

Study on Toll Plazas for Impact Assessment and Remedy Measures on Existing ETC System

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Abstract: Electronic toll collection (ETC) through RFID Tags can reduce delay from the toll area. In this the identification of arrived vehicle is done with the help of radio frequency (RF). A vehicle will hold an RFID tag on its windshield so that mounted RFID reader can transmit the radio frequency for collecting toll fee from the user account. Whenever the vehicle passes from tolling lane, the tax amount will be deducted from his prepaid account. As vehicles don't need to stop during a queue, this helps to reduced traffic jam at toll plazas and helps in lower fuel consumption. At study area End lanes from both sides are having mixed lane configuration that is it mode of payment for collecting toll fee is via cash or through FASTag and rest all intermediate lanes are dedicated FASTag lanes. After implementation of 100% ETC in India, still vehicles are facing delay problem at ETC lanes, so with the help of data collected and on-site survey at both cash lane and FASTag lane some more sources of traffic congestion have been noticed. Based on the vulnerabilities found on the Toll Site, this paper proposes some recommended configurations for various traffic conditions for the toll plaza.

Index Terms – Electronic Toll Collection (ETC), RFID, FASTag Lanes, 100% ETC, Peak Hour.

1. INTRODUCTION

India is a developing country therefore developing India needs more number of good roads on national highways and expressways. Highways are an important segment of the road network, due to their large share of passenger and freight traffic. India had neglected its highway development for a long time, but gained momentum after the formation of the National Highways Authority of India (NHAI) in 1995 as a nodal agency. The launch of the National Highway Planning Program (NHDP) in 2001 gave a significant boost to the planning of highways.

NHAI used the traditional contract model of Engineering, Procurement and Construction (EPC) contracts in the early stages of highway development, which included only highway developers with restricted participation in project execution. Subsequently, with the grant of potential concession contracts with BOT variants for individual stretches of national highways, it started attracting players from the private sector. To promote rapid development by obtaining private sector participation, NHAI is given more freedom to take up and execute projects.

In the early period, the government departments and agencies both the Centre and the State used their funds for many decades to fully construct roads and highways. This arrangement produced modest performance and was fraught with many organizational and financial problems. The opening of roads to the private sector began with the construction of highways after the establishment of NHAI.

A tolling lane also known as a turnpike or toll-way may be a public road or driveway on which a passage fee is charged. It is a kind of road pricing that is usually introduced to help recoup construction and maintenance costs. Tolls are collected with electronic toll collection systems to reduce costs and eliminate time delays.

1.1 Objective of study

1. Study the existing ETC system implemented on all the toll plazas of India
2. Provide remedy measures for existing ETC system to improve its functionality during peak hour.

2. LITERATURE REVIEW

Electronic toll collector; Electronic toll is an inter-operability system that enables cashless payment at national highway toll booths. It boosts profits, decreases leakages, and ensures smooth nationwide travel.

Without the electronic toll system, the issue is that most people have to stand in the queue of slowly moving vehicles. Other concerns include delays in reaching the destination and wasted time.

The primary focus of the E-toll project is to raise funds to support road network building and repair. In addition, E-toll allows the provision of advanced services focused on data that the networks are capable of collecting. The systems include a variety of things, from vehicle maintenance for private firms to traffic management, reducing traffic congestion or warning drivers in advance about traffic queues and road accidents. It will prove successful in tracking stolen vehicles and the exchange of money. The delay in reaching the destination is thus stopped.

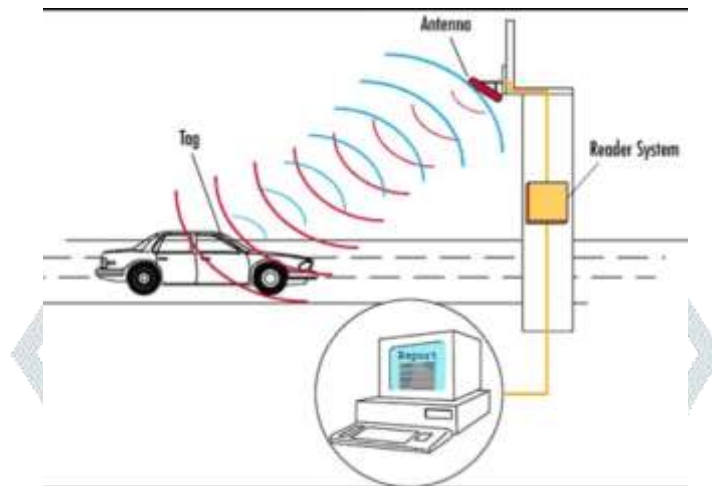
RFID: Many forms of RFID exist, but we can classify RFID devices into two groups at the highest level: active and passive. Active tags include a power supply, either attached to a power grid or using energy stored in an internal battery. But in the passive tag case, the lifetime of a tag is constrained by the energy collected, balanced against the amount of read operation the system performs.

