

# Viability of Commercially Operational Hybrid Toll Plaza: A Review

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**Abstract** - According to NHAI, the number of vehicles in India has increased at a rate of 10.16% per year over the last 5 years. As a result, the current processing capacity of the pre-installed toll plazas falls short to meet the increasing demand, thus causing traffic congestions and increase in waiting time. For this purpose, new and efficient methods of toll collection are being proposed and implemented across India; FASTag being one of them.

In the current scenario of toll tax collection methods, multiple issues are faced by the authorities and the travelers. The degree of these issues vary from one location to other due to varying factors such as size of the toll plaza, processing capacity, traffic density at the toll plaza, employee efficiency and system efficiency.

The serviceability of the toll plazas during peak hours reduces when the rate of incoming vehicles is more than the processing capacity. The components involved in the cash transaction system are more prone to errors and faults due to the outdated nature of technology.

The delay and queue are mostly caused by FASTag card errors, overloaded commercial vehicles, and two distinct charging systems known as Manual Toll Collection and Electronic Toll Collection. Furthermore, several other reasons of traffic congestion were discovered using data collected and a visual on-site assessment.

Taking into account all of these factors, this study proposes several solutions to these challenges. The traffic volumes revealed that the toll booth capacity and kind of toll service had an impact on traffic operation and indeed the efficiency of the toll plaza. Based on the problems discovered at the selected toll site, various recommended designs for varied traffic circumstances and toll plaza arrangement are given. This study is a valuable resource for management and decision making.

**Key words:** Electronic toll collection (ETC), Overloading Penalties, Traffic Congestion, FASTag,

## 1. INTRODUCTION

Urban transportation in India has entered a new century, with large-scale and high-speed growth. Rapid urbanization and the increase in the number of vehicles on the road are posing new problems to urban traffic, and the issue of road traffic safety is becoming more significant. As a result, it is regarded as a key component of urban traffic safety management, which includes the scientific and rational planning of traffic congestion, accidents, and fuel

consumption, among other things, as well as the enhancement of urban road traffic safety standards. In an electronic toll collection (ETC) system, when a user passes through a toll gate, the toll charge is automatically deducted from his bank account in no time without interrupting the consecutive traffic. For the first time in 2014, India used electronic tolling collection (ETC) for the Golden Quadrilateral project in Ahmedabad. The goal of electronic tolling is to reduce traffic congestion and offer automobiles with a cashless pass through. ETC's main goals are to make toll collection easier with less manpower and thereby reducing the corruption. Overloading in vehicles has become a widespread problem that has sparked widespread concern. Overweight vehicles may cause significant harm to road infrastructure and hasten its deterioration. Fatigue difficulties in pavement components are the most prevalent problem, and they can drastically reduce roadway service life. In certain severe circumstances, the overloaded vehicle weight may surpass the pavement's load-carrying capability, causing the road to collapse. Furthermore, vehicles that are overloaded are more likely to be engaged in traffic accidents. The overloading penalties which are enforced by government are still collected by cash transaction which promotes money escalation. This problem may be solved by introducing heavy penalties and by electronic transaction which reduces the average lane clearance time and so the fuel consumption and harmful gas emission that increases the tolling efficiency.

## 2. LITERATURE REVIEWS

- **Astarita, V., Florian, M., and Musolino, G. (2001)** Based on examining mixed toll collection stations with separate toll collection systems and introduced a new microscopic simulation model for vehicle movement at the toll place location.
- **Sadoun, B. (2005)** explains how, given a time-dependent traffic and a set of model parameters, the finite model of event simulation may be used to approximate the required ideal number of tollbooths and the consequent mean delay. According to the findings, toll plaza efficiency improves as the number of tollbooths grows, and there is less time spent waiting in lines.
- **Al-Deek, H. M. (2005)** Using the toll plaza modeling, model developed by the Transportation Systems Institute at the University of Central Florida, the intensity of the peak hour location delay was investigated.

