Impacts of Integrated Security-Based Approach on Traffic Congestion in Eldoret City, Kenya

Denis K. Sugut[1] & Steve O. Ngodhe[1*]

[1]*Department of Environmental Studies, Maasai Mara University, Kenya*

**Corresponding author: omari@mmarau.ac.ke*

https://doi.org/10.62049/jkncu.v5i1.439

Abstract

This study sought to assess the effects of integrated security-based approach on Traffic congestion in Eldoret city. Traffic congestion in Eldoret City's Central Business District (CBD) poses enormous problems to mobility, economic output, and urban safety. In this study, integrated security-based approaches were analyzed based on Systems Theory, Urban Mobility and Trip Generation Theory, and Triple Convergence Theory to evaluate the impacts. A descriptive research was applied to a sample size of 80 respondent's which include those CBD commuters, traffic police and county officials, out of which 75 responses received (93.75% response rate). Data was collected by questionnaire and analyzed through descriptive statistics and described in frequency tables and percentages. Findings therefore showed that poor urban planning (40%), inadequate road capacity (26.7%), weak traffic enforcement (20%) and over-reliance on private vehicles (13.3%) are major causes of congestion consistent with Systems theory perception of transport systems. Effects include prolonged travel time (33.3%) air pollution (26.7%) economic losses 20% and safety risks 20% petty theft and delayed responses to emergencies confirm. The current traffic management methods, mainly road expansions, which were apparently worthless to 73.3 percentage points of respondents, confirmed Triple Convergence Theory's insults at supply-side remedies drawing latent demand. A high level of support was evident for security-based interventions through increased surveillance (40%), restrictive enforcement (33.3%), intelligent transport systems (ITS) (20%), public awareness campaigns (6.7%), concurs with Systems Theory's focus on adaptive systems. The study finds that congestion in CBD Eldoret is one of its systemic problems caused by structural, behavioral, and technical flaws. Current solutions are ineffective because of technology and coordination limitations that require merged intervention.

Keywords: Congestion, Eldoret City, Integrated Security-Based, Traffic

Background Information

Human society relies on transportation as its primary activity because it creates possibilities to reach economic prospects along with essential services and social platforms. The facilitation of goods and people movements occurs across multiple geographic ranges which includes both local community settings and global network operations. Road transport dominates all other transportation methods because it offers both flexibility and extensive network reach according to (Anciaes et al., 2025).

Globally, High-traffic congestion has evolved into a major urban issue which affects both developed and developing countries across the world. According to the World Bank (2019) the economic performance reduces, and pollution rises while life quality decreases in congested urban areas. Through combined strategies of congestion pricing and surveillance systems and mass transit integration London and Singapore manage to reduce traffic congestion. Global traffic congestion continues to be a permanent challenge because urbanization rates keep increasing.

In Africa, the path of urban expansion surpasses the development of necessary infrastructure at a speed that creates complexities across African urban settings. The urban areas of Lagos and Johannesburg with Accra among them face continuous congestion which leads to prolonged journeys and rising automobile pollution levels and transportation expenses (Ukpata & Etikaa, 2012). African governments started investing in physical infrastructure, but these investments became less effective because of missing integrated and secure traffic management systems. The combination of insufficient planning together with enforcement difficulties and low smart mobility technology adoption enhances current challenges (Kwoba & Mettke, 2020).

Kenya is no exception. Vision 2030 development blueprint changed the face of the country with major national investments devoted for construction of bypasses in addition to highways and modernized interchanges. The highway construction of Thika Superhighway had acted as the main infrastructure enterprise that would have reduced traffic congestion in the city. On Mombasa Road Jogoo Road, physical infrastructure projects continue to experience heavy traffic congestion thus clearly showing that physical infrastructure cannot reduce congestion problems. The poor relationships between road management and existing traffic laws, as well as problematizing road uses as found in Muguro et al. (2022), make traffic congestion worse in Kenyan cities. The Transport and Urban Decongestion Authority (TUDA) functions in Nairobi County but its statistics-based traffic system has limited to some output.