Electronic Toll Collection, an automatic system, does not require any monitoring of the operation by personnel. The device is sufficient for Electronic Toll Collection, as RFID uses radio waves to connect between the tag and the reader.

FASTag: It was followed up on 8 November 2017 by making FASTag mandatory on all new vehicles sold after December 2017 in India. It was announced on 19 October 2019 that FASTag will be obligatory on all National Highways from 1 December 2019, and double the toll will be paid to non-FASTag users. On 15 December 2019, across India, FASTag became compulsory.

The Ministry of Road Transport and Highways (MORTH) has made it obligatory for drivers of highway motor vehicles to follow FASTag to pay tolls nationally. The implementation date has been delayed to 15 December 2019. The National Highways Authority of India (NHAI) has introduced the Electronic Toll Collection (ETC) system to minimise traffic congestion and facilitate the smooth movement of traffic on highways via digital toll collection.

FASTag serves as a transponder and functions on the technology of Radio Frequency Identification (RFID). The process is identical to that of metro smart cards. The sticker should be fixed to the middle of the vehicle's windscreen. When the vehicle crosses the boom barrier, the tag is checked by a computer and money is immediately deducted from the account of the holder. For each payment, an SMS message will be sent to the registered mobile phone.



Working of RFID based ETC system



Tolling lane with mounted RFID reader and signal

Past Research Work:-

Private Participation in Toll Road Projects

Shubra, (1999) expressed that public financing constraints were met with road growth in India, so the industry witnessed the rise of PPP in the early 1990s. While the National Highway Authority of India (NHAI) managed to carry out regulatory functions, including project supervision, setting up quality standards, etc., the infrastructure generated during the defined time is managed and maintained by the operators. In addition, the Operate, Maintain and Transfer Principle was adopted with the goal of ensuring sufficient quality of highway facilities and protection and safety requirements for road users when commuting and paying tolls on toll road stretches.

The implementation agency, NHAI, was established in 1995. It focused on basically one project during the period 1995-97, i.e. a widening of 330 km. Plan for a long National Highway (NH) connecting five states. The NHAI has the country's first toll road, an 80 km long stretch from Jaipur to Kotputli in Rajasthan, on which after March 1998 it began tolling.

Toll Revenue trend

The method of tolling roads has achieved recognition slowly but gradually. This has been expressed in the marked growth in both national and state toll collection and has inspired the decision to introduce further projects. Toll receipts from national highways have steadily improved. Toll receipts are forecast at Rs10.3 billion for 2006-07, a rise of approximately 30 percent over 2005-06. Of all, 80% of the collections originate from projects sponsored by the state and the remaining 20% are from private projects.

Prior to this, collections in 2005-06 had growth rates of 76 percent and in 2004-05 of 25 percent. The fall in 2006 and 2007 was due to the delay in the implementation of eight new stretches under the toll net. In the 2007-08 and 2008-09 financial years, the department managed to earn INR1, 415 crores and INR 1,702 crores, respectively. The annual data indicates that the collection of tolls was much higher than the estimated receipts in the last two financial years, i.e., 2013-14 and 2014-15 (Phadke, 2015). Experts say that it is possible to further boost the tolling capacity of national motorways (Phadnis, 2015). For the Golden Quadrilateral (GQ) and North-South-East-West (NSEW) schemes, the projected toll collections are INR 5 million per km and INR 1.8 million per km, respectively.

Facilities for road users

(In 1993, Khanna). For eg, patrol services, ambulance facilities at the time of incidents, contact facilities, parking lots, roadside toilets, motels etc. are required to be offered to the travelling public by the toll road operators. Although a large amount of money is being collected as toll, as the analysts or passengers claim, roadway safety and accident prevention initiatives are far from sufficient and they also challenge the lack of safety and insufficient facilities on roads and highways, in terms of clean toilets, parking bays, emergency services, etc.

Toll road operation

Opoku et al (2013), the efficiency of toll places fitted with manual and electronic operations was assessed. Service time, service speeds, vehicle headway, etc. are the main performance metrics studied. In order to forecast system efficiency under different traffic conditions, models are built on the basis of these main indicators.

