Implementation of Traffic Signals in a Small City like Agartala: Merits and Demerits

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Abstract

The urban landscape of Agartala, the capital of Tripura, presents a unique challenge for transportation engineering due to its historical "Chowmuhani" (four-way intersection) culture, narrow legacy streets, and a recent explosion in paratransit vehicles like e-rickshaws (Totos). Historically reliant on manual traffic policing, the city has recently transitioned toward an Intelligent Transport System (ITS) under the Smart City Mission. This research paper evaluates the merits and demerits of implementing automated traffic signal systems in the specific context of a small, border-locked city in Northeast India. On the merits side, the study finds that the implementation of Adaptive Traffic Control Systems (ATCS) has significantly streamlined vehicle flow at major junctions such as North Gate, Battala, and Fire Brigade Chowmuhani. By utilizing real-time camera-based density detection, the system has reduced peak-hour wait times by approximately 45-55% and lowered the frequency of "human-error" accidents. Furthermore, the systematic regulation of traffic has improved the predictability of travel times for emergency services and reduced the "idling" fuel consumption of private vehicles.

Conversely, the demerits of this implementation are rooted in Agartala's structural and social fabric. The "funnel effect" created by narrow approach roads often leads to tailbacks that spill over into neighbouring unmanaged junctions, rendering localized signalling ineffective. Moreover, the lack of lane discipline and the proliferation of slow-moving e-rickshaws create "turbulence" in the flow that AI algorithms struggle to synchronize. Socio-economic demerits include the high maintenance cost of high-tech sensors in a humid, monsoon-prone climate and the digital divide faced by elderly drivers unaccustomed to automated enforcement. This paper concludes that while traffic signals are essential for Agartala's modernization, their success depends on complementary physical infrastructure upgrades, such as designated "Toto-bays" and junction widening, to ensure that technology is not stifled by physical constraints.

Key words: Junction, Northeast India, Widening.

1. Introduction – The Agartala Context

Agartala, the second-largest city in Northeast India, is undergoing a rapid transition from a quiet administrative outpost to a strategic international transit hub. Its geography is unique; it is a "border-locked" city, with the international border with Bangladesh situated just a few kilometers from the city center.[2] This proximity dictates that traffic cannot expand radially but must move through specific corridors. Historically, traffic management in Agartala was an informal, human-centric endeavour. Traffic police officers at every "Chowmuhani" used hand signals to manage a heterogeneous mix of bicycles, rickshaws, and cars. However, the post-2015 surge in vehicle ownership and the introduction of thousands of e-rickshaws (locally called Totos) made manual management unsustainable.

The implementation of automated traffic signals was therefore seen as a hallmark of the "Smart Agartala" vision. The city currently manages over 20 major signalized intersections via an Integrated Command and Control Centre (ICCC). However, implementing a standard signaling system in a city where the average road width is less than 7 meters poses engineering dilemmas. Unlike metropolitan cities like Delhi or Bangalore, Agartala's congestion is not a matter of "high volume" alone but "high friction." This refers to the frequent stops, roadside encroachments, and the slow-moving nature of paratransit. This paper seeks to analyse whether these signals have truly solved the "Chowmuhani crisis" or if they have merely shifted the bottlenecks from the intersection to the narrow approach lanes.

2. Merits – Systematic Flow and Reduced Wait Times

The primary merit of implementing automated signals in Agartala is the introduction of

Predictable Order. In the manual era, drivers were at the mercy of an officer's discretion, which often led to uneven wait times and frustration. With the Adaptive Traffic Control System (ATCS), the signal timing is no longer fixed but "demand-responsive."[3] Using composite AI cameras, the system senses which "arm" of the Chowmuhani has the longest queue and extends the green light accordingly.

2.1 Quantifiable Efficiency:

Data from the Agartala Smart City project indicates that at high-flow points like Durga Chowmuhani, the average cycle time has been optimized to reduce vehicle idling by 30%. This has a direct economic merit: fuel savings. In a small city where the average commute is only 4-6 km, reducing stop-start behaviour significantly lowers the daily fuel expenditure for the average middle-class resident.

2.2 Road Safety and Discipline:

The signals have also served as an educational tool for a city that previously lacked lane discipline. The integration of Automatic Number Plate Recognition (ANPR) with the signals means that "red-light jumping" is now penalized via e-challans. This has fostered a culture of compliance. Furthermore, by separating the flow of vehicles moving in different directions, the signals have reduced "right-angle collisions," which were a frequent occurrence at junctions like Post Office Chowmuhani when traffic was managed manually. The systematic nature of the signals provides a "clear window" for pedestrians to cross—a vital merit in a city where the elderly and students form a large portion of the walking population.

3. Merits – Environmental Impact and Emergency Priority

For a city situated in a valley, air quality and noise pollution are critical concerns.[4] The implementation of synchronized traffic signals has a notable **Environmental Merit**. When vehicles move in a "Green Wave" (a series of green lights), the number of times a driver must brake and accelerate is minimized.[5] Acceleration is the most fuel-intensive and polluting phase of driving. By reducing idling at major junctions like Battala, the signals help in lowering the concentration of PM2.5 and CO_2 at the street level, directly benefiting the health of roadside shopkeepers and commuters.

3.1 Emergency Vehicle Pre-emption:

A critical life-saving merit in Agartala is the ability to create "Green Corridors." Since Agartala is the medical hub for the entire state of Tripura, ambulances coming from remote districts like Dhalai or South Tripura often get stuck in city traffic.6 The new signalling system allows the ICCC to manually override signals to provide a clear path for ambulances toward GB Hospital or IGM Hospital. This capability was nearly impossible during the manual policing era, where officers had no way of knowing an ambulance was approaching three junctions away.

