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Occupational Health and Safety training using online platforms in road transport - a case study

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Abstract. The road transport sector is characterized by dynamic working conditions and persistent occupational safety risks, requiring continuous and context-sensitive training approaches. While online platforms are increasingly used for occupational health and safety (OHS) training, their effectiveness is often evaluated using static frameworks that overlook behavioral adaptation and real-time operational feedback. This study investigates the impact of a data-driven, adaptive digital training system implemented in two freight transport companies. Unlike conventional approaches, the training platform dynamically adjusted content based on driver performance indicators derived from telematics and incident reports. A longitudinal research design was applied, combining learning analytics, behavioral monitoring, and safety performance indicators over a nine-month period. The results indicate that adaptive digital training leads to more consistent behavioral improvements compared to standard e-learning approaches. Drivers exposed to personalized modules showed a 37% reduction in safety-critical events and improved compliance stability across varying operational contexts. Furthermore, the findings highlight that training effectiveness is strongly influenced by feedback loops between operational data and learning content. The study suggests that digital OHS training should be conceptualized as a continuous, adaptive process embedded within organizational systems, rather than as a discrete instructional activity..

Keywords: *occupational safety, adaptive learning, road transport, digital training.*

Introduction

The road transport sector continues to be among the most vulnerable in terms of occupational risks. Professional drivers operate under time pressure, irregular schedules, and variable traffic environments, which increases exposure to those risks. Traditional Occupational Health and Safety (OHS) training methods, typically based on periodic sessions and standardized materials, are often insufficient in addressing these challenges. They tend to treat safety knowledge as static, while real-world operations require continuous adjustment and decision-making under uncertainty. Digital platforms have introduced new possibilities for training delivery, including remote access, automated assessment, and content standardization. However, many implementations simply replicate traditional training in digital form, without using the potential of real-time data integration and personalization.

Recent work in digital OSH training shows that such platforms can support broad organizational deployment at relatively low cost. However, many implementations still reproduce the logic of

classroom instruction in digital form, focusing on module completion and certification rather than ongoing adaptation to operational risk signals. At the same time, road safety studies indicate that targeted and feedback-based interventions can reduce risky driving behavior more effectively than generic training.

Web-based instruction that is automatically assigned according to behavioral patterns has been associated with measurable reductions in unsafe driving. Also, telematics systems and in-vehicle data recorders have demonstrated value in monitoring driving behavior and generating driver-specific feedback. More recent evidence shows that structured driver feedback in real-world conditions can improve behavior and reduce crash-related risk, although long-term effects depend on how feedback is integrated into broader organizational systems.

This study proposes an alternative perspective: digital OHS training as an adaptive system continuously informed by operational data.

The objective is to analyze how such an approach influences driver behavior and organizational safety performance in two road freight transport companies. Instead of evaluating training as a simple event, the paper examines it as a dynamic loop between telematics-derived evidence, personalized learning content, and behavioral correction over time.

1. Digital training as an adaptive system

Digital occupational health and safety training has evolved from static, compliance-oriented instruction toward more dynamic and data-driven approaches that reflect the complexity of real work environments. In road transport, where driver behaviour is continuously influenced by operational variability, effective training must go beyond standardized content and incorporate mechanisms that adapt to actual performance conditions. In this context, digital training platforms can be conceptualized as adaptive systems that integrate operational data, learning processes, and feedback loops to support continuous behavioural improvement.

1.1. From static instruction to dynamic learning

Most digital training systems are designed as linear learning environments. Participants complete predefined modules, pass tests, and receive certification. While efficient from an administrative perspective, this model assumes that knowledge transfer automatically translates into safer behavior. This approach is widely adopted in occupational health and safety (OHS) contexts because it facilitates scalability and ensures compliance with regulatory requirements across large and geographically distributed workforces [1].

In reality, behavior is shaped by context. Drivers must constantly adjust to traffic conditions, deadlines, fatigue, and unexpected disruptions. Therefore, training effectiveness depends not only on what is learned, but also on how learning is reinforced and adapted over time. Empirical studies in the field of road safety demonstrate that improved understanding of safety procedures does not automatically translate into safer operational behavior, particularly in complex and dynamic environments such as road transport [2].

In real-world settings, driver behavior is strongly influenced by contextual variables, including traffic density, time pressure, fatigue, and environmental uncertainty, which continuously shape decision-making processes during driving tasks [3] [4].

