

Benefits of Implementing Intelligent/Electronic Toll Plaza on Jalandhar-Amritsar National Highway-NH1A

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ABSTRACT

In India, the collections of the toll on highways are based on the manual method which is collected by the toll plaza constructed on highways. The vehicles are allowed to into the national highway after giving the toll fee by cash. Albeit in this manual method structure the toll fee is directly taken from the road users. The existing toll plazas cause the increase in time of journey, increase in air pollution and fuel consumption. In developed countries, Electronic Toll Collection system is in use. This system has noticeable number of benefits to the greatest extent that is surrounded by the reduction in fuel utilization by start/stop process, increases the level of toll road user satisfaction, increase in vehicle speeds, reducing the number of workers for toll aggregation, passenger comfort, centralized incorporating of the fiscal system, real monitor of traffic and Synchronization of aadhar card with vehicles number and bank account. This focal point of this paper is on the economic benefits and road user satisfaction technical analysis of Electronic Toll Collection after investigating if Electronic Toll Collection systems will be implemented in Jalandhar-Amritsar highway NH1A. As this route is for the international airport and to the holy golden temple which is one of the country's most conspicuous sites the site is visited by over one hundred thousand people per day and it is of the holiest shrines in the world.

Keywords :— Toll Road, Intelligent Transportation System, India, Environmental Effect, ETC, NH1, UIDAI

I. INTRODUCTION

Toll roads have been in existence in many countries for a long time. Roads where the costs are recovered through such user fees are known as toll roads. Toll tax is collected because the construction, maintenance, repairs, expenses on toll operation and interest on the outlay could be recovered. Therefore tolling is an efficient method of charging the actual road user and is thus an equitable form of user taxation [1]. In India, the highway projects are given on PPP basis which means Public Private Partnership. In this, the private entrepreneur funds, designs, construct and operate and maintain the highway facility. The tax is collected for a certain time frame then the facility is give up to the government[2]. All over the world these tolled highways/expressways are emerged as the economic booster for the infrastructure of roads and also fund to expand it. When any vehicle runs on highway it has to pay some amount of money i.e. toll for the utilization of highway the common way of collecting the toll is to stop the vehicle and the highways are blocked by some barriers and the vehicles are permitted to pass the road once they pay the toll and in this form the toll is collected from the road user directly that is manually but during this vehicles are interrupted which cause inconvenience in the form of excessive fuel consumption, increase in time of journey, increase in air pollution in that region, less secure for both public and government and long queues. In future India especially on the NH1 Jalandhar-Amritsar the manual method of collecting toll becomes

extensively difficult due to increase in traffic volume and rapidly increase in population too.

II. NEED FOR INTELLIGENT TOLL PLAZA OR ELECTRONIC TOLL COLLECTION

In developed countries, another method of collecting toll apart from the manual one is the Electronic Toll Collection (ETC) on highways which increases the lane throughput as the vehicle not need to stop. This method comprises of some electronic equipments on the toll plaza roadside as well as on the vehicle like cameras, super sensors, piezoelectric sensors, transponders, payment via Internet banking, SMS & Unique Identification Authority of India (UIDAI) aadhar card that is already synchronized with all bank accounts and should be attached with vehicle number recognition of the car owner given by the administration or governing authority. This method brings

- Reduce traffic congestion.
- Saving of time in collecting toll.
- Passenger convenience.
- Road user satisfaction.
- Reducing the number of personnel required for toll collection.
- Reduced travel time journey.
- Reducing the crime and terrorism rate due to aadhar card Synchronization.
- Reduction in corruption at a toll plaza.
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III. IMPLEMENTATION EXAMPLES

The ETC is actively used worldwide like used in Norway (Hensher, 1989), Taiwan (Chen, Fan, Farn, 2006; Tseng, Lin, Chien, 2014), South Korea, Spain (Perez-Martinez, Ming, Dell'Asin, Monzon, 2011), England and Italy (Lee, Tseng, Wang, 2008) even the Melbourne has this system since 70's [3]. In Pakistan this system is used by the National Database and registration authority, in between 2004-2005 Santiago, Chile implemented world's first 100% full speed vehicle operation at toll plazas with transponders and in 2007 road and traffic engineering implemented the ETC in united Arab emirate known as salik [4].