Eldoret City continues to expand as a regional economic hub while facing severe traffic jam problems in its Central Business District (CBD) that become worse at peak times. The blocked traffic patterns create obstruction of transportation while also lowering operational output and creating safety threats. The combination of poor coordination with inadequate modern technology integration between existing road expansion and bypass implementation projects explains why these measures have failed to deliver sustainable solutions (Cheboi & Kilimo, 2023).

Real-time surveillance together with weak traffic regulation enforcement and limited ITS applications all lead to significant performance reductions in current intervention methods. Repeating traffic congestion occurs because of insufficient planning combined with population growth of vehicles and the absence of data-guided management strategies (Langat, 2020; Muguro et al., 2022). The urban locations that have experienced success with federated learning and vehicle-to-infrastructure communication have not

maximized these best practices (Ghulam et al., 2024; Ta & Dvir, 2020). Eldoret's traffic issues will worsen because the town lacks a security-focused operational partnership between stakeholders and enforcement agencies together with planners which would threaten regional development goals. The research aimed to resolve these gaps through security-focused integrated strategies which understand the specific urban characteristics of Eldoret city.

Materials and Methods

The study employed a descriptive cross sectional research design. The target population consisted of youths and organisations directly or indirectly affected by traffic congestion in Eldoret's City. This includes private vehicle drivers, public transport operators such as matatu and boda boda riders, pedestrians, traffic police officers and the county government officials charged with urban planning and transport management. According to estimates on the Uasin Gishu County Integrated Development Plan (2018-2022), it is estimated that Eldoret's CBD serves around 10,000 daily commuters including 4,000 private motorists, 3,000 public transport owners, and 2,500 pedestrians, 100 traffic police and 50 county employees. These groups are important in the study of the interplay of behavioral, operational, and institutional forces that lead congestion. The target population is reachable in the CBD and, as such, it is easy to collect data (Ogao, 2019).

The research used a mix of stratified and purposive sampling methods in the bid of achieving representativeness and relevance. The stratified sampling technique was applied to form homogeneous subgroups (strata) of the target population in reference to their roles: private vehicle drivers, public transport operators, pedestrians, traffic police and county officials. This method guarantees that every group is well represented in the sample (Muguro et al., 2022). In each strata simple random sampling is used to select respondents and bias is reduced. A purposive sampling technique is used when selecting the county officials and traffic police officers since they are professionally knowledgeable and in minimal numbers, thus ensuring that key informants give appropriate in-depth insights (Ogao, 2019). The sample size was computed from the Cochran's formula for finite populations, as is suitable for the known target population (10,650). The formula is:

Sample Size Formula:

$$n = \frac{Z^2 \cdot p \cdot q \cdot N}{E^2 \cdot (N-1) + Z^2 \cdot p \cdot q}$$

Where:

- n : Sample size
- Z: Z-score for 95% confidence level = 1.96
- p : Estimated population proportion = 0.5
- $q = 1 - p = 0.5$
- E : Margin of error = 0.1
- N : Population size = 10,650

Workings:

$$n = \frac{1.96^2 \cdot 0.5 \cdot 0.5 \cdot 10{,}650}{0.1^2 \cdot (10{,}650 - 1) + 1.96^2 \cdot 0.5 \cdot 0.5}$$

$$n = \frac{3.8416 \cdot 0.25 \cdot 10{,}650}{0.01 \cdot 10{,}649 + 3.8416 \cdot 0.25}$$