Training effectiveness depends not only on the content delivered, but also on the extent to which learning is reinforced, contextualized, and dynamically updated in relation to actual work conditions. Research on targeted web-based instruction programs has shown that interventions tailored to specific behavioral patterns can significantly reduce risky driving behaviors, highlighting the importance of contextual relevance in training design [5] [6].

Adaptive learning systems address this limitation by adjusting content based on user performance [7]. In OHS contexts, this means integrating data such as: driving behavior (e.g., harsh braking, speeding), compliance with rest regulations, incident and near-miss reports. Such systems create a feedback loop between work-as-performed and training content, enabling continuous alignment [8].

Adaptive learning systems introduce mechanisms that adjust training content based on user performance and real-time data inputs. In contrast to static e-learning environments, adaptive systems continuously personalize instructional pathways, enabling a closer alignment between individual needs and training interventions [9].

In the context of OHS in road transport, this adaptive approach is supported by the integration of telematics and monitoring technologies, which provide detailed insights into driver behavior during real operations. These systems collect data on key indicators such as speeding, harsh braking, acceleration patterns, and compliance with driving regulations, allowing organizations to identify risk patterns at both individual and fleet levels [10].

The availability of such data enables the development of feedback-based training mechanisms, where drivers receive targeted interventions based on observed deviations rather than generalized instruction. Telematics-driven feedback has been shown to support behavioral improvement by increasing awareness of unsafe practices and enabling more precise corrective actions. Moreover, the continuous collection and analysis of operational data allows training systems to function as dynamic regulatory mechanisms within the socio-technical system, rather than as isolated educational tools [11]. This creates a feedback loop between work-as-performed and training content, in which real-world performance informs learning, and learning, in turn, influences future behavior. Such feedback loops are essential for reducing the gap between prescribed procedures and actual practice, a gap that is widely recognized as a key challenge in safety management [12]. By continuously aligning training with operational realities, adaptive systems contribute to the stabilization of behavior and the reduction of undesirable variability in system performance. In this sense, digital training evolves from a static process of knowledge transmission into a dynamic, data-driven system that supports ongoing learning, behavioral adaptation, and proactive risk management in complex operational environments [13].

1.2. Adaptive learning and operational feedback

Adaptive learning systems address the limitations of static instruction by adjusting content based on user performance and contextual indicators. In OHS training for road transport, this means integrating data such as harsh braking, speeding, rapid acceleration, rest-period non-compliance, and incident or near-miss reports into the training delivery. Such systems enable a feedback loop between work-as-performed and training content, making learning more responsive to actual behavioral risk patterns. Evidence from telematics-based safety research and randomized protocol designs supports the broader potential of data-driven feedback to improve road safety outcomes.

Recent systematic evidence further reinforces the role of feedback. A review of real-world driving studies concluded that driver feedback can improve driving behavior and reduce crash-related risk, although its effectiveness depends on implementation conditions and behavioral sustainability [14]. A naturalistic telematics study likewise found that high-resolution behavioral monitoring can support measurable behavioral change, especially when feedback is structured and linked to motivation or incentives [15]. From this perspective, digital training is no longer just an educational tool. It becomes a regulatory component of the socio-technical system: operational data identifies behavioral deviations, the platform adapts content accordingly, and repeated interactions aim to stabilize future performance. This reduces the gap between prescribed safe behavior and real operational practice [16].

1.3. Engagement, reinforcement, and compliance stability

Training engagement theory argues that training effectiveness depends on processes unfolding over time and across levels, including the learner, the task, and the organizational setting [17]. In digital environments, this is particularly relevant because the platform records not only test outcomes, but also patterns of access, repetition, completion, and time-on-task. These traces allow a more nuanced evaluation of whether workers merely completed a module or actively engaged with corrective learning [18].

In high-risk domains, repeated reinforcement is essential. A driver who repeatedly receives adaptive micro-modules on fatigue, speed management, or pre-trip risk assessment after telematics-

detected deviations is more likely to connect training content with lived operational experience. This mechanism supports compliance stability, understood here as the maintenance of safer behavior across changing work conditions rather than isolated short-term improvement.

