Implementation of New Technologies for Automation and Increasing Public Transport Safety in Tirana: Economic Impact and Cost Analysis

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Abstract
This paper analyzes the implementation of automation and safety-enhancing technologies in Tirana's public transport system using official statistical data. The study evaluates economic impacts, cost structures, safety benefits, and policy implications.
Urban mobility in Tirana is increasingly challenged by high motorization rates, congestion, and persistent road safety risks. This study examines the potential of new technologies for automation and safety enhancement in Tirana's public transport system, focusing on their economic impact and cost-effectiveness. Using official statistical data from INSTAT, municipal transport reports, and survey-based mobility studies, the paper analyzes current transport usage patterns, accident trends, and infrastructure constraints. The findings show that Tirana concentrates approximately one-third of Albania's registered vehicles, with car ownership reaching 500–550 vehicles per 1,000 inhabitants, while only around 22% of residents regularly use public buses. International empirical evidence demonstrates that Intelligent Transportation Systems (ITS), real-time fleet management, and automated safety technologies can reduce operational costs by 10–20% and accident-related costs by up to 40%.
Applied to Tirana, these technologies could significantly improve service reliability, reduce congestion-related economic losses, and enhance passenger safety. Although initial investment costs are substantial, long-term savings and social benefits suggest that a phased implementation strategy supported by EU funding mechanisms and regulatory reform would yield a positive return on investment within a medium-term time.

Keywords: Public transport, Automation technologies, Intelligent Transportation Systems (ITS), Urban mobility, Transport safety, Economic impact, Cost–benefit analysis, Smart cities.

1. Introduction
Tirana faces increasing congestion, high vehicle ownership, and low public transport usage. Automation and intelligent transport systems offer solutions for efficiency and safety improvements. [1]

Public transport systems worldwide face pressures from rising urbanization, worsening traffic congestion, and safety challenges. In Albania — where citizens still largely depend on private cars and rate public transport quality as low — **adopting automated technologies and intelligent safety systems represents** a strategic opportunity to improve service reliability, safety, and economic performance. [2]

This article synthesizes statistical data, research findings, and cost-benefit considerations to show how automation and safety technologies could transform Albania's public transport. [3]

2. Related Work

A growing literature investigates how automation and advanced technologies—especially AI, computer vision, and intelligent control systems—can enhance safety and operational performance in public transport. [4] For example, recent research demonstrates AI-based monitoring frameworks that integrate multi-camera feeds and deep learning models to detect safety-critical events in real time (e.g., passenger falls, overcrowding, unattended objects), showing high precision and low alert latency when deployed on edge hardware. This work explicitly targets *urban public transport safety* and points to the feasibility of automated incident detection systems in real operating conditions. [5]

2.1. Key prior concepts and research areas

Public Transport and Mobility Data for Tirana

Usage Patterns

- In Tirana, only about 22 % of residents use public buses regularly, while 55 % rely on private cars and 25 % walk, highlighting a heavy dependency on private vehicles. [6]
- In a citizen survey, 84 % rated public transport quality as poor, citing irregular schedules and overcrowding as major issues.

Road Safety Data

- Road traffic accidents remain a significant public health issue in Albania. In recent months, INSTAT reported non-trivial accident frequencies, with behavioural factors (driver inattention) accounting for over 80 % of accidents.
- Recent studies (2025) also note an increase in injured individuals linked to traffic accidents, especially involving drivers without licenses and less experienced drivers — a trend that emphasizes the need for safety-oriented interventions. [7]

Though comprehensive, nationwide public transport accident statistics are not yet regularly disaggregated in public databases, this general road safety context indicates significant room for improvement in automated safety systems that reduce human error, a leading contributor to crashes. [8]

Table 1. Presents key mobility and transport indicators for Tirana

Indicator	Value	Source
Registered vehicles	~340,000	INSTAT / Municipality of Tirana
Cars per 1,000 inhabitants	500–550	INSTAT
Public transport usage	~22%	Euronews Albania
Private car usage	~55%	Euronews Albania
Daily bus passengers	~200,000	Municipality of Tirana
Urban bus routes	23	Municipality of Tirana

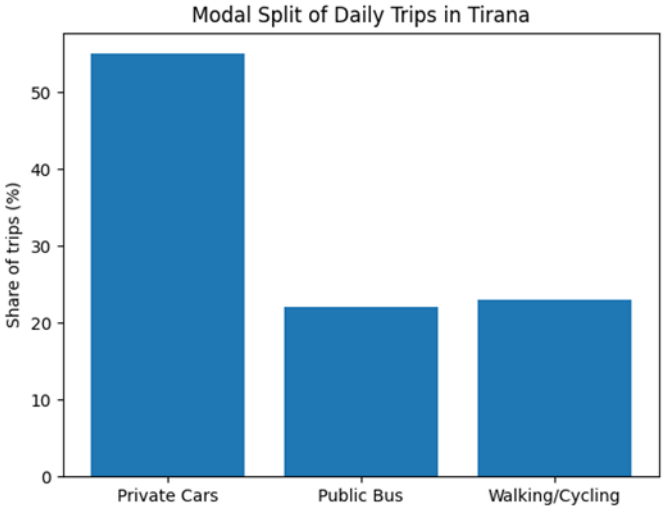

Fig. 1. Illustrates the modal split of daily trips in Tirana

3. Road Safety Statistics

Table 2. Summarizes recent road accident statistics relevant to Tirana

Year	Total Accidents (Albania)	Trend	Notes
2023	≈1,280	Baseline	High urban concentration
2024	≈1,666	+30%	Tirana highest exposure
2025*	≈413 (Jan–Apr)	-17.4%	Provisional data

