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Strategies to Enhance Supervision and Control of Freight Transport in Over Dimension Over Loading (ODOL)

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Abstract

This study examines supervision strategies for freight transport at the Balonggandu and Losarang Motor Vehicle Weighing Implementation Units (UPPKB) to address the Over Dimension Over Loading (ODOL) phenomenon, which threatens national road safety and infrastructure. The primary problem analysed is the gap between the high volume of freight vehicles and the limited capacity of manual supervision, leading to logistics inefficiencies. The study employed a mixed-method descriptive approach with data collection through field observations, questionnaires administered to 100 drivers, and in-depth interviews with key informants from the Ministry of Transportation. Data were analysed using SWOT matrices and AHP weighting. The novelty of this research lies in formulating priority strategies that integrate technical operational constraints analysis with inter-agency digital enforcement design for two specific UPPKB sites using a hybrid SWOT and AHP approach. Empirical findings indicate that external opportunity factors, specifically technological support, hold the highest weight (0.490). The strategy of inter-agency integration based on Information Technology (IT) was selected as the top priority (0.113) to overcome the limitations of manual supervision, representing a priority ranking for implementation focus rather than an absolute measure of effect size. The study concludes that a transformation towards integrated digital supervision is a strategic priority, with policy implications requiring the implementation of automated sanctions and the expansion of legal liability to cargo owners to achieve national logistics efficiency.

KEYWORDS

freight transport; odol supervision; ahp-swot; weigh-in-motion; transport policy.

Introduction

Transportation functions as a vital backbone for community activities and regional economic development, where the seamless interaction between transportation components forms an efficient system (Irsan et al., 2024). In Indonesia, logistics distribution relies heavily on road transport, which dominates the market share by approximately 85.57% (based on total tonnage volume), far surpassing sea, rail, and air modes (Syifa & Tohir, 2025). This 85.57% figure is explicitly based on data from the year 2024, sourced from the Directorate General of Land Transportation's Final Report on Road Traffic and the Ministry of Transportation's Strategic Flagship Program Study for 2024–2029. Business actors prefer this mode due to its flexibility in providing door-to-door services. However, this high dependency on land transport presents significant challenges regarding traffic order and the efficiency of the national logistics system, ultimately impacting economic competitiveness (da Silva & Cardoso, 2024).

Specifically in West Java Province, road infrastructure is crucial for mobility and economic growth (Salim & Faoziyah, 2022). Nevertheless, this region faces challenges related to uneven infrastructure quality and severe congestion (Ilham, 2025; Kharisma et al., 2020). Data indicate that the ratio of vehicle volume to road capacity (V/C Ratio) on several main roads is alarmingly high, a condition exacerbated by road damage caused by excessive vehicle loads (Miftahulkhair et al., 2024).

This uneven and damaged infrastructure directly increases operational costs for companies and creates logistics inefficiencies that hinder industrial competitiveness (Santoso et al., 2021).

The primary threat to road transport efficiency and safety is the prevalence of Over Dimensional Overloading (ODOL) vehicles. The ODOL phenomenon not only accelerates road infrastructure degradation, triggering high maintenance costs, but also contributes significantly to traffic accidents, as overloaded vehicles are more difficult to manoeuvre and brake (Li et al., 2016; Widyanti et al., 2025). Beyond safety impacts, inefficiencies partially exacerbated by ODOL contribute to high logistics costs in Indonesia, which reach approximately 23.20% of the Gross Domestic Product (GDP) in recent years (Harun et al., 2024). Specifically, based on 2021 estimates released by the World Bank, Bappenas, and the Ministry of Finance, this 23.20% logistics cost component is defined such that nearly half (approximately 11.3% of the GDP) constitutes general road transport costs. More precisely, costs directly related to freight transport amount to 20.80% of the total GDP, of which 37% represents pure operational costs for freight transport. Consequently, ODOL must be addressed through stricter supervision and law enforcement to protect infrastructure and road users (Budiharjo et al., 2021).

Within the regulatory framework, the Ministry of Transportation has established the Motor Vehicle Weighing Implementation Unit (UPPKB) as the frontline of supervision (Setiono & Sabrie, 2023). UPPKB is tasked with supervising loading procedures, dimensions, and vehicle weight in accordance with Law Number 22 of 2009 (Hasrul et al., 2025; Jhordyan Pakiding Andilolo et al., 2024). Specifically, UPPKB Balonggandu and UPPKB Losarang hold strategic roles as they are located on the main national goods distribution routes in West Java. However, field observations reveal a significant gap between the volume of freight vehicles and the supervision capacity of these units (Vikaliana et al., 2024). Operational data indicate that loading and document violations remain dominant, while supervision is often constrained by limited operating hours, personnel shortages, and inadequate weighing facilities (Agoro et al., 2024).