2. Methodology

The study used a longitudinal comparative case-study design over nine months. Two freight transport companies operating international and domestic road haulage routes were included. Company A implemented an adaptive digital OHS platform, while Company B used a conventional online training system with fixed modules and periodic assessments. The comparison was intended to examine whether personalization based on operational data produces stronger and more stable behavioral change than standard e-learning.

The total sample consisted of 48 professional drivers: 25 in Company A and 23 in Company B. All participants operated heavy goods vehicles and performed long-haul or regional freight transport. The companies had similar fleet profiles, route variability, and regulatory obligations. Drivers had at least one year of professional experience and had completed mandatory initial OHS induction before the study.

2.1 Description of the adaptive training intervention

The adaptive platform used in Company A included:

- Modular OHS content on fatigue management, speeding, distraction, vehicle checks, load securing, and incident reporting.
- Automated quizzes after each module.
- Learning analytics dashboards.
- Dynamic reassignment of content based on telematics indicators and monthly incident records.

When a driver exceeded predefined thresholds for harsh braking, speeding events, or rest-period non-compliance, the platform automatically assigned refresher micro-learning units and scenario-based exercises relevant to the observed deviation.

Company B used the same broad thematic domains but through a fixed quarterly e-learning structure without individualized reassignment.

Three categories of data were collected:

- Learning analytics
  - login frequency;
  - module completion rate;
  - average time spent per module;
  - repetition frequency for corrective modules.
- Behavioral indicators from telematics
  - speeding events per 1,000 km;
  - harsh braking events per 1,000 km;
  - abrupt acceleration events per 1,000 km;
  - rest-period non-compliance events per driver-month.
- Safety performance indicators
  - near-miss reports;
  - minor incident reports;
  - procedural non-compliance observations.

Two composite indicators were defined: Adaptive Training Engagement Index (ATEI) and Behavioral Stability Improvement Rate (BSIR).

Adaptive Training Engagement Index (ATEI)

$$ATEI = 0.35CR+0.25LF+0.20TM+0.20RF$$

where:
CR = normalized completion rate
LF = normalized login frequency
TM = normalized average time spent on assigned modules
RF = normalized repetition frequency for corrective modules

Adaptive Training Engagement Index (ATEI) is a composite indicator designed to measure how actively drivers interact with the digital training platform, rather than simply whether they complete assigned modules. It combines four key dimensions of engagement: completion rate (CR), login frequency (LF), time spent on training (TM), and repetition of corrective modules (RF), each weighted according to its contribution to meaningful learning. The higher weight assigned to completion rate reflects the importance of finishing training content. The inclusion of repetition and time spent captures deeper cognitive involvement and reinforcement of knowledge. Overall, ATEI provides a more realistic evaluation of training effectiveness by emphasizing sustained interaction and behavioural engagement instead of passive participation.

Behavioral Stability Improvement Rate (BSIR)

$$BSIR = \frac{SCEpre - SCEpost}{SCEpre} \times 100$$

where:
SCE = safety-critical events, aggregated from speeding, harsh braking, abrupt acceleration, and rest non-compliance.

Behavioral Stability Improvement Rate (BSIR) is an indicator used to quantify the extent to which unsafe driver behaviour decreases after the implementation of a training intervention. It is calculated as the relative reduction in safety-critical events, comparing values recorded before and after training, thus providing a clear measure of behavioural improvement over time. The indicator integrates multiple types of deviations, such as speeding, harsh braking, abrupt acceleration, and non-compliance with rest periods, offering a comprehensive view of operational safety performance. By expressing the result as a percentage, BSIR allows easy comparison between different groups, time periods, or training approaches. A higher BSIR value indicates a stronger positive impact of training on driver behaviour, reflecting not only improvement but also greater stability in maintaining safe practices under varying working conditions.

The data analysis was designed to capture both the temporal evolution of training effects and the relationship between engagement and behavioral outcomes. A longitudinal approach was applied, allowing the comparison of indicators before and after the implementation of the digital training system over multiple monthly intervals. For each period, average values were calculated at the company level, ensuring consistency and reducing the influence of short-term fluctuations in operational data. This aggregation made it possible to observe general trends in both training engagement and safety-related behavior.

To explore the relationship between these variables, Pearson correlation analysis was used, focusing on the association between the Adaptive Training Engagement Index (ATEI) and the Behavioral Stability Improvement Rate (BSIR). This statistical method provided insight into whether higher levels of engagement with the training platform were linked to stronger improvements in driver behavior.

