

A Comparative Study of Toll Collection Systems in India

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ABSTRACT:- This paper is based on comparison of conventional toll collection and some existing automatic toll collection systems. Some Automatic toll collection systems discussed in this paper are FASTag which employs RFID (Radio-Frequency IDentification) technology and the other is BookMyToll. There is also a system called an Automated Toll Collection System (ATCS) for collecting tax automatically wherein a unique RFID tag is attached to the windshield of the vehicle. Another toll collection system, named BookMyToll System does payment through Android App and the mobile is detected using a smart device near Toll Plazas. Here we also propose an automatic toll collection system using Image Processing.

Keywords:- Toll Collection System; BookMyToll; RFID; FASTag; Traffic Management; Toll plaza; Automation.

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I. INTRODUCTION

The amount of traffic in recent years is increasing due to the increasing number of vehicles. Every day, millions of people use their personal vehicles instead of public transport systems and due to this, there is increase in traffic in developing countries. Increasing number of vehicles on the roads, result into many problems such as congestion, air pollution and fuel wastage etc. There are certain types of roads where you have to pay money to travel on the road which are called Toll Roads. To travel on that road, you need to pay a tax called a toll tax. Toll tax is applied only to the users of the toll road. Sometimes there may also be more than one Toll Plaza on one particular toll road.

A toll road doesn't stay a toll road forever. Tolls may be removed, once the cost of construction has been recovered from the toll amount is collected. All highway toll plazas are manually operated, where an operator collects cash from the driver and provides a receipt. This procedure can be slow, which often results in traffic jams at the toll plazas on busy highways. Although, there are many lanes on toll booths to keep traffic moving as quickly as possible. On some lanes, you can pay with change or cash, while there are also other lanes called express lanes which are for the users who have an electronic pass attached to their vehicle. Special detectors senses vehicle's electronic pass and deducts amount directly from an account, such as a credit card or a bank account, whichever is connected to your electronic pass. Generally, these electronic passes are used by the commuters to travel the toll roads daily in order to avoid delay at toll roads to pay cash.

II. RELATED WORK

A. Electronic Toll Collection

The Electronic Toll Collection(ETC) system is currently used throughout the world. Some countries that have the ETC system are Canada, Poland, Japan, Italy and Singapore, among many others [1]. Some Electronic Toll Collection Systems in India, owned by NHAI (National Highways Authority of India) operated by different toll management systems are NH-6 toll road at Kharagpur operated by Toll Tax Toll Collection System, Delhi Gurgaon Expressway at Delhi operated by Metro Electronic Toll Collection Systems, Lucknow Sitapur Expressways Ltd at Uttar Pradesh operated by Rajdeep - Toll Management System, Madhurai Rameshwaram Expressways Ltd and Cochin in Tamil Nadu operated by Technovaa - Toll Management System, GMR Ambala-Chandigarh Expressway in Haryana & Punjab operated by Rajdeep - Toll Management System etc.

B. Fastag

FASTag is an electronic toll collection system in India, operated by the National Highway Authority of India. The system was initially set up as a pilot project in 2014 on the stretch of the Golden Quadrilateral between Ahmedabad and Mumbai. The system was implemented on the Delhi - Mumbai arm of the Quadrilateral on 4 November 2014. In July 2015, toll plazas on the Chennai - Bengaluru stretch of the Golden Quadrilateral started accepting FASTag payments [5]. By April 2015, FASTag was rolled out to 247 toll plazas

on national highways across India, representing 70% of all toll plazas in the country at the time [6]. As on 23 November 2016, 347 fee plazas out of 366 on national highways across the country accept FASTag payments [7].

C. Electronic Tolling Systems

Electronic Toll Collection is a system enabling collection of toll payments electronically allowing for near-nonstop toll collection and traffic monitoring. Under the system, a RFID chip-embedded sticker is put on the vehicles allowing deduction of money at toll plazas automatically. The first interoperable Radio Frequency Identification Device (RFID) technology based on Electronic Tolling System was launched at Charoti Toll Plaza, Dahanu in Thane District, Maharashtra [11]. The interoperable RFID based system would allow vehicles to sail through six toll plazas, operated by three different road developers Larsen and Toubro (L&T), IRB Infrastructure and NHA. These include IRB toll plazas at Charoti, Bhagwada, Boriach and Choriyasi besides NHA plaza at Narmada Bridge and L&T IDPL Plaza at Karjan, Vadodara. The pilot project for this has also been launched on Chandigarh-Parwanoo on NH-5.