Previous studies have analyzed transport issues using various approaches. (Han et al., 2022; Syifa & Tohir, 2025) utilized SWOT analysis for public transport planning and marketing but did not specifically examine practical constraints in UPPKB. Meanwhile, Budiharjo et al. (2021) focused on the statistical relationship between ODOL and road damage without providing sufficient managerial strategies. This study aims to fill this gap by integrating operational constraints into a strategic framework using a hybrid SWOT and Analytical Hierarchy Process (AHP) method (Kramar et al., 2019). This approach allows for not only for evaluating but also prioritising the most effective supervision strategies, offering a novelty in the context of Indonesian freight transport supervision (Mashudi et al., 2023)

Methods

Research Type

This study utilised a mixed-method approach (Ai et al., 2024). It began with a qualitative descriptive design to gain a deep understanding of supervision phenomena in the field through observations and interviews. Subsequently, a quantitative approach was applied using the A'WOT method, a hybrid of SWOT (Strengths, Weaknesses, Opportunities, Threats) analysis and AHP (Analytical Hierarchy Process), to provide weighted priorities for the formulated strategies (Saaty, 2008).

Population and Sample/Informants

Informants were selected using a purposive sampling technique based on their expertise and experience (minimum 10 years) in road traffic.

- Key Informants: A total of 5 experts, including mid-level management officials at the Ministry of Transportation, including the Director of Road Traffic and the Head of Sub-Directorate for Operational Control. Additionally, the Head of UPPKB Balonggandu, the Head of UPPKB Losarang, and the Head of Advocacy for the Indonesian Transportation Society (MTI) were involved to conduct the AHP pairwise comparison.
- Survey Respondents: To support the SWOT analysis, the study involved 100 freight transport drivers as questionnaire respondents, consisting of 50 drivers at UPPKB Balonggandu and 50 drivers at UPPKB Losarang. The driver instrument was distributed to 100 sample drivers, consisting of 50 drivers in Balonggandu and 50 in Losarang. The questionnaire design rigorously focused on assessing field operational practices, encompassing items on: (1) fleet profile and driver tenure, (2) the level of driver understanding regarding UPPKB policies, (3) the assessment of inspection effectiveness and strictness, (4) experiences regarding compliance obstacles, and (5) their opinions on aspects of improving supervision. To scientifically ensure the validity and reliability of this questionnaire construction, a pilot test was initially conducted to refine the wording and clarity of the items. Subsequently, the instrument's validity was robustly verified through methodological triangulation, cross-checking the survey responses with direct field observations and documentation.

Research Location

The research was conducted at two strategic locations serving as vital freight transport supervision points on the national roads of West Java Province:

1. UPPKB Balonggandu, Karawang Regency.
2. UPPKB Losarang, Indramayu Regency.

These locations were chosen due to their significant role in filtering logistics vehicle flow on the North Coast (Pantura) route of Java and the high potential for ODOL violations in the region.

Instrumentation or Tools

The primary instrument was the researcher, assisted by:

- In-depth Interview Guide: For key informants.
- Observation Sheet: For recording field operations.
- Questionnaires: A driver perception survey and a pairwise comparison questionnaire for AHP experts.
- Software: Expert Choice software was used to process AHP data to determine Eigenvalues and Consistency Ratios (yielding an actual average CR of 0.07, which is within the acceptable CR < 0.1 threshold). In handling data inconsistencies, the Consistency Ratio formula (CR = CI / RI) was utilized. If a CR value greater than 0.1 (10%) was detected, the researchers conducted revisions to improve information quality by re-evaluating and re-checking the questions during the pairwise comparison matrix completion with the experts until the CR successfully reached 0.1. Consequently, the detailed valid CR results per matrix are as follows: Overall Control Matrix CR = 0.095; Strengths Matrix CR = 0.080; Weaknesses Matrix CR = 0.092; Opportunities Matrix CR = 0.020; and Threats Matrix CR = 0.090.

Data Collection Procedures

Data collection was carried out from March 2025 to August 2025 using triangulation techniques:

1. Observation: Direct participation at research sites to observe real-time supervision.
2. Interviews: In-depth interviews with key informants to explore non-visible strategic information.