The analysis was performed at the company-month level, which allowed for a more detailed understanding of how changes in engagement corresponded to variations in safety performance over time. The identified correlations indicate associations between variables, but they do not establish direct causal relationships. Despite this limitation, the analysis offers valuable evidence regarding the

potential role of adaptive digital training in influencing behavioral outcomes in complex operational environments.

3. Results

The results presented in this section reflect the impact of the adaptive digital training system on driver behaviour and organizational safety performance over the study period. The analysis is based on a comparative approach, examining differences between the adaptive training model and the standard e-learning system implemented in the two companies. By integrating learning analytics, telematics data, and safety performance indicators, the study captures both individual behavioural changes and broader operational trends. This multidimensional perspective allows for a comprehensive evaluation of how adaptive training influences safety outcomes in dynamic road transport environments.

3.1 Learning analytics and platform use

Drivers in Company A showed higher and more sustained interaction with the platform than drivers in Company B. The adaptive group had a mean completion rate of 91.4%, compared with 78.6% in the standard e-learning group. Corrective module repetition was also markedly higher in Company A, indicating that drivers repeatedly accessed targeted content after behavioral triggers rather than completing modules only once (Table 1).

Table 1. Learning analytics indicators.

Indicator	Company A (adaptative)	Company B (standard)
Completion rate (%)	91.4	78.6
Mean logins/month	6.8	3.9
Mean time on platform (min/month)	84	51
Corrective module repetition/month	2.7	0.8

The analysis of learning analytics and platform use reveals significant differences between the adaptive training approach implemented in Company A and the standard e-learning system used in Company B. Drivers in Company A demonstrated not only higher levels of participation, but also more consistent and sustained interaction with the digital training platform throughout the study period. The completion rate reached 91.4% in the adaptive system, compared to 78.6% in the conventional approach, indicating that personalized content and dynamic assignment mechanisms increased user motivation and commitment to the training process.

The frequency of logins and the average time spent on the platform were substantially higher in Company A, suggesting that drivers did not perceive training as a one-time obligation, but rather as an ongoing activity integrated into their work routine. This pattern reflects a shift from passive consumption of information to active engagement with learning materials. Particularly relevant is the repetition of corrective modules, which was more than three times higher in the adaptive system. This indicates that drivers repeatedly accessed targeted content in response to identified behavioral deviations, reinforcing learning through practice and feedback.

In contrast, the standard e-learning approach in Company B showed lower interaction levels across all indicators, reflecting a more static and compliance-oriented use of the platform. Drivers typically completed assigned modules once, with limited revisiting of content, which reduces the potential for reinforcement and long-term behavioral change.

3.2 Changes in safety-critical events

A clear difference emerged between the two companies in the evolution of safety-critical events (Table 2).

Table 2. Safety-critical events per 1,000 km or driver-month.

Indicator	Company A pre	Company A post	Company B pre	Company B post
Speeding events/1,000 km	4.6	2.8	4.4	3.7
Harsh braking/1,000 km	3.1	1.9	3.0	2.6
Abrupt acceleration/1,000 km	2.7	1.8	2.6	2.3
Rest non-compliance/driver-month	1.9	1.1	1.8	1.5

The analysis of safety-critical events highlights a clear and consistent difference between the two companies in terms of behavioral improvement following the implementation of digital training. In Company A, where the adaptive training system was applied, all monitored indicators show a substantial reduction in unsafe driving patterns. Speeding events decreased from 4.6 to 2.8 per 1,000 km, while harsh braking and abrupt acceleration events were also significantly reduced, indicating improved control and anticipation during driving. Similarly, non-compliance with rest periods dropped from 1.9 to 1.1 events per driver-month, suggesting better adherence to fatigue management regulations (fig.1). Company B, which used a standard e-learning approach, exhibited only moderate improvements across the same indicators. Although reductions were observed, they were less pronounced and less consistent, reflecting the limited impact of static training on real-world behavior. Drivers in this group appeared to improve primarily in response to general awareness rather than targeted behavioral correction.

The aggregated results further emphasize this difference, with Company A achieving a 37% reduction in safety-critical events, compared to only 16% in Company B. This substantial gap suggests that adaptive training mechanisms, which continuously align learning content with observed performance, are more effective in influencing driver behavior. The ability to deliver personalized feedback and corrective modules based on real operational data appears to play a key role in reinforcing safe practices. Overall, these findings indicate that training systems that integrate telematics data and adaptive learning strategies can produce not only greater improvements, but also more coherent and sustained behavioral changes. This supports the idea that safety performance in road transport can be significantly enhanced when training is directly connected to actual work conditions and continuously updated based on observed risks.