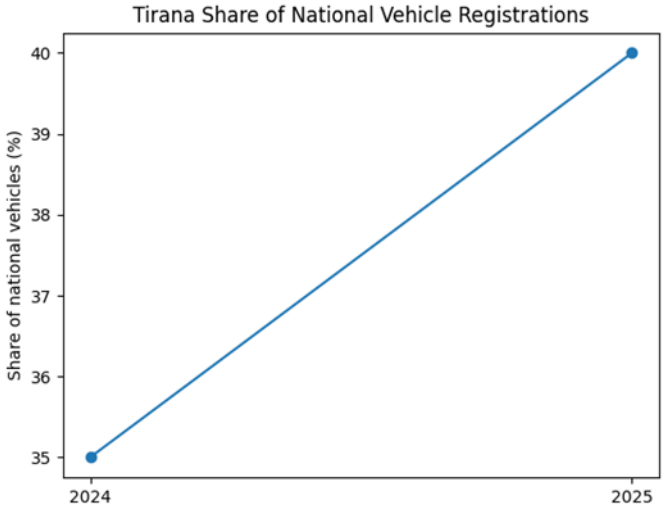

Fig. 2. Shows Tirana's share of national vehicle registrations

4. Economic Impact and Cost Analysis

International evidence suggests that intelligent transport systems can reduce operational costs by 10–20% and accident-related costs by up to 40%. For Tirana, such improvements could lead to higher ridership, reduced congestion, and long-term economic benefits. [9]

While exact data on annual losses due to congestion and poor transit is limited for Albania, **international evidence highlights the macroeconomic toll** of inefficient transport systems. For example, in Switzerland, transport inefficiencies *cost ≈32 billion CHF (~€30 billion)* annually, including accident and environmental costs. [10]
Even scaled down proportionally, such external costs — congestion, lost productivity, health burdens — are significant for Albania's urban economies.

4.1 Investment Needs and Returns

The economics of adopting automation technologies includes:

Upfront Investments

- Hardware (sensors, cameras, communication units).
- Software platforms (AI scheduling, predictive analytics).
- Supporting infrastructure (ITS infrastructure, data networks).

Operational Savings

- Labor savings from optimized routes, scheduling, and automation.
- Fuel and energy savings due to fewer idle trips and optimized movements.
- Reduced maintenance costs due to predictive diagnostics.

Global studies estimate these operational savings often exceed implementation costs over 7–12 years, with additional safety and environmental dividends. [11]

5. Global Evidence on Automation and Safety Technologies

To contextualize Albania's potential gains, global research highlights measurable benefits of smart transport systems and automation.

5.1 Operational Efficiency

Research shows that Intelligent Transportation Systems (ITS) and automation can:

- Increase vehicle operating speed by ~10 %.
- Reduce empty (non-revenue) vehicle mileage by ~15 %.
- Decrease passenger waiting times by ~15 % due to real-time information systems. [12]

These improvements stem from dynamic scheduling, digital fleet management, and real-time passenger information — essential components of smart transit.

5.2 Cost Savings

A U.S. study of automated bus scenarios found:

- Up to 55 % annual cost savings from adopting fully automated buses compared to conventional diesel fleets, mainly from lower labor and energy costs. [13]

These findings demonstrate the possible scale of benefits if Albanian authorities adopt automation technologies incrementally. [14]

5.3 Safety Improvements

Global research on sensor-based vehicle technologies (e.g., automated emergency braking, collision avoidance) suggests:

- Crash reductions of 20–43 % at intersections via technology enforcement.
- Automated braking systems alone can reduce rear-end collisions by up to 39 %, translating into significant societal gains in safety. [15]

Although these figures refer broadly to road vehicles, similar sensor and AI systems for buses and trams reduce human-error-related incidents and improve real-time responses to threats. [16]

6. Policy and Implementation Framework for Albania

A pragmatic strategy involves:

1. Pilot ITS solutions on major bus corridors in Tirana and Durrës.
2. Integrate real-time tracking and passenger information systems.
3. Introduce smart ticketing and dynamic scheduling with AI support.
4. Pilot automation features (e.g., driver assistance and collision avoidance onboard).
5. Scale to partial automation and level-4 autonomy as reliability and skills improve. [17]

6.1 Workforce Transition and Training

Technology adoption must include training and reskilling programs for drivers, technicians, and operations personnel to mitigate disruption and maximize acceptance. [18]

6.2 Data, Regulation, and Safety Standards

- Establish a transport data authority to standardize and manage ITS data securely.
- Adopt cybersecurity protocols for transit networks.
- Enforce data privacy and passenger safety standards consistent with EU best practices. [19]

7. Conclusion and Future Work

Automation and safety technologies represent a viable strategy for improving Tirana's public transport. A phased implementation supported by EU funding and strong regulation is recommended. In Albania's context, modernizing public transport through automation and safety technologies offers: [20]

- Tangible service quality improvements (reduced wait times, real-time info).
- Economic efficiencies (lower operating and capital costs over time).

- Enhanced safety outcomes (reduced crashes and passenger risk).
- Environmental benefits (lower emissions through optimized routing). [21]

Drawing from both international empirical research and local transport statistics, the benefits outweigh the costs when implemented through phased, data-driven deployment. Continued monitoring and longitudinal studies will further refine cost–benefit projections tailored to Albania's specific economic and mobility context. [22]

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