barriers to road safety management include motivational barriers such as lack of incentives for implementation, information, or awareness, absence of safety culture, and limited resources or infrastructure. The absence of incentives emerged as the top barrier, indicating the need for clearer organizational drivers. This resonates with [53], who emphasized that motivation is crucial for knowledge transfer and aligning individual behavior with organizational goals [54] highlighted that internal awareness is essential for implementing socially responsible logistics systems, and ref. [55] explained that scarce resources and short-term perspectives limit dynamic capabilities for maintaining safety initiatives.

Operational responsiveness barriers include loss of flexibility, pressure for punctuality, complex or overly bureaucratic processes, and lack of governance systems. The loss of flexibility was the highest loading variable in this factor, suggesting that rigid operational structures hinder safety adoption [56] emphasized that responsiveness integrates human capital and technology for coordinated, agile management, while ref. [8] stressed responsiveness as essential for adapting to uncertain environments. The correlation between loss of operational efficiency (B11) and time pressure (B14) indicates that efficiency losses undermine the implementation of new safety systems across operations [57] called for public sector responsiveness to align policies with market needs, which could enhance safety adoption within logistics providers.

Overall, this research demonstrates that road safety management in logistics providers is driven by planning, economic, and sustainability motivators, but hindered by barriers rooted in organizational culture, information gaps, rigid operational structures, and lack of incentives. Addressing these challenges requires integrating safety into strategic planning, enhancing incentives, promoting a proactive safety culture, streamlining processes, and aligning public policies with logistics operational realities to achieve effective road safety management that advances both public health and organizational sustainability goals. These insights are further developed and organized in the following SWOT analysis, which synthesizes the internal and external factors shaping road safety management within logistics providers and explores their alignment with the Sustainable Development Goals [58].

5.1. Integration of SWOT Analysis with Mixed-Methods Findings and Sustainable Development Goals

This study employed a sequential mixed-methods design comprising two phases: Phase 1 involved qualitative data collection through expert interviews, while Phase 2 consisted of a quantitative survey administered to logistics professionals. The SWOT analysis synthesizes internal and external factors influencing road safety management in logistics providers by integrating empirical evidence from both phases. This synthesis provides a structured framework to identify challenges and opportunities, contextualized within the framework of pertinent Sustainable Development Goals (SDGs) (Figure 1).

INTERNAL FACTORS	
STRENGTHS +	WEAKNESSES –
Motivators: - Strong economic incentives: The recognition that road safety practices can prevent economic losses and enhance operational efficiency. - Positive economic impacts: Understanding the potential benefits from investments in road safety, including lives saved and reduced accident-related costs. Practices: - Implementation of well-structured road safety systems. - Adoption of innovative technologies and vehicle automation for enhanced safety.	Barriers: - High implementation costs: Perceived or actual costs hindering the widespread adoption of road safety practices. - Lack of information and awareness: Insufficient understanding about the advantages of implementing road safety practices. Practices: - Limited integration of road safety training and education within company operations.
EXTERNAL FACTORS	
OPPORTUNITIES +	THREATS –
Motivators: - Economic performance gains: Recognizing the positive effects of road safety on overall economic performance. - Public–private partnerships: Collaborating with the public sector to develop infrastructure and innovative road safety solutions. Practices: - Promoting educational actions and training: Encouraging road safety education, awareness campaigns, and training initiatives.	Barriers: - Lack of resources and infrastructure: Insufficient resources that hinder effective implementation of road safety measures. - Lack of incentives for implementation: Low motivation to adopt new safety systems due to insufficient incentives. Practices: - Potential loss of operational efficiency: Risk of decreased efficiency when implementing new road safety systems, potentially slowing down logistics operations.

Figure 1. Integrated SWOT analysis for Road Safety Management in Logistics.

5.1.1. Internal Factors: Strengths and Weaknesses

Phase 1 findings highlighted motivators such as economic incentives, regulatory compliance, and organizational culture as key internal strengths that support the adoption of road safety practices. These factors were substantiated in Phase 2, where respondents affirmed the relevance of structured safety management systems and the incorporation of advanced technologies, including vehicle automation. These strengths correspond with SDG 8.8, which aims to promote safe and secure working environments, and SDG 3.6, which targets the reduction in road traffic injuries and fatalities.

Despite these strengths, both phases identified persistent internal weaknesses. High implementation costs, whether perceived or actual, were consistently recognized as a significant impediment to the widespread adoption of safety initiatives. Additionally, limited dissemination of information regarding the benefits of road safety measures and insufficient integration of safety training within routine operational activities were reported. Such weaknesses inhibit the development of a robust safety culture and constrain proactive management of road safety risks.

5.1.2. External Factors: Opportunities and Threats

The qualitative phase underscored the potential for public–private partnerships as an opportunity to enhance resource sharing and infrastructure development, which was further corroborated by quantitative data. These collaborative opportunities align with SDG 17.17, which encourages multi-sector partnerships for sustainable development. Moreover, expanding educational initiatives and safety training across the sector were identified as mechanisms to increase overall safety awareness.

Conversely, both phases identified several external threats. Inadequate resources and infrastructural limitations, coupled with insufficient incentives for implementation, restrict the capacity to establish comprehensive safety systems. The quantitative data also revealed operational concerns such as potential reductions in efficiency and pressures to maintain punctuality, reflecting the complexity of integrating safety measures within demanding logistical contexts.