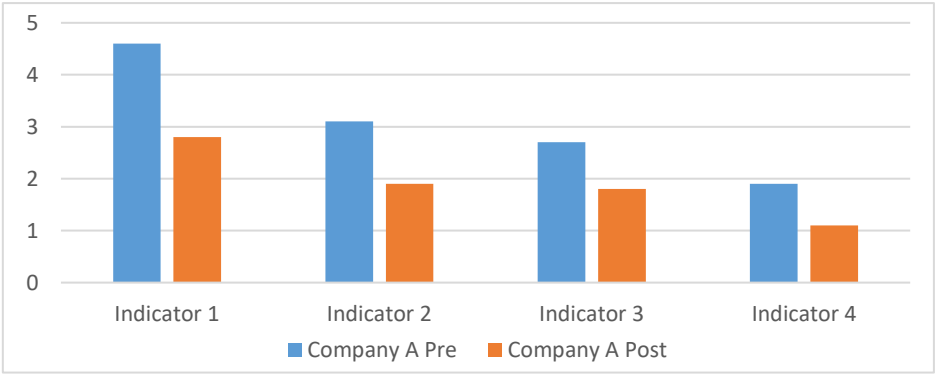

Figure 1. Aggregate reduction in safety-critical events (Indicator 1 - Speeding events/1,000 km, Indicator 2 - Harsh braking/1,000 km, Indicator 3 - Abrupt acceleration/1,000 km, Indicator 4 - Rest non-compliance/driver-month).

3.3 Behavioral stability across contexts

The adaptive group also showed lower fluctuation across months with varying route pressure and seasonal workload. In other words, improvements were not limited to isolated periods but remained more stable under changing operating conditions (Table 3).

This is important because safety performance in road transport is strongly shaped by context, and durable improvement requires not only lower averages but also reduced inconsistency.

Table 3. Composite indicators.

Company	ATEI	BSIR (%)
A	0.86	37
B	0.61	16

At the company-month level, the correlation between engagement in adaptive training and behavioral improvement was strong:

$$r(\text{ATEI}, \text{BSIR}) = 0.74$$

The analysis of behavioral stability across varying operational contexts reveals one of the most important advantages of the adaptive training approach.

In Company A, where training content was continuously adjusted based on telematics data and performance indicators, driver behavior showed not only improvement but also greater consistency over time. Monthly fluctuations in safety-critical events were significantly lower compared to Company B, even during periods characterized by increased workload, seasonal peaks, or more demanding routes. This suggests that the adaptive system supported drivers in maintaining safer behavior regardless of changing external conditions, rather than only improving performance in stable or low-pressure situations.

Company B displayed more variability in behavioral indicators across the same time intervals. Although some improvement was observed after training sessions, these effects were less stable and tended to diminish under operational stress. This pattern indicates that static e-learning may produce temporary gains in awareness, but lacks the mechanisms required to sustain behavioral consistency in dynamic environments such as road transport.

The comparison of composite indicators further supports this interpretation. Company A achieved a higher Adaptive Training Engagement Index (ATEI = 0.86) alongside a significantly stronger Behavioral Stability Improvement Rate (BSIR = 37%), while Company B recorded lower values for both indicators (ATEI = 0.61; BSIR = 16%). The strong positive correlation identified between ATEI and BSIR ($r = 0.74$) highlights the link between sustained engagement with adaptive training and the ability to maintain improved safety behavior over time.

Overall, these results emphasize that training effectiveness should not be assessed only through average improvements, but also through the stability of behavior across varying conditions. Adaptive digital training appears to enhance not only the level of safety performance, but also its resilience, enabling drivers to consistently apply safe practices in the face of operational variability.

3.4 Safety performance indicators

Organizational records also showed improvement in near-miss and procedural non-compliance trends (Table 4).

Table 4. Safety performance outcomes.