IV. STRUCTURE OF ELECTRONIC TOLL COLLECTION

The ETC comprises of four systems 1. Automatic Vehicle Identification (AVI) 2. Automatic Vehicle Characterization (AVC) 3. Vehicle Enforcement System (VES) 4. Back Office System (BOS)

A. Automatic Vehicle Identification (AVI)

The AVI checks each registered vehicle properly with full accuracy to charge the toll. The AVI includes some important equipments which are installed roadside as well as on vehicles such as automatic license plate recognition, barcoded labels, and transponders. The receiver communicates with the barcode tag fixed on the windshield and takes the information. The radio frequency waves are mostly used as they have high frequencies as high as 300 GHz and the for other reason they offer very less error in data transfer in bad weather as there are other electromagnetic waves for data transferring like inductive, laser and optical but they are not so efficient as radio waves. Therefore AVI systems use radio frequency identity (RFID) and plate detection technology.

B. Automatic Vehicle Characterization (AVC)

The toll is not same for all vehicles, therefore, the categorization is must which depends upon size and weight of the vehicles for this AVC technique is used for different forms vehicles like buses, cars, minibuses, multi-axle trucks among this equipment which are part of AVC include coils, treadles, video processing software, scanning equipment, light curtain, optical beams and weigh-in-motion scales.

C. Vehicle Enforcement System (VES)

The main intention of VES is to decrease the number those vehicles which try to skip the toll by not having sufficient balance in the account or having unauthorized tags attached on their vehicles. The violators should be recognized and administration should punish the violator for an unpaid trip. The system image processors can be used for vehicle plate identification and the aadhar synchronization with the vehicle plate number that also helps in finding the violators easily. The main equipments are cameras, good lights, centralized computer systems.

D. Back Office System (BOS)

The important function of BOS is to give customer services in the form of collecting all the transactional data of all lanes, to maintain the summary of whole data and matching the transaction with particular account holder and to provide temporary RFIDs for new vehicles coming from other states, and to maintain the central system of whole toll plaza like transponders, cameras others things etc.

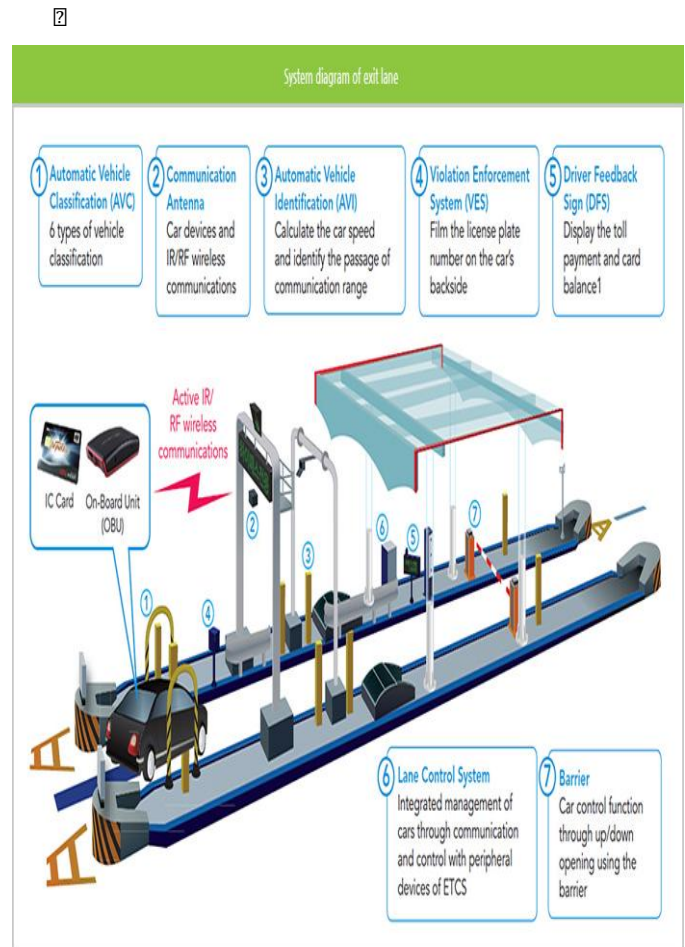


Fig.1 Structure of electronic toll collection [5]

V. ANALYSIS ON ROAD USER SATISFACTION

There are two toll plazas on Jalandhar-Amritsar highway when travelling from Jalandhar to Amritsar or vice-versa both the two toll plazas face extensively high traffic volume during peak hours and even during the festival seasons like Diwali or Gurburb (festival that is related to the lives of Sikh guru) that too comes in the month of November which is prone to fog and bad weather so it becomes a big matter of concern for the toll authorities to overcome this. So as the road survey done by us we found mind-blowing results and survey was done in the two forms like drivers who had faced traffic congestion at toll booth and the drivers who never faced any problem in their driving at toll plaza in comparison with ETC and old existing technology and we also divide it into levels like very convenient, rather convenient, not convenient and hard to answer as showed in chart 1 and 2.