5.1.3. Recommendations and Alignment with Sustainable Development Goals

Drawing on findings from both phases, the SWOT analysis informs several recommendations aligned with SDGs 3.6, 8.8, 9.1, 11.2, and 17.17. Logistics providers are encouraged to leverage existing strengths by emphasizing the potential for long-term cost savings, improved operational efficiencies, and safety outcomes consistent with these goals. The adoption of advanced technologies and automation supports SDG 9.1, which promotes resilient infrastructure and sustainable industrialization, thereby facilitating safer and more efficient logistics operations.

To address internal limitations, logistics providers should prioritize cost-effective safety practices and develop communication strategies to enhance understanding of their benefits. Implementation of targeted training and awareness programs is essential to develop a safety-oriented culture and embed safety management within organizational processes.

Externally, realizing identified opportunities necessitates the development of strategic collaborations with public sector entities and industry stakeholders in accordance with SDG 17.17. Such partnerships enable co-development of infrastructure, pooling of resources, and alignment of safety objectives with operational requirements. To mitigate external threats, providers should pursue diversified resource acquisition and develop incentive structures compatible with organizational culture to encourage adoption of safety measures.

The SWOT framework, derived from integrated qualitative and quantitative findings, provides a coherent and evidence-based tool for improving road safety management in logistics. By explicitly linking identified internal and external factors with relevant Sustainable Development Goals, this framework could help the advancement of logistics operations that are socially responsible and economically sustainable. This integrative approach highlights the importance of reconciling theoretical perspectives with practical constraints to enhance the effectiveness and sustainability of road safety interventions within the logistics sector.

5.2. Implications for Policy, Practice, and Theory

5.2.1. Implications for Practice

The findings suggest that logistics companies can significantly enhance road safety performance by integrating safety considerations into their strategic and operational planning. Investments in infrastructure, training programs, and safety monitoring systems should be prioritized. Managers are encouraged to encourage a proactive safety culture and implement internal incentive mechanisms that promote adherence to safety standards.

Companies may also benefit from adopting structured safety management systems, such as those based on ISO 39001 [59], to formalize and continuously improve their practices.

5.2.2. Implications for Policy

Public authorities play a critical role in enabling safer logistics systems. Policymakers should support logistics providers through targeted incentive programs, such as tax benefits or preferential procurement policies tied to safety performance (SDG 3.6, SDG 8.8). There is also a need to expand and harmonize regulatory frameworks that align with emerging technologies and market dynamics (SDG 9.1). Moreover, partnerships between government and private operators should be strengthened to co-develop infrastructure, disseminate best practices, and invest in capacity-building initiatives (SDG 17.17).

5.2.3. Implications for Theory

From a theoretical standpoint, this study contributes to the literature on sustainable logistics and corporate social responsibility by addressing the underexplored organizational dimensions of road safety. The validated framework of practices, motivators, and barriers offers a basis for future empirical testing using advanced methods, such as structural equation modeling (SEM) or longitudinal case studies. The results also suggest that road safety can be better conceptualized as a strategic capability, influenced by both internal drivers and external pressures—an approach that can be further examined through the lenses of dynamic capabilities theory and stakeholder theory.

In summary, enhancing road safety in logistics requires coordinated efforts across practice, policy, and theory. By recognizing safety as a shared responsibility and embedding it into the operational and strategic core of logistics organizations, significant progress can be made towards reducing road-related injuries and deaths, while also promoting more efficient, resilient, and socially responsible transport systems.

6. Conclusions

This study examined the practices, motivators, and barriers that influence road safety management within Brazilian logistics companies. By applying a mixed-methods approach, the research developed and validated a conceptual framework grounded in both expert insights and empirical data from industry professionals.

The findings show that effective road safety management in logistics is primarily driven by operational planning, infrastructure development, and regulatory compliance. Economic and financial motivators, particularly cost avoidance and efficiency gains, play a central role in the adoption of safety practices. However, companies face persistent barriers related to limited internal motivation, lack of awareness, operational rigidity, and insufficient incentives.

The integrated analysis provides both theoretical contributions and practical guidance for advancing road safety as a strategic pillar in logistics operations. This study demonstrates that safety efforts can support not only operational performance but also broader societal goals, including those articulated in the United Nations Sustainable Development Goals (SDGs), particularly SDG 3.6, SDG 8.8, SDG 9.1, and SDG 11.2.

Nonetheless, the research acknowledges certain limitations. The sample size in the quantitative phase ($N = 104$) suggests a cautious interpretation of the exploratory factor analysis results and indicates that further studies with larger samples could enhance generalizability. Additionally, the focus on Brazilian companies means that cultural and institutional factors may influence the results, suggest caution when apply the findings in other national contexts.

Future studies could expand on this framework by applying structural equation modeling (SEM) to test causal relationships among motivators, barriers, and safety outcomes; conducting comparative analyses across countries to assess the role of regional or cultural differences; exploring how public–private partnerships and certification standards (e.g., ISO 39001 [59]) influence the maturity of road safety management systems; and investigating how training programs and real-time data systems can reinforce awareness and organizational integration.

In conclusion, improving road safety management in the logistics sector requires a systemic and strategic approach. By integrating safety into corporate planning, strengthening internal capabilities, and promoting cross-sector collaboration, logistics providers can reduce traffic-related risks, improve performance, and contribute to safer, more sustainable transport systems.

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