Indicator	Company A pre	Company A post	Company B pre	Company B post
Near-miss reports/quarter	11	7	10	9
Minor incidents/quarter	6	4	5	5
Procedural non-compliance observations/quarter	14	8	13	11

The analysis of safety performance indicators provides additional evidence regarding the broader organizational impact of the adaptive digital training system. Beyond the improvements observed in telematics-based behavioral metrics, Company A also recorded noticeable reductions in near-miss events, minor incidents, and procedural non-compliance. Specifically, near-miss reports decreased from 11 to 7 per quarter, while procedural non-compliance observations dropped from 14 to 8, indicating a more consistent alignment with safety procedures in daily operations. These changes suggest that the effects of training extended beyond individual driving behavior and influenced overall safety culture within the organization.

Company B exhibited only marginal improvements in these indicators. While a slight reduction in near-miss reports was observed, the number of minor incidents remained unchanged, and procedural non-compliance showed only a limited decrease. This pattern indicates that standard e-learning, although useful for maintaining baseline awareness, may not be sufficient to produce significant organizational-level improvements in safety performance.

The differences between the two companies highlight the importance of integrating training with real-time operational feedback. In Company A, the continuous loop between telematics data, incident reporting, and adaptive learning content likely contributed to increased awareness and more proactive behavior among drivers. As a result, safety improvements were reflected not only in measurable driving patterns but also in the reduction of events that typically precede more serious incidents.

These findings reinforce the idea that adaptive digital training can function as a systemic intervention, influencing both individual behavior and organizational safety outcomes. By connecting learning processes with real operational data, such systems support a more proactive and preventive approach to safety management, enhancing the organization's ability to identify, address, and mitigate risks before they escalate into critical events.

4. Discussion

The findings of this study support the argument that digital occupational health and safety (OHS) training in road transport should not be treated as a one-time educational intervention, but rather as a continuous and adaptive process embedded within the operational system. In dynamic environments such as road transport, where working conditions are constantly changing, safety cannot be ensured solely through periodic knowledge transmission. Instead, it requires ongoing alignment between training content, real-time operational data, and behavioral reinforcement mechanisms. This perspective shifts the role of training from a compliance-driven activity to a functional component of safety management, directly influencing how drivers perceive, interpret, and respond to risk in everyday operations.

The superior performance observed in Company A can be explained through several interconnected mechanisms. First, the adaptive training platform significantly increased the relevance of learning content. Drivers were not exposed to generic modules delivered at fixed intervals, but to targeted micro-learning interventions triggered by specific behavioral deviations identified through telematics data. This personalization ensured that training addressed actual performance gaps rather than assumed deficiencies. As a result, drivers were more likely to recognize the practical value of training, which in turn increased engagement and facilitated the transfer of knowledge into real-world behavior.

This finding is consistent with existing research showing that targeted and context-specific training interventions are more effective in reducing unsafe driving behaviors than standardized approaches.

Second, the adaptive system created a continuous feedback loop between operational performance and learning processes. Telematics data, such as speeding events, harsh braking, or rest-period violations, were not only recorded for monitoring purposes but actively used to inform training content. This integration transformed feedback from a passive reporting tool into an active learning mechanism. Drivers received immediate and context-relevant instructional input, allowing them to connect their actions with consequences and corrective strategies. Compared to traditional systems, where feedback is often delayed or detached from training, this real-time linkage enhances situational awareness and accelerates behavioral adjustment. The study thus reinforces the idea that the effectiveness of digital training is significantly increased when it is directly connected to operational data streams.

A third important mechanism relates to the improvement of compliance stability. In safety-critical systems, it is not sufficient to achieve temporary reductions in unsafe behavior; it is equally important to maintain consistent performance across varying conditions. The results show that drivers in Company A exhibited lower variability in safety-critical events over time, even during periods of increased workload or operational complexity. This suggests that adaptive training contributes to the internalization of safe practices, enabling drivers to apply them more consistently under different circumstances. In contrast, the more fluctuating results observed in Company B indicate that static training approaches may produce short-term improvements, but lack the reinforcement mechanisms necessary for long-term behavioral stability.

A key contribution of the study lies in its methodological implications. Traditional evaluation models of training effectiveness often rely on indicators such as test scores, completion rates, or certification status. While these metrics are useful for assessing knowledge acquisition, they provide limited insight into how training influences actual behavior. In this study, learning analytics, such as login frequency, repetition of corrective modules, and time spent on training, offered a more nuanced understanding of user engagement and learning processes. These indicators reflect not only whether training was completed, but how it was experienced and internalized by participants. This aligns with training engagement theory, which emphasizes that learning effectiveness is shaped by continuous interaction, reinforcement, and contextual relevance.