D. BookMyToll System

BookMyToll is the brain child of Malola Innovations Pvt. Ltd. Malola Innovations is a start-up company based out of Hyderabad, India and was co-founded by the team having 14 years of industrial experience in IT field. BookMyToll can be used by both the smart phone users as well as Non-Smart Phone users. BookMyToll system is having an Android application and even a web application in which you can register and vehicles in the menu.

On, going through various systems and its implementation, we find that, ETC system is installed at selected toll plaza in India which is owned by NHA while BookMyToll system is currently under development. Moreover, on every toll plaza at least one lane of FASTag is being installed.

III. COMPARATIVE STUDY

A. Conventional Systems

At present the conventional toll plazas are working manually. This method of toll collection is time consuming. The conventional way of collecting the toll from the vehicle owners or the drivers is to stop the car at the Toll Plaza and then pay the amount to the toll collector by the side of the toll booth, after which the gate is opened either mechanically or electronically for the driver to get through the toll station. These halts, on seemingly well laid roads, and sudden breaks, results in wastage of precious fuel. Another issue is that one needs to handle cash and even wait for getting the change.

After paying the toll tax, a receipt is provided which one needs to preserve when the ticket purchased is a two-way ticket. Possibility that one may escape the toll plaza without paying is also there. Suppose the manual toll collection system is very efficient, and time taken by one vehicle to stop and pay taxes is 50 seconds. Now if 200 vehicles cross the toll plaza, then time taken by 1 vehicle with 50 seconds average stop time in a month is: $50 \times 30 = 1500$ seconds

$$\text{Yearly total time taken} = 1500 \times 12 = 18000 \text{seconds} = 5.0 \text{ hours}$$

On an average each vehicle that passes through the toll plaza has to wait 5.0 hours, keeping their engines turned on. This figure is staggering, as if on an average we take 200 vehicles pass through the toll plaza each day, then yearly 72000 vehicles pass through the toll plaza, so each year 72000 vehicles waits for 5.0 hours keeping their engines on and thereby aiding pollution and wasting fuel and money [4].

B. RFID

Typically, An RFID chip is capable of carrying 2,000 bytes of data or less [9]. The RFID device serves the same purpose as a bar code or a magnetic strip on the back of a credit card or ATM card; it provides a unique identifier for that object, just as a bar code or magnetic strip must be scanned to get the information, the RFID device must be scanned to retrieve the identifying information.

1) Working:

For ATCS one needs to have an RFID card. At present, the smallest RFID tags are about the size of a coin. In this an RFID tag is attached to the windshield of the vehicle. The tag assigned is unique and identical for every vehicle. The deduction of balance from the RFID card is very much similar to that of mobile recharging process, that is, it can be prepaid or post-paid. By using such a technology at every toll plaza, congestion and the long queues of traffic can be avoided which will automatically result in time saving as well as one will not need to do the payments manually. Also an Electronic Toll Collection system is able to determine if a car is registered in a toll payment program, and it alerts enforcers of toll payment violations, and debits the participating account [10].

The advances in the technologies related to wireless communication has led to the emergence of several engineering designs to aid the human requirements. Today, on one side the importance for secured access is growing in several fields and on the other side with technology advancements the RFID cards and readers are becoming low cost. Both these aspects are the primary reasons for rapidly growing RFID based authentication system. Today, several wireless technologies are used for building wireless networks. Among them the 2.4GHz wireless network is most widely deployed and used [2].

As the data collected by the RFID readers is accurate and does not take more than few seconds to read all the products, it reduces the amount of time taken to count the stock and then store them at the designated location.

C. FASTag

NHAI (National Highways Authority of India) has rolled out program for Electronic Toll Collection on Toll Plazas on National Highways to be called FASTag [8].

FASTag is a device that uses Radio Frequency Identification (RFID) technology for making toll payments directly from the prepaid account linked to it.