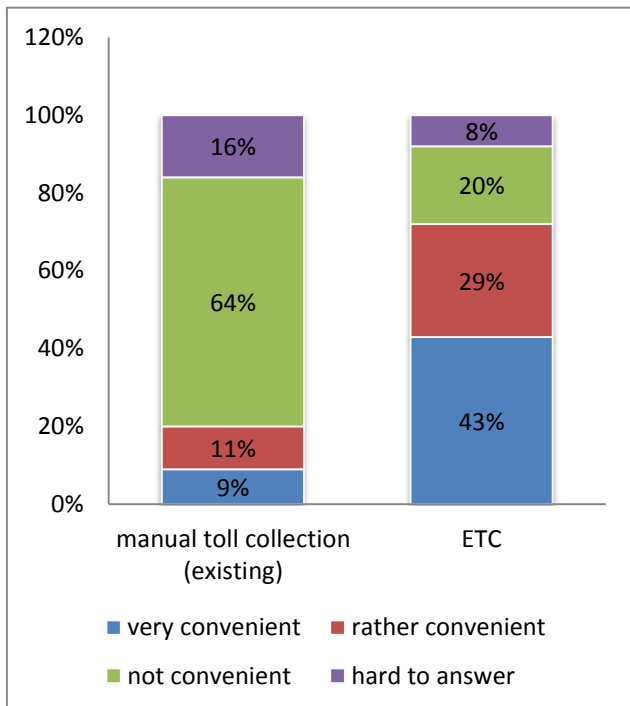


Chart -1: People who faced congestion at toll booth

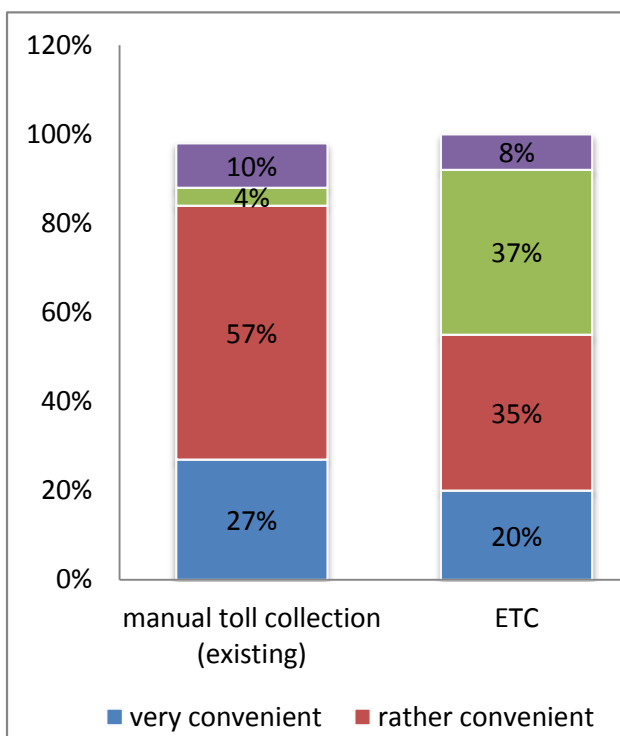


Chart -2: People who never faced congestion at toll booth

we came across the fact despite the government of India is taking big measures to have an effect of digit India still people don't know about it and found hard to answer and still people are concerning about the money which will be deducted automatically. We also suggest that government should also

hold programs regarding digitalization and enhances the internet banking as much as possible. Therefore if the ETC will get implemented on the Jalandhar-Amritsar highway remarkable road user satisfaction is expected to increase especially for the people facing traffic congestion problem at toll booth 43% to 72% that is from very convenient to rather convenient.