$$n = \frac{3.8416 \cdot 2{,}662.5}{106.49 + 0.9604}$$

$$n = \frac{10{,}227.09}{107.4504}$$

$$n \approx 95.16$$

Structured questionnaires were used to collect quantitative information from private vehicle drivers, public transport operators, and pedestrians on travel patterns, on congestion experience and perceptions of security-based interventions. The questions used are Likert-scale – to determine attitudes and open-ended questions to provide qualitative results (Muguro et al., 2022). The traffic police officers and county officials were interviewed semi-structurally to obtain in depth data on enforcement practices, policy implementation and institutional challenges. The use of interviews in this study provides flexibility in exploring such emerging themes as the feasibility of intelligent transport systems (ITS) in Eldoret (Kwoba & Mettke, 2020). Observational research methods were also conducted at important CBD intersections to observe traffic flow, function of signal and driver behavior. Observations were taken through checklists to ensure consistency, and they occur at peak and off-peak hours for timing variations (Ogao, 2019). All instruments were pre-tested with a pilot group of 10 respondents to ensure clarity and reliability. Data collection took place in May 2025 for a period of four weeks. Data was analyzed by the use of descriptive and inferential statistics using the Statistical Package for the Social Sciences (SPSS)version 26 for data processing and analysis. Qualitative information gathered from interviews with open-ended questionnaire responses was analyzed through thematic analysis. Responses were transcribed and coded into themes including enforcement challenges, gaps in technologies and stakeholder coordination. NVivo software was used to upload qualitative data into the software/ program and organize it (Ogao, 2019). The observational data were then described to determine the flow of traffic and violations which support conclusions obtained from the questionnaire and interviews. Findings were reported in tables and charts.

Results and Discussions

Table 1 below represents respondents' ratings of current traffic management measures in Eldoret's CBD. A majority (40%) found measures very ineffective, and 33.3% rated them somewhat ineffective, reflecting the lack of intelligent transport systems (Kwoba & Mettke, 2020). Only 20% found them somewhat effective, and 6.7% very effective, suggesting limited success of road expansions, consistent with Triple Convergence Theory (Downs, 2004).

Table 1: Effectiveness of Current Traffic Management Measures

Effectiveness Level	Frequency	Percentage (%)
Very ineffective	30	40.0
Somewhat ineffective	25	33.3
Somewhat effective	15	20.0
Very effective	5	6.7
Total	75	100.0

The high rating of ineffectiveness (73.3%) of existing measures is a reflection of Eldoret's dependency on supply-side solutions such as road expansions, which Triple Convergence Theory criticizes as attracting latent demand (Downs, 2004). This missed opportunity of ITS such as adaptive signal control constrains dynamic control (Kwoba & Mettke 2020). The Uasin Gishu CIDP proposed reforms (2018–2022), but implementation gaps remain. There is implied a need for demand side interventions (e.g. congestion charging) and technology-oriented solutions to manage traffic.

The integrated security-based interventions to reduce congestion is as shown in figure 1 below. Enhanced surveillance (40%) was most favored, aligning with Ogao (2019) on enforcement needs. Stricter enforcement (33.3%) supports Systems Theory's emphasis on coordination (Suryani et al., 2020). Intelligent transport systems (20%) reflect Ta and Dvir (2020), while public awareness campaigns (6.7%) indicate lower priority but align with behavioral change needs (Houshmand Masoumi, 2021).