Furthermore, the strong correlation identified between the Adaptive Training Engagement Index (ATEI) and the Behavioral Stability Improvement Rate (BSIR) highlights the importance of sustained engagement in achieving meaningful safety outcomes. This relationship suggests that training effectiveness is not simply a function of content quality, but also of how frequently and intensively users interact with the learning system. In adaptive environments, repeated exposure to targeted content appears to strengthen behavioral patterns, contributing to more durable safety improvements.

From a broader perspective, the study contributes to the ongoing transition from reactive to proactive safety management. By integrating training with real-time operational data, organizations can identify emerging risks and address them before they escalate into incidents. This approach aligns with contemporary safety paradigms that emphasize anticipation, monitoring, and continuous improvement rather than post-event analysis. In this context, digital training platforms become not only tools for instruction, but also instruments for risk regulation within complex socio-technical systems.

In conclusion, the discussion highlights that the effectiveness of digital OHS training in road transport depends less on the delivery of information and more on the integration of learning processes with operational realities. Adaptive training systems that incorporate feedback loops, personalization, and continuous engagement mechanisms have the potential to significantly enhance both individual behavior and organizational safety performance.

Limitation. Several limitations should be acknowledged. The study examined only two companies and a relatively small sample, which limits generalizability. The design was longitudinal and

comparative, but not randomized, so causal inference remains limited. Some indicators depended on the quality of company reporting systems, particularly for near-miss and procedural non-compliance records. In addition, the adaptive logic was based on selected telematics and incident variables; other dimensions such as stress, sleep quality, or route complexity were not modeled directly.

5. Conclusions

This study examined the role of adaptive online occupational health and safety (OHS) training in the road transport sector through a nine-month case study conducted in two freight transport companies. The results demonstrate that digital training systems integrated with telematics data and incident-based feedback mechanisms can generate significantly stronger and more stable behavioural improvements compared to conventional e-learning approaches. Drivers who were exposed to personalized and dynamically adjusted training modules achieved a 37% reduction in safety-critical events, along with improved consistency in compliance with safety procedures. These outcomes were also reflected in broader organizational indicators, including reductions in near-miss events and procedural non-compliance, suggesting that the impact of training extended beyond individual behaviour to influence overall safety performance.

A key conclusion of the study is that the effectiveness of digital OHS training cannot be fully understood when it is treated as a discrete instructional activity. Instead, the findings support the conceptualization of training as a continuous and adaptive system, embedded within the operational and organizational context. In such a system, learning is not limited to predefined modules but evolves dynamically based on real-world performance data. The integration of telematics indicators, learning analytics, and feedback-driven micro-learning creates a closed-loop mechanism in which operational behaviour informs training, and training, in turn, shapes future behaviour. This continuous interaction enhances the relevance of training content, supports behavioural reinforcement, and contributes to the stabilization of safe practices over time.

From a practical perspective, the study highlights the potential of adaptive digital platforms to strengthen safety management in high-risk and mobile work environments such as road transport. By leveraging real-time data and personalized learning pathways, organizations can move from reactive safety approaches, based on incident reporting and post-event analysis, to proactive strategies focused on anticipation and prevention. The use of targeted interventions allows for more efficient allocation of training resources, ensuring that attention is directed toward drivers and behaviours associated with higher risk levels. In addition, the integration of training with operational monitoring systems facilitates continuous oversight and supports decision-making at both managerial and operational levels. The results also underline the importance of engagement and interaction in digital training environments. The effectiveness of the adaptive system was closely linked to sustained user involvement, repeated exposure to corrective content, and the alignment between training and real work conditions. This suggests that future developments in OHS training should prioritize not only content quality but also the design of interactive and responsive learning environments that encourage continuous participation and behavioural reflection.

Future research should extend this approach by testing adaptive digital training systems in larger and more diverse samples, including different types of transport operations and organizational contexts. Longitudinal studies over extended timeframes would be particularly valuable in assessing the durability of behavioural improvements and the long-term impact on safety performance. In addition, further work should explore the integration of advanced technologies such as artificial intelligence and predictive analytics, which could enhance the capacity of digital platforms to anticipate risk patterns and deliver even more precise and timely training interventions.

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