VI. TIME AND ECONOMIC ANALYSIS

Once the Road Transport and Highways Minister Nitin Gadkari said in Mumbai cited that Rs.88000 crore will be saved when the Electronic toll collection will be implemented in the whole country [6].let's take any one of the two toll plazas on Jalandhar-Amritsar highway the toll plaza normal day carrying capacity is 43000 vehicles per 24 hours but the demand is 49500 vehicles, therefore, the difference is 6500 vehicles .It means that for a transition of 6500 vehicles the time is calculated as (a difference between demand and carrying capacity x 24/carrying capacity) that is $6500 \times \frac{24}{43000} = 3.6$ hours additional. That means it will take 27.6 hours for all vehicles to clear the toll booth.so simply the time loss during thus traffic congestion could get by(demand vehicles X additional hours) that is $49500 \text{ vehicles} \times 3 \text{ hours} = 148500 \text{ vehicle-hours}$. Similarly when there is the festival season like Diwali or Gurburb is expected to increase by using the existing technology of manual collection of toll. Now let's discuss another point if the vehicle do not waste time in queue as many drivers don't face any congestion at toll plaza but they save to waste time in stopping the vehicle then pay the toll to the employee there. This shows that motorists have to decrease the speed from at least 115 to 0 km/during this period the time wastage here is almost at an average of 35 seconds.Therefore if here even demand is taken as total amount vehicles to pass through a toll plaza without queuing the time loss is (demand X time wastes to stop car/3600) that means $49500 \times \frac{35}{3600} = 481.25 \text{ vehicle-hours}$. Thus in the existing system of manual collection, the total time loss is during waiting or even not in a queue by only braking/acceleration it becomes $148500 + 481.25 = 148981.5 \text{ vehicle-hours}$.

Now for the economic considerations, the time factor is very important and also the persons who are traveling have different values for the time some people go for educational purposes and some for work and some for leisure these impact on economy differently.in Punjab, the monthly income per capita is 12635.33[7].Thus the economic loss for this is $148981.5 \times 12635.33 = \text{Rs. } 18802430416/\text{annum}$ and even if we consider that all households don't have vehicle and they don't cross that toll plaza on Jalandhar-Amritsar and take this monthly income per capita as one- fourth still it shows tremendous loss like $148981.5 \times 3158.83 = \text{Rs. } 470607604/\text{annum}$

Another important aspect in economy is the fuel factor which is utilized during the starting of vehicle and changing the gears and also when the speed is decelerated for this the table is given below.

Table 1 fuel factor with respect to economic analysis

Total number of vehicles per day (demand)	49500
Payment time in existing manual system (seconds)	07
Vehicle speed(km/h)	115
Time wasted during decelerating from 115 to 0 km/h in seconds	35
Average time of waiting in a queue (second)	240
Fuel consumption in one second (litre)	0.000333
Fuel consumption in wastage	$7+240 \times 0.000333 = 0.082251$

Therefore Fuel consumption in wastage in queuing and paying the toll will be $7+240 \times 0.000333 = 0.082251$ litre/second. Hence the price of petrol in Punjab is Rs. 75/litre there the total price in wasting seconds would be $0.082251 \times 75 =$ Rs.6.16 and for demand vehicles, the sum will be $49500 \times 6.16 =$ Rs. 305356.83 per day and for a year it will be 3664282.05 amount of money at only one toll plaza where the figure will come exactly to the saying of Road Transport and Highways Minister that 88000 Crores could be saved if ETC is implemented all over the country.

VII. SYNCHRONIZATION OF AADHAR CARD WITH VEHICLES NUMBER AND BANK ACCOUNT

Since aadhar is the 12 digits unique-identity number given to all citizens of Republic of India that is based on biometric authentication and demographic data as it is the largest biometric identification of world with over 1.171 billion enrolled members as of 15 Aug 2017. The World Bank Chief Economist Paul Romer described Aadhar system as "the most sophisticated and well-informed identification programme in the world"[8].we suggest through this paper that the linking up of aadhar card with all bank accounts is necessary for any Indian that is already in progress this aadhar card should be synchronized with the vehicle number so that a person think at least two times before giving his vehicle to anyone unknown as it also provides the real-time monitor of traffic and the

persons that are leaving one area and entering the other area. This will automatically reduce the crime rates and terrorism which is the big security concern as well or will help the authorities to find the culprits easily.

VIII. CONCLUSIONS

In this paper the road user satisfaction, economic benefits and time wastage in long queues of toll plaza were analysed that showed the old manual toll collection results in increase in capital, cost of operation as compared to ETC as in India people are less aware of technology that is why this thing will take little time to implement in India and ETC will ensure 100% toll collection rate as compared to manual collection that is always in headlines for corruption. Other prominent advantages are decrease in cost of transportation as travel will take less time, real-time traffic monitor and longer vehicle life and other items.

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