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Integrated Road Safety Management System (IRSMS) As Policy Innovation and Educational Strategy for Underage Child Road Safety in Kupang City, Indonesia

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Abstract

Traffic accidents involving underage drivers remain a pressing public safety issue in Indonesia, particularly in urban areas such as Kupang City. This study examines the effectiveness of the Integrated Road Safety Management System (IRSMS) as both a governance innovation and an educational instrument to reduce accidents among children and adolescents who operate vehicles without meeting licensing requirements. Employing a mixed-method design, the research integrates quantitative analysis of police and hospital records with qualitative insights from interviews with teachers, parents, and community leaders. Findings reveal a significant decline of 18–25 percent in accidents involving underage drivers during the first two years of IRSMS implementation. Quantitative data highlight recurring risk factors, including unlicensed motorcycle use, lack of helmet compliance, and commuting patterns around schools. Qualitative evidence underscores IRSMS's role in strengthening school-based curricula and community campaigns, making road safety education more relevant through localized accident data. Despite these achievements, challenges persist, including limited infrastructure, incomplete real-time data coverage, and insufficient training for educators and enforcement officers. The study concludes that IRSMS is effective as both a technical system and an educational strategy. Its integration into policy and education offers a replicable model for fostering a sustainable road safety culture across Indonesia.

1. Introduction

The Road safety is a global public policy concern, with the World Health Organization (WHO) reporting that traffic accidents are among the leading causes of death among children and

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adolescents. Within this context, underage driving—children and adolescents operating vehicles without meeting legal licensing requirements—represents a critical challenge. Road safety is therefore not only a technical matter of transportation but also a fundamental issue of child protection.

In Indonesia, traffic accident rates remain high. Data from the Indonesian National Police Traffic Corps (Korlantas Polri) recorded more than 100,000 cases in 2022, resulting in tens of thousands of fatalities. Among these, underage drivers are a particularly vulnerable group, frequently involved as unlicensed motorcycle riders or as pedestrians with limited knowledge of traffic rules. Kupang City, the capital of East Nusa Tenggara Province, reflects this challenge. Rapid motorization has not been matched by adequate public awareness, and local police data show frequent involvement of underage children in traffic accidents, both as victims and as perpetrators.

This situation reveals a gap between road safety policies and community behavior. Formal education on traffic safety remains limited, while parental and community supervision of children's driving activities is often weak. As a result, structured education—both in schools and through community campaigns—has become increasingly urgent to address the risks of underage driving. The Integrated Road Safety Management System (IRSMS), introduced by the Indonesian National Police, offers a policy innovation that integrates accident data in real time and serves as a resource for educational programs. IRSMS data can inform school curricula, road safety simulations, and evidence-based community campaigns. By linking policy with education, IRSMS strengthens children's awareness of traffic discipline and the dangers of driving without a license.

Beyond schools, IRSMS supports non-formal education through campaigns in communities, churches, and youth organizations, where underage children are more receptive to messages from their immediate environment. The integration of evidence-based policy and community education creates a synergistic effect: strong policies require education for effective implementation, while education gains legitimacy through data-driven policy. This study therefore examines the effectiveness of IRSMS as both a public policy innovation and an educational instrument. The focus is on how IRSMS contributes to reducing traffic accidents involving underage drivers in Kupang City through the integration of evidence-based policy and school-based and community-based education programs. In order to clarify the position of this study, the subsequent section presents a review of relevant literature and theoretical frameworks.

Global Perspectives on Underage Driving

Traffic accidents remain one of the leading causes of death among children and adolescents worldwide. A critical dimension of this issue is underage driving, where minors operate vehicles without meeting licensing requirements. International studies emphasize that the risks stem not only from physical immaturity but also from limited knowledge of traffic rules and unsafe behavioral patterns. Reports from UNICEF (2021) and the Global Road Safety Partnership (GRSP) highlight the importance of embedding traffic safety education into both formal schooling and community initiatives. Evidence from countries with advanced safety systems shows that combining strict enforcement with structured education significantly reduces accidents involving underage drivers.

National Context: Indonesia

In Indonesia, traffic accident rates remain high, with underage drivers frequently involved as unlicensed motorcycle riders or pedestrians lacking traffic awareness. Research in Central Java (Anggoro et al., 2022) and Bekasi (Kompas.com, 2025) demonstrates that integrating traffic safety into school curricula can reduce risks, but such initiatives are often fragmented and localized. The Asian Transport Observatory (2025) notes persistent weaknesses in accident data quality, which undermine evidence-based policymaking. Many interventions remain reactive, focusing on enforcement after accidents occur rather than preventive strategies aimed at discouraging underage driving.

IRSMS as a Digital Governance Innovation

The Integrated Road Safety Management System (IRSMS), introduced by the Indonesian National Police Traffic Corps, represents a major step forward in digital governance for road safety. By enabling real-time accident reporting and analysis, IRSMS strengthens the government's capacity to respond to complex traffic challenges. Its implementation aligns with Indonesia's broader smart city agenda, where technology is leveraged to improve public services. Early evidence suggests IRSMS has contributed to accident reductions in several urban areas, highlighting its potential to address the specific risks posed by underage drivers (Trisantama et al., 2022; Kompas.com, 2024).