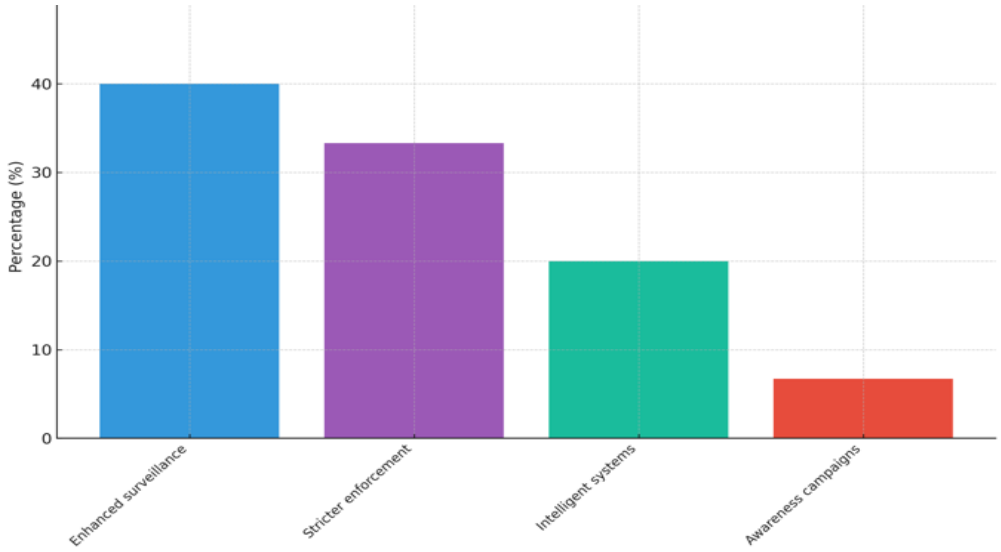

Figure 1: Integrated Security-based interventions in Eldoret City, Kenya

Heavy support towards surveillance (40%) and enforcement (33.3%) concurs with emphasis on organized, adaptive systems as articulated by Systems Theory (Suryani et al., 2020). Such interventions would consider such behaviors as noncompliance which worsens congestion (Ogao, 2019). Support for ITS (20%) is associated with an acknowledgment of the technology's ability to streamline flow in its optimization (Ta & Dvir, 2020). Low support for awareness campaigns (6.7%) indicates favouring of structural solutions, but behavioural change still holds true (Houshmand Masoumi, 2021). These results support integrated approaches, including surveillance, enforcement and technology.

Table 1 below is a reflection of the views of the respondents as to the main causes of traffic congestion in Eldoret City. Poor urban planning was one of the answers made by 40% of respondents due to unplanned urban sprawl and absence of pedestrian pathways (Muguro et al., 2022). Insufficient road capacity (26.7%) concurs with Langat (2020), observing Eldoret's outdated road network. Weak enforcement (20%) and over-reliance on private vehicles (13.3%) back Ogao (2019), McGuckin (2015) on trip generation difficulties respectively.

Table 2: Main Causes of Traffic Congestion in Eldoret CBD

Cause	Frequency	Percentage (%)
Poor urban planning	30	40.0
Inadequate road capacity	20	26.7
Weak traffic enforcement	15	20.0
Overreliance on private vehicles	10	13.3

The top cause identified (40%) of poor urban planning relates back to unplanned growth of Eldoret with sprawled residential area and lack of a pedestrian infrastructure which add to trip lengths and vehicular use (Muguro et al., 2022). This is supportive of Urban Mobility and Trip Generation Theory, in that patterns of land use cause trip generation (McGuckin, 2015). The reduced road capacity (26.7%) is an indication of the mismatch between Eldoret's road network and increases in flow volumes: a systemic problem according to Systems Theory (Armah et al, 2010). Poor enforcement (20%) establishes the role of human behavior and institutional failures because illegality of parking and non-compliance unlawfully interrupt flow (Ogao, 2019). Existence of over-reliance on private vehicles (13.3%) is related to socio-economic factors including, lack of public transportation options which support private car usage (Houshmand Masoumi, 2021). Such findings suggest that congestion is a complicated, systemic issue and that a solution to congestion is a cross-cutting issue that calls for simultaneous intervention in planning, infrastructure, enforcement and behavior.

The consequences, including more time spent in motion, air quality degradation, and economic and hazard factors ulcerate congestion's widespread effect. More time to travel (33.3 %) makes productivity lower consistent with Ghulam et al (2024) on economic inefficiencies. Air pollution (26.7%) indicates environmental degradation, and similar to Armah et al. (2010), correlates congestion with emissions in African cities. Economic losses (20%) discourage investment because the expenditure is increased for businesses (Ghulam et al., 2024). Safety risks (20%), theft and delayed emergency responses, expose security concerns (Ogao & Makokha, 2018). These findings have highlighted the importance of need for security-based interventions to improve safety and efficiency which supports the study's relevance to surveillance and enforcement.