- **Wong, S. C., Sze, N. N., Hung, W. T., Loo, B. P., and Lo, H. K. (2006)** conducted a test traffic management system at the busy road tunnel plaza and the purpose of the system is to enhance traffic flow and safety at the toll area.
- **Komada, K., Masukura, S., and Nagatani, T (2009)** studied traffic patterns and traffic congestion delays on a toll road with multi-lane tollgates. With rising density and differing number of tollgates they concentrated on the shifting traffic conditions. They also derived the actual traffic flow density diagrams on the toll highway, where the actual saturates at a low density at the nearest tollgate, and the accumulation increases with increasing density to the nearest tollgate.
- **Jacob A Bernard et al. (2010)**, trucks exceeding permissible mass restrictions increase the likelihood of traffic accidents and infrastructure damage. They also lead to unfair rivalry among forms of transportation and businesses. As a result, it is critical to verify that truck weight requirements are followed. Technologies are being developed for more effective overload screening and enforcement. Weigh-in-Motion (WIM) systems allow vehicles to be weighed while in motion, without disrupting operations. WIM solutions that can lead to better and more effective truck service have lately made significant progress in terms of development and integration.
- **Minghe Yu et al, (2011)** the purpose of the electronic toll collection is to reduce the congestion on toll roads by electronically collecting tolls. ETC decides when the vehicles driving by are participating in the scheme, warns enforcers for those that are not, and automatically debits the accounts of authorized car owners without asking them to wait.
- **Obelheiro, M. R., Cybis, H. B., and Ribeiro, J. L.(2011)** proposed a framework for evaluating the level of service at toll plaza. Toll plaza scenarios were developed and tested by qualitative analysis by toll plaza users from various Brazilian states, and by technical personnel from regulatory agencies and concessionaires responsible for the service of toll plazas.
- **Ismail, M. F., and Sarkar, M. A. R. (2012)** Built an automatic system for collecting tolls by vehicle weight and a car number plate identification method made using MATLAB image processing technology.
- **Zhou, G., and Alouis, C. (2013)** evaluated the effectiveness of Zimbabwe's toll gate networks as viable ways to raise domestic revenue. Effectiveness was measured on the basis of administrative capacity, toll yields, ease of operation and toll gates comparative efficiency vis-à-vis other heads of revenue. Data were collected by questionnaires, interviews, visits to the toll site and analysis on the desks. Trend analyses of tolling revenues contributions in Zimbabwe are performed and then standardized benchmarking contrasts them with experiences in other nations. Research results indicate that tolling schemes, if operated with prudence, offer a possible self-financing model for road infrastructure maintenance in Zimbabwe.
- **Karsaman, R. H., Mahendra, Y., Rahman, H., and Sulaksono, S. (2014)** the amount of processing time required for ticket purchase and toll collection caused a long line at tollgates, which was investigated on the Jakarta Intra Urban, Cikupa-Merak, and Cawang Pluit. When modelled, the queue at the tollgates followed a Poisson distribution, according to toll Roads. In comparison to the cash system, the ETC plan is more effective in reducing the number of queued cars, according to this data.
- **Amol A. Chapate et.al,(2015)** the suggested framework incorporates the technologies for radio frequency identification, GSM and host computers. RFID is utilised to read vehicle information; an RFID tag with a unique ID is attached to each automobile, and an RFID reader at the toll gate reads the information on the tag.
- **Caldas, M. A. D. F., and Sacramento, K. T. (2016)** Using Highway Capacity Manual and Discrete Event Modeling, studied and suggested a mesoscopic simulation approach for classifying highway flows and their service levels. Monte Carlo simulation approach makes use of this application to model and test success metrics. Comparison effects of this approach with empirical method. The theoretical solutions of the proposed queuing models depend upon the parameters of the input system. The findings of the queuing models and computational tests for simulation process are very useful in real-life (practical) processes, such as toll Plaza, Train ticket counter, hospital etc. Today's growing convergence of road traffic congestion with information management and networking technologies results in increasingly complicated networks that need an extensive model and strategies to better interpret their efficiency metrics and to forecast performance and service quality.
- **Hameed S. and Prathap C(2018)** studied impact of overloaded vehicles on flexible pavement. VDF is determined and it has been compared with the IRC to determine the damages and its pattern. Vulnerability of terrain roads is studied and also evaluates the overload impact on the highway economy.

### 3. PROPOSED METHODOLOGY

It is desirable to study overloaded vehicle behaviour to know the ground condition of following policies for overloading and the effective implementation of central government policy regarding overload penalty which are plying over highway. Result to which causes damage to highway pavement and tremendous increase in maintenance cost.

#### Site selection

The operational toll roads are the roads that have completed the construction phase with high level quality assurance & qualifying all desired quality test. Accordingly, toll operations are started commercial on the subjected road for the mentioned time period as specify in the concession agreement between client (NHAI) & Concessionaire.

#### Preliminary Survey

The preliminary survey of toll Plaza will be carried out to determine research objectives and understanding the functioning of plaza with the help of toll plaza operators.

#### Data Collection

- Collection of data for toll traffic to examine peak traffic. Peak hour is been determined for a day.
- Survey will be required for lane clearance time for a single ETC lane to estimate the delay pattern.
- Data selection of overloaded vehicles provided by the toll plaza authority. It should be of previous months to determine the overloading trend after implementation of policies by government.
- Data collected from weight measurement equipment like Ms-WIM (Medium speed weigh in motion) and SWB (Static weigh bridge) to review the performance of them.

### 4. CONCLUSIONS

- The literature shows that there are various ways of collecting toll without creating traffic congestion.
- Much focus has been given in transfer from manual toll collection system to electronic toll collection system.
- Various literature reviews have been studied for the congestion and overloading problems on toll plazas and it has been concluded to formulate our study path.
- Study is carried out in 3 phase namely Peak Hour estimation, Lane clearance time and Lane clearance delay due to overloaded vehicles.

- Major factors to enhance the toll plaza level of service can also be estimated.

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