Loannis et al. 1 (2011) covered efficiency metrics such as Intelligent Transport Systems (ITS) for traffic control. It is also recognised that it is impossible to evaluate the programmes and strategies critically in the absence of significant proposals. It is possible to assess the efficiency of the ITS with regard to reducing emissions. With the assistance of the analytical tool, performance measures (PMs) are developed and PMs are implemented in the assessment process, facilitating decision-making and continuing project performance monitoring. Examples-Goal: connectivity and mobility and related aims: to leave private traffic and to include bike lanes and walking paths are specifically specified with priorities and objectives.

Modern tolling methods and technology to increase efficiency

“Operational benefits of electronic toll collection by H.M. Al-Deek, A. A. Mohamed and A. E. Radwan (2010)”, Traffic congestion is faced on metropolitan and suburban highways in the United States by many travellers every day. A strategy that will solve this question is the technical revolution called intelligent transportation systems (ITS). The electronic toll collection (ETC) scheme, which uses automatic vehicle identification (AVI) technology to boost toll collection performance, is part of ITS. When they pass along toll lanes, the AVI technology has the capacity to distinguish vehicles. With the aid of wireless communications, AVI operates between a tag (transponder) on an automobile and a sensor on the side of the lane. The sensor periodically transmits brief pulsed signals to the transponder and returns a changed signal containing the identity of the vehicle. The toll plaza lanes were categorised as one of the following types of lanes: a manual toll lane, a mixed AVI lane where AVI is placed on a manual lane, an automatic lane, or both, a dedicated AVI lane allowing only AVI customers. The Express AVI lane allows up to 88 km / h of free-flow speed. The increase in the performance of the E-PASS lanes could not be due to a natural increase in the demand for traffic at the plaza, but was triggered by the launch of the dedicated AVI lanes and the transition of traffic from the mixed lanes to these E-PASS lanes.

3. METHODOLOGY

1. Selection of toll site for study
2. Preliminary survey
3. Traffic flow and traffic composition survey
4. Data collection
 - Collection of data from Toll plaza authorities.
 - Conducting field survey for calculating vehicles plaza crossing time.
 - Collection of data from various official websites such as website of MORTH, GOI and NHAI etc.
5. Analysis of collected data with the help of MS-Office and photos captured during site observations.

4. ANALYSIS OF DATA AND RESULTS

In relation to above, collecting mixed hourly traffic data is analyzed properly which produces multiple results that are arrange in proper manner for obtaining outputs.

Following data were collected during field survey, in which survey was done on Saturday and Sunday because in these days traffic volume at study toll plaza is high as compare to other week days. A traffic survey is conducted on ETC lane during Peak Hour for calculating vehicle average crossing time. Simultaneously factors were also noted down for cause of delay occurs during peak hour.

Table 4.1 Average plaza crossing time for all class of vehicles

CLASS	Average crossing time	
	At Morning (9 AM-11 AM)	At Evening (5 PM-7 PM)
CAR	00:00:30	00:01:25
LCV	00:01:20	00:01:40
BUS	00:00:25	00:02:20
2-Axle	00:01:55	00:00:50
3-Axle	00:00:45	00:01:05
4-Axle	00:00:55	00:01:05
5-Axle	00:00:55	00:01:35
6-Axle	00:02:30	00:02:55
OSV	00:02:10	00:02:40

While comparing recent implemented ETC system with manual cash collection system, delay faced by road user is significantly reduce but not as much required. It was observed from study that existing ETC system has some marginal issues during its operation which create unnecessary delay to both commercial and non-commercial vehicles.

5. CONCLUSIONS

Study on this project is to identify and overcome the factors accounting for traffic delay and providing some remedy measures on existing ETC system at the toll plaza. Over the course of project completion, various surveys were conducted and information for different type of vehicle was collected. According to analysis of site survey following troubles was observed which were mainly causing the delay and increasing the vehicle plaza crossing time. The study revealed that long queue length on tolling lanes make drivers confused during peak hours. Due to this confusion Non-FASTag vehicle driver enter their vehicle into dedicated FASTag lane which imposes 2-time penalty charges on it leading to argument with toll staff and resulting into increase plaza crossing time for queued vehicles. Since 100% ETC roll out is recently implemented in India so it has some marginal issues like blacklisting of vehicles, provided signs and marker position are improper at toll plaza, bank payment issues and Non-FASTag vehicle asking for toll exemption at FASTag lane etc.

Hence all this problems are most prominent at toll sites which require proper monitoring and improvement in existing ETC system.

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