Driving Efficiency in Toll Operations Through Al

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"Efficiency" in toll operations



Efficiency today goes beyond reducing wait times. It includes faster vehicle throughput, accurate classification, minimum leakages, reliable enforcement, and real-time visibility.

- > Faster vehicle throughput
- Accurate classification
- Minimum leakages
- Reliable enforcement
- Real-time visibility.



"From Manual Tolling to Seamless ETC Systems





Manual Tolling System:

First toll collection system across the globe which was cash and labour-intensive and became inefficient with time.



Single Lane tolling

The system is highly interoperable, and reliable and tags associated with tolling are low-cost. High maintenance costs are associated with it.

Electronic Toll Collection (ETC)

ETC System is an automatic and wireless toll collection method, capable of charging toll fees from a prepaid customer account through real-time monitoring and tracking of vehicles.

Multi-Lane Free Flow

Saves waiting time, and fuel and helps reduce pollution hence inducing huge economic savings and moving towards green targets.

Dedicated Short Range Communication (DSRC)

Cheap OBUs and highly reliable systems with high maintenance costs associated with them.

Way Forward

More and more countries are moving toward MLFF road pricing using futuristic technologies like IoT, ML, Big Data etc.





.. GNSS-GPS:

Functions with a very low maintenance cost, high implementation cost for user and operator and less accurate for parallel free roads and intersections.



Major challenges in tolling - Al can help address



- > Long queues during peak hours
- > Toll evasion and misclassification
- > Human error at manual lanes
- Revenue leakage and fraud
- > Poor enforcement visibility
- Inconsistent data for planning and forecasting



"Al offers automation, predictive analytics, and surveillance-based enforcement that directly reduce these inefficiencies"

Key applications of AI in toll operations



- > Enhanced toll collection and payment
 - Automatic Number Plate Recognition (ANPR)
 - Real-time billing
- > Fraud detection and Revenue Assurance
 - Anomaly detection
 - Automated auditing
 - Tamper detection
- > Optimized Traffic Management
 - Dynamic lane allocation
 - Congestion pricing
 - Predictive analytics



Key Technologies Used



Artificial Intelligence (AI) and Machine Learning (ML):

 Core technologies for processing data, learning from patterns, and making adaptive decisions

Automatic Number Plate Recognition (ANPR)

 A computer vision technology that reads vehicle license plates for identification and payment

Computer Vision

• Used to analyze images for vehicle classification (e.g., vehicles with trailers) and detect features for tolling and enforcement.

> Sensors and Internet of Things (IoT)

Gather real-time data from vehicles and the environment to feed AI systems

Benefits of Al-driven toll operations



| Benefit | Impact on toll operations |
|------------------------------|--|
| Increased throughput | Automatically processing vehicles without requiring them to stop, increases the number of vehicles handled per hour, reducing congestion. |
| Reduced operational costs | Automation lowers reliance on manual labor for toll collection and administration, leading to significant cost savings. |
| Improved user experience | Drivers experience lower wait times, faster commutes, and less hassle, leading to greater customer satisfaction. |
| Environmental benefits | Less time spent idling in traffic queues results in reduced fuel consumption and lower carbon emissions. |
| Enhanced safety and security | Al can monitor for unusual vehicle behavior, detect violations, and integrate with surveillance systems to improve highway safety and reduce illegal activities. |

The future of AI in toll operations



- Connected vehicles (V2I): Vehicles equipped with built-in communication can interact directly with toll infrastructure, removing the need for physical tags.
- ➤ Blockchain technology: This can be integrated with AI to create a transparent and secure payment system that further reduces fraud risk and ensures accurate financial records.
- ➤ Edge and cloud computing: Advanced data processing systems can enhance real-time toll management capabilities by analyzing data locally at the toll plaza (edge) and centrally in the cloud