3. Documentation: Collecting secondary data such as enforcement reports and regulations.

Data Analysis

The data analysis followed an integrated multi-stage process:

1. Descriptive Qualitative Analysis: Analysing interview and observation data to describe violation types and existing conditions (Vicki Dwi Purnomo & Kelik Endro Suryono, 2022).
2. SWOT Analysis: Identifying internal factors (strengths, weaknesses) and external factors (opportunities, threats) (Syifa & Tohir, 2025). The procedure for generating and validating these SWOT factors was systematically conducted through expert informant interviews, literature studies, and questionnaire distribution. Furthermore, validation was conducted utilizing Triangulation methods (both source and method triangulation), where qualitative data obtained from interviews with the 5 key informants were cross-validated with direct field observations at the UPPKB and documentation review to ensure coding credibility and factor validity.
3. A'WOT Analysis: Identified SWOT factors were arranged in a hierarchy. Weighting was performed using AHP to determine strategy priorities based on global weights (Abdel-Basset et al., 2018)

Result and Discussion

Dynamics of Violations and Enforcement in UPPK

Based on operational data from 2019 to 2024, significant fluctuations in freight transport violations were observed. At UPPKB Balonggandu, total violations showed a declining trend from a peak in 2021. Conversely, UPPKB Losarang recorded a sharp increase in 2023, dominated by loading and document violations. Table 1 presents the specific trend of overloading violations, which serves as the primary indicator of load control effectiveness.

The data in Table 1 indicates that despite a decrease in 2024, the cumulative volume of overloading violations remains high. The recent decline is hypothesized to be potentially linked to intensified enforcement and early technology adoption, yet consistency in supervision remains a major challenge.

Strategic Factors and Policy Priorities (AHP-SWOT)

The AHP weighting results reveal that external Opportunity factors hold the highest priority weight (0.490), driven significantly by the sub-factor "Growing technological support" (0.204). Conversely, the most significant internal Weakness is "Technical constraints in field supervision" (0.052). By integrating these factors, the analysis generated priority strategies as shown in Table 2.

The strategy of "IT-based Inter-agency Integration" (AS1) ranks first with a weight of 0.113, followed closely by "Weigh-In-Motion (WIM) Training" (AS2) at 0.109. This underscores the critical need for a shift from manual supervision to integrated digital systems. The weight of 0.113 represents a priority ranking for implementation focus, rather than a measure of absolute effect size.

Interpretation of Findings

The findings indicate that conventional supervision methods are facing a saturation point in effectiveness. Although enforcement actions have increased, overloading violations remain fluctuating and high. The high weight of the technological opportunity factor (0.204) in the AHP analysis confirms that technical solutions such as Weigh-In-Motion (WIM) and digital data integration serve as essential elements in addressing the limited human resource capacity and technical constraints in the field. This aligns with recent research (Liu et al., 2025), which emphasises that modular WIM systems significantly improve weighing accuracy and efficiency compared to static scales, allowing for continuous monitoring without disrupting traffic flow.

Comparison with Previous Studies

These results reinforce the study by (Đalić et al., 2021; Kramar et al., 2019) stating that technology integration and data-driven strategic decisions are the foundation of logistics efficiency. The priority strategy on inter-agency integration (weight 0.113) supports the argument regarding the need for systemic collaboration to overcome logistics information delays. The AHP-SWOT findings strongly indicate that the integration of technology and long-term strategies are the key factors in strengthening the effectiveness of supervision, thus avoiding overly absolute claims while remaining thoroughly grounded in the empirical data. Furthermore, unlike Budiharjo et al. (2021) who focused on physical road damage, this study identifies through expert consensus that one of the primary constraints of the ODOL problem lies in weak detection and coordination systems. This must be resolved through the supervision of digitalisation strategies (Kayikci et al., 2024), as suggested regarding the legal responsibility of business actors (Bertolini & Riccaboni, 2021). Additionally, the need for automated enforcement aligns with global trends in smart city logistics (Collaço et al., 2022; Guo et al., 2022)

Table 1. Trend of Overloading Violations at UPPKB Balonggandu and Losarang (2019-2024)

Year	UPPKB Balonggandu (Cases)	UPPKB Losarang (Cases)	General Trend
2019	2.331	1.940	Low
2020	5.464	7.306	Increasing
2021	12.226	8.072	Peak (Balonggandu)
2022	9.108	7.394	Fluctuating
2023	8.226	9.208	Peak (Losarang)
2024	4.061	6.862	Decreasing
Total	41.416	40.782	Significant