2) *Working:*

FASTag is affixed on the windscreen of a vehicle and enables one to drive through toll plazas. FASTag can be recharged by making payment through cheque or online through Credit Card/ Debit Card/ NEFT/ RTGS or through Net Banking. FASTag account can be recharged up to a maximum of Rs 1 lakh from a minimum of Rs 100. FASTag users have to follow the standard operating procedure (SOP) for crossing the toll plazas. Toll Plazas may have a dedicated FASTag lane or provision for validating FASTag through a handheld reader. The dedicated lanes will be marked and boards/screens will be displayed with the FASTag logo about 70m from the toll plaza.

FASTag is a perfect solution for a hassle free trip on national highways and the convenience of cashless payment of toll fee.

3) *Advantages:*

- Saves Fuel and Time: FASTag is read by the tag reader at the plaza and the toll amount is deducted automatically, when the vehicle approaches the toll plaza. The vehicle with FASTag doesn't need to stop at the toll plaza for the cash transaction.
- SMS alerts for transactions: Customer will receive SMS alerts on his registered mobile numbers for all the transactions done in his tag account.
- Online recharge: Customer may recharge his tag account online through, Credit Card/ Debit Card/ NEFT/ RTGS or Net Banking.
- No need to carry cash: Customer doesn't need to worry about carrying cash for the toll payments.
- Web portal for customers: Customers can access their statements by logging on the FASTag customer portal.

D. BookMyToll

BookMyToll is one such system which enables users to pay toll tax using the App. BookMyToll is currently implemented in Chennai Bye-pass Porur, Surapattu toll plazas and then in Nallur (Red Hills), Sriperumbdur (Nemili) toll plazas near Chennai.

4) *Working:*

In BookMyToll, we just need to add Vehicles and the first added vehicle is selected as a default. Default vehicle means that the Mobile is mapped to that vehicle and the payment is done for that vehicle. For travelling with other vehicle you need to swap the default vehicle. Hence it provides the ease to travel with multiple vehicles, no need to always enter the vehicle number and type every time you want to travel. Before starting the journey, the user can choose the toll centre (to which BookMyToll has made the agreement) through which he will be travelling and make the payment for it in advance. Thus, time is saved by pre-payment of the toll tax and reduce the congestion at toll booths. When the user approaches the toll centre with which BookMyToll has made the agreement, a smart device installed before the Toll Centre will detect the Mobile Phone and initiates the payment through CCAvenue payment gateway. The payment is not done in advance i.e. the transaction is initiated when the user arrives near the toll centre. Hence the problem to handle cash is avoided. There are no chances of escaping the toll plaza. By the time the user reaches the Toll Plaza, toll tax is already paid. BookMyToll will even advise the Lane number of that Toll Centre through which the vehicle need to pass through. When the user approaches the toll centre for which he made the payment, the toll operator checks the vehicle number and if the payment is done, he will pass the vehicle. This system saves time and reduces traffic [3].

Table 1. Comparison of various systems

	Conventional Systems	RFID	FASTag	BookMyToll (as per system description)
Time Consumption	High	Average	Average	Average
Fuel wastage	High	Low	Low	Low
Traffic	High	Average	Average	Average
Payment Mode	Cash/Debit Card/Credit Card	Online	Online	Online
Processing	High	Average	Average	Average

IV. CONCLUSION & FUTURE WORK

All highway toll plazas are manually operated, where an operator collects cash from the driver and provides a receipt. Since this procedure can be slow, we often encounter traffic jams at the toll plazas on busy highways. Automatic process of toll collection will save time, effort, and man power. Above mentioned systems are RFID based FASTag toll collection system and the other is Automatic toll collection which speeds up the toll collection process and hence reduces the traffic jams at the toll plaza. Instead, we develop a system to provide a fast and safe environment for toll collection and to automatically control the vehicle movements at the toll stations through Image Processing. Payment can be facilitated through mobile wallets, credit cards or net banking before reaching the toll plaza through an Android application. By using Image Processing, we wouldn't require any smart device to be installed at the toll plaza as the processing can be directly done from the video feed received through CCTV installed at toll plaza.

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