Evidence-Based Policy and Reliable Data

Effective road safety policies depend on accurate and integrated data. IRSMS addresses Indonesia's longstanding data challenges by providing a centralized platform for accident reporting and analysis. This supports evidence-based policymaking, allowing interventions to be more precisely targeted at underage driving risks. Beyond accident analysis, IRSMS data can inform educational programs and community campaigns, aligning with WHO and GRSP recommendations that emphasize the role of reliable data in shaping sustainable safety strategies (Indonesia Road Safety Partnership, 2010).

Education as a Preventive Strategy

Education plays a pivotal role in complementing policy innovation. School-based programs, such as the Road Safety School initiative in Bekasi, demonstrate that embedding traffic safety into curricula can instill discipline and awareness from an early age. UNICEF (2021) advocates for national strategies that integrate traffic safety education into schools, ensuring children understand both the risks and responsibilities of driving. Community-based education also proves effective, as shown in Grobogan, Central Java (Oktopianto et al., 2022), where workshops and parental involvement raised awareness about the dangers of underage driving. IRSMS strengthens these initiatives by providing localized accident data, making educational campaigns more relevant and evidence-based.

Research Gap

Despite IRSMS's demonstrated effectiveness in integrating accident data, academic studies connecting the system with educational strategies remain limited. Most research focuses on its technical and policy dimensions, overlooking its potential as an educational instrument for preventing underage driving (Trisantama et al., 2022). Yet IRSMS data could be directly applied

to school curricula, extracurricular activities, and community campaigns, particularly in high-risk areas such as Kupang. Addressing this gap, the present study explores IRSMS not only as a technical system but also as a tool for evidence-based education, aiming to strengthen the culture of road safety among underage drivers.

2. Method

This study employs a mixed-method design to evaluate the effectiveness of the Integrated Road Safety Management System (IRSMS) in reducing accidents involving underage drivers in Kupang City. Quantitative data were drawn from police and hospital records, focusing on accident frequency, demographic profiles, and types of incidents involving children and adolescents who operate vehicles without meeting licensing requirements. Qualitative data were collected through semi-structured interviews with teachers, parents, and community leaders to explore how IRSMS informs school-based and community-based education programs aimed at discouraging underage driving.

Quantitative analysis used comparative trend methods to measure accident rates before and after IRSMS implementation, while qualitative data were examined through thematic analysis to identify recurring themes such as inter-agency coordination, educational integration, and implementation challenges. Triangulation was applied to cross-check institutional records with stakeholder insights, ensuring validity and reliability. This dual approach not only quantifies IRSMS's impact on reducing accidents but also contextualizes its role as both a governance innovation and an educational strategy for shaping road safety culture among underage drivers in Kupang City.

3. Data presentation

Quantitative Findings

Police and hospital records in Kupang City indicate a significant decline in traffic accidents involving underage drivers following the implementation of IRSMS. Within the first two years, accident rates dropped by approximately 18–25 percent. The most notable reduction occurred in cases involving adolescents riding motorcycles without a valid license, which had previously accounted for a large share of traffic incidents among youth. IRSMS enabled authorities to identify accident-prone areas (blackspots) and recurring causal factors, such as reckless driving behavior, failure to wear helmets, and limited pedestrian awareness among children.

Beyond the overall decline, IRSMS data revealed important demographic patterns. Most underage drivers involved in accidents were between 13 and 16 years old, with male adolescents more frequently represented than females. A majority of incidents occurred during commuting hours to and from school, suggesting that daily mobility routines significantly contribute to risk exposure. These findings highlight the need for targeted interventions, including stricter monitoring around school zones and awareness campaigns directed at parents and guardians to reduce the risks associated with underage driving.

Qualitative Findings

Interviews with teachers, parents, and community leaders show that IRSMS is perceived not only as a technical system but also as an educational resource. Teachers reported that IRSMS data could be incorporated into classroom discussions, particularly in Civic Education and extracurricular programs, to raise awareness among students about the dangers of driving without a license. Parents emphasized that campaigns supported by IRSMS data were more persuasive, as they provided concrete evidence of local accident risks. Community leaders noted that IRSMS strengthened collaboration between schools, families, and local organizations in promoting traffic discipline among adolescents.

Nevertheless, several challenges were identified. Teachers expressed the need for training to interpret IRSMS data effectively, while parents pointed to inconsistent enforcement against underage drivers in their neighborhoods. Community leaders highlighted infrastructural limitations, such as incomplete real-time data coverage in rural areas, which reduced the system's effectiveness. Despite these obstacles, the qualitative findings suggest that IRSMS has strong potential to bridge the gap between policy and education, provided that its implementation is supported by adequate resources and stronger institutional coordination.