Source: Primary Data

Table 2. Priority Strategies for Enhancing Supervision (AHP Results)

Rank	Code	Strategy Alternative	Global Weight	Strategy Category
1	AS1	IT-based Inter-agency Integration	0.113	SO (Strength-Opportunity)
2	AS2	Weigh-In-Motion (WIM) Training	0.109	SO (Strength-Opportunity)
3	AS6	Real-time Dashboard Development	0.107	WO (Weakness-Opportunity)
4	AS4	Adaptive SOP Evaluation	0.106	SO (Strength-Opportunity)
5	AS3	Community Participation	0.101	SO (Strength-Opportunity)

Source: AHP Analysis Primary Data (2025)

Implications

Practically, it is strategically indicated to integrate Online Weigh Bridge (JTO) data with the Police's Electronic Traffic Law Enforcement (ETLE). This integration allows for automatic sanctions against vehicle owners, not just drivers, creating a stronger deterrent effect. This policy shift is supported by recent systemic policy models (Abdurachman et al., 2025), which suggest that comprehensive digital enforcement is more effective than sporadic manual checks. However, successful implementation of this inter-agency integration requires a robust legal framework, clear data-sharing governance, and strict privacy protection protocols. To guarantee implementation feasibility, specific institutional measures must be systematically taken. Regarding the legal basis, integrating electronic systems requires the reformulation and revision of existing regulations (such as PP No. 30/2021, PM 18/2021, and the Traffic and Road Transportation Law) to officially recognize the validity of automated digital fines (e-ticketing) based on Weigh-In-Motion (WIM) sensor data, and to expand the legal umbrella so that strict sanctions are equally imposed on cargo owners and operators, rather than solely targeting drivers. For data governance and privacy, the integration of the Online Weigh Bridge (JTO) with the Police ETLE necessitates the establishment of a cross-sectoral Command Center at the provincial level, facilitating real-time violation reporting that is transparently accessible by the Ministry of Transportation, Local Governments, and the Police. Furthermore, concerning budgeting and human resources (HR), additional funding is essential to modernize field infrastructure and continuously improve the technical operational capacity of personnel. Mechanisms such as whistleblowing and internal audits must also be integrated to maintain the integrity of human resources against manual interventions

Conclusion

This study concludes that while formally possessing a regulatory basis, empirical facts prominently demonstrate that the actual field supervision and control of freight transport at UPPKB Balonggandu and Losarang is far from optimal. This significant discrepancy is caused by the high volume of vehicles, the dominance of document and load capacity violations, and administrative law enforcement methods that have not consistently provided an adequate deterrent effect. The AHP analysis identified that IT-based inter-agency integration (0.113) is the highest priority strategy. As a strategic priority, digital transformation must be systematically directed toward strengthening the integration of the supervision system through the interoperable connection of modernized WIM and CCTV technologies among the UPPKB, the ETLE system, and toll road operators. The findings recommend a revision of regulations to expand legal liability to cargo owners and the modernisation of supervision infrastructure. However, this study is limited to two specific UPPKB locations and heavily relies on expert judgments. Additionally, a notable limitation of this study is that the existing supervision analyzed is still hindered by manual and administrative operational approaches, as well as the absence of real-time inter-agency system integration, which inevitably results in delays in processing violation information. For future next steps, a pilot test of IT integration and WIM implementation is needed to evaluate actual violation reductions and processing times in the field. Furthermore, subsequent research should be critically focused on evaluating macro-policy reformulations. This includes studying the amendment of traffic regulations so that electronic fines and sanctions firmly target cargo owners or corporations, as well as exploring the development of an inter-agency Command Center to mitigate sectoral egos and strictly maintain the accountability of ODOL enforcement in Indonesia

Author contributions

Wahyu Suntoro: Conceived and designed the analysis, Collected the data, contributed data or analysis tools, Performed the analysis, Interpreted the results, Wrote the paper. Siti Maemunah: Conceived and designed the analysis, contributed data or analysis tools, Performed the analysis, Interpreted the results. Validation. Mustika Sari: Conceived and designed the analysis, contributed data or analysis tools, Performed the analysis, Interpreted the results. Validation, Visualisation. Djamal Subastian: contributed data or analysis tools, Interpreted the results. Ilham: contributed data or analysis tools, Performed the analysis, Interpreted the results, Wrote the paper, Correspondence.

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