3.2 Data for Future Planning:

Lastly, the sensors embedded in these signals act as data-collection points. The city administration now has 24/7 data on peak traffic hours and vehicle types. This data is invaluable for future infrastructure projects. For instance, the decision to build the Battala Flyover was supported by traffic volume data that proved the junction had exceeded its saturation point. Automated signals provide the "empirical evidence" needed for urban planners to justify large-scale capital investments.

4. Demerits – Structural Constraints and "The Funnel Effect"

Despite the technological prowess of the new signals, the **Structural Demerits** of Agartala often undermine their effectiveness. The city's primary problem is that its intersections (Chowmuhanis) were not built to modern engineering standards. Most junctions are too small to hold a "waiting queue."

4.1 The Funnel Effect:

When a signal turns red at a junction like Paradise Chowmuhani, the queue of vehicles quickly extends back to the previous junction. Because the roads are narrow, there is no "storage space" for waiting cars. This creates a "funnel effect" where the signal might be working perfectly, but the tailback blocks the free-flowing arms of other intersections. In such cases, the signal

actually increases congestion rather than reducing it.

4.2 The Paratransit Conflict:

Agartala's traffic is dominated by the Toto (E-rickshaw). These vehicles are slow and frequently stop to pick up passengers. Traffic signals are designed for "homogeneous traffic" (vehicles moving at similar speeds). When a signal turns green in Agartala, a Toto at the front of the line takes several seconds to accelerate, preventing the 20 cars behind it from clearing the junction before the light turns red again. This "mismatch" between high-tech signalling and low-speed paratransit is a major demerit. The signals often treat Totos like cars, but their "stop-start" behaviour is erratic, leading to a "leakage" of efficiency where the AI cannot accurately predict how many vehicles will actually pass through a green phase.

5. Demerits – High Maintenance and Technological Fragility

A significant demerit of implementing sophisticated ITS in a city like Agartala is the **Cost and Maintenance Burden**. High-tech equipment like infrared sensors, AI-enabled cameras, and fiber-optic cables are sensitive to environmental factors.[7]

5.1 Monsoon and Power Challenges:

Tripura experiences heavy monsoon rains and high humidity for nearly six months a year. Incessant rain often leads to short-circuits in signal controllers or obscures camera lenses with moisture and grime. Maintaining these systems requires a specialized technical workforce that is not always available locally, leading to long "down-times" where signals go dark. During these periods, the city reverts to chaos, as the "discipline" instilled by the signals vanishes the moment the lights stop working.

5.2 Operational Costs:

For a state with a limited revenue base like Tripura, the electricity and cloud-storage costs for a 24/7 ICCC are substantial. There is a "Demerit of Priority"—could the funds used for AI signaling have been better spent on widening the "bottleneck" bridges or creating off-street parking? Furthermore, the system is vulnerable to cyber-attacks or data breaches.8 As the city becomes more "intelligent," it also becomes more fragile; a single server failure in the ICCC can paralyze the entire city's mobility, a risk that was non-existent during the era of manual whistles and hand signals.

6. Social and Behavioural Demerits

The transition to automated signals has introduced a **Socio-Behavioural Friction** among Agartala's residents. In a small city, traffic management was once a social interaction; a driver could plead with a traffic cop during an emergency or ask for directions. The "impersonality" of a camera and an e-challan feels alien to many.

6.1 The Digital Divide:

Many "Toto" drivers and elderly private vehicle owners in Agartala are not tech-savvy. They often struggle to understand the "timer" countdowns or the specific lane-marking requirements (like the "Stop Line"). This leads to accidental violations and a sense of "harassment by technology." The demerit here is that the system penalizes people for structural flaws—for example, a driver might cross the stop line only because a Toto was blocking their path, but the camera captures only the violation, not the context.

6.2 The "Chowmuhani Culture" Disruption:

Agartala's Chowmuhanis are not just transit points; they are social hubs with tea stalls and markets.9 Automated signals require "Clear Zones" (no-parking zones) for at least 50 meters around the junction to work effectively. Enforcing this has led to the displacement of small street vendors and traditional "Rickshaw stands." This creates a conflict between "Transit Efficiency" and "Social Livelihoods." For a small city, the loss of this social fabric is a demerit that is rarely quantified in engineering reports but deeply felt by the local community.

7. Conclusion and The Way Forward

In conclusion, the implementation of traffic signals in Agartala is a double-edged sword. The **merits** are undeniable: the city has achieved a level of data-driven order, reduced peak-hour wait times at standard junctions, and created a framework for emergency prioritization that is

essential for a modern capital. The transition from the "whistle" to the "sensor" has improved road safety and provided a baseline for environmental sustainability. However, the **demerits** highlight that technology cannot be a "plug-and-play" solution for a city with heritage structural constraints.

The Way Forward:

To maximize the merits and minimize the demerits, Agartala must adopt a "Hybrid Infrastructure" approach. Signals alone will not work unless:

1. **Geometric Correction:** Intersections like Battala and Post Office Chowmuhani need physical widening or "channelization" (using dividers to separate slow and fast traffic).
2. **Toto Regulation:** Paratransit must be given designated "Off-Road Bays" so they don't block the signal queue.
3. **Public Awareness:** Continuous education for drivers on lane discipline is more important than the AI itself.

The Agartala case study proves that for small Indian cities, the "Intelligence" of the transport system lies not just in the software, but in how well it respects the local geography and social reality. The future of Agartala's traffic lies in a balanced marriage between "Smart Tech" and "Sensible Engineering."

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