Conclusion

The integrated security-based approach to alleviate traffic congestion has not fully achieved its intended purpose since the traffic snarl along the major streets in the city are still being experienced despite the implementation of the integrated security-based approach. The management should therefore enforce more strict policies and employ technology-based approaches like deployment of Intelligent Transport Systems (ITS). This system provides real-time congestion detection and dynamic signal modification, decreasing bottlenecks (Ta & Dvir, 2020). Other recommendations include better planning for public transport, stakeholder coordination and awareness campaigns. They correspond to Systems, Urban Mobility, and Triple Convergence Theories, providing a route map for a secure, efficient and sustainable transport system in Eldoret City.

References

Anciaes, P., Cheng, Y., & Watkins, S. J. (2025). Policy measures to reduce road congestion: What worked? *Journal of Transport & Health, 41*, 101984. https://doi.org/10.1016/j.jth.2025.101984

Armah, F. A., Yawson, D. O., & Pappoe, A. N. M. (2010). A systems dynamics approach to explore traffic congestion and air pollution in the Accra metropolitan area. *Sustainability, 2*(1), 252–265. https://doi.org/10.3390/su2010252

Cheboi, J., & Kilimo, J. K. (n.d.). *Planning for smart transportation system in urban Kenya: A case of Eldoret municipality* [Master's thesis, University of Eldoret]. http://erepository.uoeld.ac.ke/bitstream/handle/123456789/2114/John%20Kilimo%20Cheboi.pdf

County Government of Uasin Gishu. (n.d.). *County Integrated Development Plan (CIDP) 2018–2022: A prosperous and attractive county in Kenya and beyond*. https://www.devolution.go.ke/sites/default/files/2024-03/UASINGISHU-CIDP-2018-2022.pdf

Downs, A. (2004). *Still stuck in traffic: Coping with peak-hour traffic congestion.* Brookings Institution Press.

Ghulam, H., Ahmad, R., Fatima, A., Mohammed, A. S., & Khan, M. A. (2024). Secure and transparent traffic congestion control system for smart city using a federated learning approach. *International Journal of Advanced and Applied Sciences, 11*(7), 1–10. https://doi.org/10.21833/ijaas.2024.07.001

Kwoba, H., & Mettke, C. (2020). *Digitalisation in Kenya's road transport sector*. https://www.changing-transport.org/wp-content/uploads/2020_Digitalisation_Kenya_Road_transport_sector.pdf

Langat, K. (2020). *Effects of land use on non-motorized transport patterns in Eldoret Central Business District* [Master's thesis, University of Nairobi]. https://erepository.uonbi.ac.ke/handle/11295/155981

McGuckin, N. (2015). *Summary of travel trends: 2015 National Household Travel Survey*. U.S. Department of Transportation, Federal Highway Administration.

Muguro, J., Njeri, W., Matsushita, K., & Sasaki, M. (2022). Road traffic conditions in Kenya: Exploring the policies and traffic cultures from unstructured user-generated data using NLP. *IATSS Research.* https://doi.org/10.1016/j.iatssr.2022.03.003

Ogao, P. J. (2019). Surveillance and enforcement gaps in Kenyan urban mobility systems. *East African Journal of Planning and Development, 5*(2), 112–125.

Ogao, P. J., & Makokha, W. (2018). Traffic congestion and urban safety in mid-sized Kenyan cities. *Kenya Journal of Safety and Urban Development, 3*(1), 55–63.

Suryani, E., Ramadhan, R., & Rosyid, M. M. (2020). Systems thinking approach in intelligent transportation systems. *Journal of Transportation Technologies, 10*(3), 241–252. https://doi.org/10.4236/jtts.2020.103015

Ta, S., & Dvir, O. (2020). Vehicle-to-infrastructure communication and urban traffic optimization: A case study review. *International Journal of Transportation Science and Technology, 9*(1), 1–13. https://doi.org/10.1016/j.ijtst.2020.03.001

Ukpata, J. O., & Etikaa, A. E. (2012). Traffic congestion in major cities of Nigeria. *International Journal of Engineering and Technology, 2*(10), 144–149.

World Bank. (2019). *Kenya National Urban Transport Improvement Project.* https://documents1.worldbank.org/curated/en/702181563299068935/pdf/Kenya-National-Urban-Transport-Improvement-Project.txt