4. Discussion

IRSMS as a Governance Innovation

The quantitative findings demonstrate that IRSMS has contributed to a measurable reduction in accidents involving underage drivers in Kupang City. This outcome highlights the importance of digital governance tools in addressing public safety challenges. By enabling real-time accident reporting and analysis, IRSMS provides policymakers with timely and reliable information, which allows interventions to be more responsive to local conditions. The system's ability to identify accident-prone areas and recurring causal factors strengthens enforcement strategies and supports evidence-based decision-making.

Beyond its immediate impact, IRSMS reflects Indonesia's broader smart city agenda, where technology is leveraged to improve public services. Its success in Kupang suggests that similar systems could be replicated in other regions, particularly those struggling with high rates of underage driving. Replication would require careful adaptation to local contexts, but the principle of integrating technology into governance remains universally relevant.

However, the effectiveness of IRSMS depends on adequate infrastructure and trained personnel. Without these, the system risks becoming a technical innovation without meaningful impact. Policymakers must therefore invest in capacity building, ensuring that local authorities and schools can interpret and apply IRSMS data effectively. This investment would transform IRSMS from a passive reporting tool into an active driver of institutional reform.

Another critical dimension is inter-agency coordination. IRSMS requires collaboration between police, hospitals, schools, and community organizations to ensure that data is not only collected but also acted upon. The system's success in Kupang demonstrates that when institutions work together, road safety outcomes improve significantly. Strengthening these partnerships will be essential for scaling IRSMS nationally.

Finally, IRSMS should be viewed not only as a governance tool but also as a catalyst for cultural change. By embedding road safety into everyday governance practices, IRSMS encourages communities to see traffic discipline as a shared responsibility. This cultural shift is particularly important in addressing underage driving, which often stems from social norms that tolerate or even encourage minors to operate vehicles.

IRSMS as an Educational Instrument

The qualitative findings reveal that IRSMS is valued not only as a technical system but also as an educational resource. Teachers reported that IRSMS data could be integrated into classroom discussions, particularly in Civic Education and extracurricular programs, to raise awareness among students about the dangers of driving without a license. Parents emphasized that campaigns supported by IRSMS data were more persuasive, as they provided concrete evidence of local accident risks. Community leaders noted that IRSMS strengthened collaboration between schools, families, and local organizations in promoting traffic discipline among adolescents.

The educational potential of IRSMS lies in its ability to localize road safety messages. Instead of relying on abstract statistics, IRSMS provides data that reflects the realities of specific communities. This makes educational campaigns more relevant and impactful, as students and parents can see the direct connection between unsafe behavior and accidents in their own neighborhoods. Such localization aligns with global recommendations from UNICEF and GRSP, which emphasize embedding traffic safety into school curricula.

Nevertheless, challenges remain in fully realizing IRSMS's educational potential. Teachers require training to interpret and apply IRSMS data effectively, while parents call for stronger enforcement to complement educational efforts. Without these supports, IRSMS risks being underutilized in educational settings. Addressing these challenges would allow IRSMS to function as a bridge between policy and education, ensuring that road safety becomes a shared responsibility among schools, families, and communities.

Another challenge is infrastructural limitation, particularly in rural areas where real-time data coverage is incomplete. This reduces the system's effectiveness and limits its educational reach. Expanding IRSMS infrastructure to cover more regions would ensure that all communities benefit from its insights. Such expansion would also strengthen national road safety education programs, making them more inclusive and comprehensive.

Ultimately, IRSMS has the potential to foster a sustainable culture of traffic discipline that discourages underage driving. By combining technical innovation with educational integration, IRSMS can transform road safety from a reactive policy into a proactive cultural practice. This dual role positions IRSMS as a unique model for other regions, demonstrating how technology and education can work together to protect children and adolescents from premature driving risks.

5. Conclusion

This study demonstrates that the Integrated Road Safety Management System (IRSMS) is effective both as a public policy innovation and as an educational instrument for addressing underage driving. Quantitatively, IRSMS reduced traffic accidents involving underage drivers in Kupang City by 18–25% during its first two years of implementation. Qualitatively, IRSMS is recognized by teachers, parents, and community leaders as a relevant system that supports both school-based and community-based education programs aimed at preventing underage driving. By providing accurate and integrated data, IRSMS enhances inter-agency coordination, enriches school curricula, and strengthens evidence-based community campaigns.

To maximize the effectiveness of IRSMS in reducing accidents caused by underage drivers, it is essential to strengthen institutional data integration for comprehensive accident analysis and faster policy responses, enhance human resource capacity through intensive training in IRSMS

operation and data interpretation, expand technological infrastructure to improve real-time data coverage particularly in suburban and rural areas, integrate IRSMS into school-based and community-based education programs to discourage underage driving through localized curricula and campaigns, and develop community-friendly IRSMS features that enable children, parents, and educators to access safety information interactively; together, these strategies will ensure IRSMS functions not only as a technical system but also as a foundation for evidence-based public policy and educational initiatives that foster a sustainable road safety culture in Kupang City.

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