
Cost effective engineering enforcement measures in heterogenous traffic environments of developing countries

N T Rao¹

Abstract

The paper aims to highlight the importance of Intelligent Transport Systems (ITS) in enabling effective enforcement of backend processes of transportation in urban environments in developing countries that mostly comprise of heterogeneous traffic environments. ITS equips enforcing authorities to streamline back-end processes including fee collections, detecting traffic offences, regulating and controlling traffic movements, and many other functions. Some of the applications further help enforcement authorities to detect speed violations, traffic signal violations, illegal parking, overloading, in-vehicle violations and other traffic abuses.

Apart from detecting violations, enforcement authorities can deploy ITS in the field of incident management involving monitoring the movement of vehicles on the road, real-time monitoring, detect incidents such as break-down or accident based on image processing / manual systems, quick emergency response, congestion/incident data leading to signal prioritisation for emergency vehicles and other

incidents for ensuring smooth traffic flows. Segments with the highest frequency of incidents can be monitored with high-end CCTV equipment. ITS aided traffic enforcement is also helpful in Automatic Number Plate Recognition (ANPR). ANPR technique is used by traffic police and transport authorities across many developing countries for law enforcement purposes and legitimacy of number plates. Some developing countries have started using ANPR for electronic toll collection. Public Private Partnership (PPP) is suggested to ease the burden on government expenditure towards urban transportation enforcement. The paper concludes by recommending various processes and procedures for traffic rules enforcement authorities in developing countries to consider for implementation in their respective urban jurisdictions, which will help in addressing one of the major urban traffic problems and facilitate safer and smarter mobility.

Keywords: (1) Enforcement (2) Traffic Violations (3) Registrations (4) Licensing

¹ Ex-Dean, MPSTME, NMIMS University

Introduction

Developing countries experience different kinds of problems on their urban roads when compared to developed nations. Most of these traffic problems can be attributed to the road user's behaviour, which may be due to lack of civic sense. It is possible that it is due to inadequate literacy levels. However, the fact that chaotic traffic situations do prevail in some prominent cities in South America and Asia with high education levels will negate the argument that it is lack of proper education which is the prominent causal factor for traffic ills. The problems in many cities in the African continent that witness lower traffic volumes and homogeneous traffic characteristics, vary in nature and magnitude.

Not many studies have precisely computed the direct benefits arising out of traffic enforcement on urban roads. The most commonly perceived and believed benefit is that better enforcement results in better traffic flow. In the absence of concrete and reliable data regarding savings in terms of travel time and the resultant higher levels of productivity, governments have not been keen to invest on traffic enforcement measures. Many countries around the world manage their huge levels of urban traffic manually with traffic policemen who are subjected to extreme weather conditions and pollutant traffic. Prohibitive initial costs and regular updating and maintenance are deterrents for government to consider adoption of technology to solve traffic engineering problems. It is a fact that traffic enforcement starts and stops at controlling and managing on-street traffic in many developing countries. Civic authorities must realise that traffic engineering problems can be solved with low cost measures at the backend. Therefore, there is an urgent need to invest and implement ITS enabled enforcement systems that can address wide ranging urban traffic problems and provide integrated solutions.

1. Enforcement in Developing Countries

At the outset, it may be mentioned that enforcement is not to be seen as limited to actual vehicular flow on

streets, but it must also be inclusive of operations like licensing, overloading, and other related aspects because many developing countries face serious problems as a result of these issues. The traffic enforcement responsibilities and operations are handled differently by different countries. In some countries, the police are mandated with all the issues ranging from vehicle and driver licensing to actual traffic management whereas separate departments and ministries oversee these functions in some other countries.

The enforcement issues broadly relate to licensing of vehicles and drivers apart from overloading of passenger and freight vehicles. While advanced countries have integrated databases that cover the entire licensing of individuals and vehicles at regional and national levels, developing countries are still struggling with large numbers of unauthorised vehicles and drivers on their roads. Data is not available regarding road accidents that these unauthorised vehicles and drivers have caused or the losses that the countries bear because of them. The driver and vehicle license databases are not integrated and are maintained separately in many countries. It is a common practice in many of the developing countries to have fake licenses or operate with illegal or even no documentation.

2. Application of its technologies in Traffic Enforcement

Application of Intelligent Transport Systems (ITS) in traffic enforcement domain involves technologies which require expertise to install, test, operate and maintain in assisting enforcement authorities on urban road networks in developing countries. Applications of ITS technologies are innumerable. However, considering prohibitively expensive systems that the developing countries can ill afford, it is being suggested that most of the ITS technologies may be made use of for backend applications only. Adopting ITS technologies will help enforcing authorities to streamline backend processes including vehicle registration, fee collections, detecting traffic offences,

regulating and controlling traffic movements apart from providing solutions to many other functions related to urban traffic. ITS applications cover a large number of areas like providing information through variable message signs, emergency response systems, traffic data collection and many others at the operations stage. Streamlining vehicle registrations and licensing through ITS enabled enforcements will help countries to eliminate unauthorised vehicles and drivers for better traffic operations. The ideal option for licensing is to adopt Electronic Vehicle Registration (EVR) to solve many ills. Application of ITS based technologies also helps in incident management on urban road networks that may include road crashes, vehicle breakdown, passenger related incidents and so on. Some aspects of application of ITS towards incident management are mentioned below.

2.1. Incident Management

Application of ITS technologies enables management of incidents on road systems that may involve severe road accidents, medical emergencies, localised events, etc. ITS application is based on the following principles:

- Monitor the movement of vehicles on the road;
- Get an understanding of real-time or live view of traffic movement;
- Detect speed of individual vehicles and flag over speeding vehicles;
- Detect incidents such as break-down or accidents;
- Provide quick and emergency response as the case may be;
- Monitor congestion/incident data leading;
- Prioritise traffic signals for emergency vehicles.

Urban traffic in many developing countries involves large volumes of heterogeneous traffic unlike in developed countries where vehicular composition is more or less homogeneous. A control room may be established to monitor the traffic movement that helps to take note of traffic offences. For shorter nodes and links of road segments, monitoring could be done at the intersection level and a limited distance upstream and downstream of the intersection. For

other segments, for example, segments with the highest frequency of incidents, it may be desired that the entire extent of the segment be observed and thus, CCTV equipment be deployed at a greater density. CCTVs can be of many types such as day/night, colour/black and white, thermal, infrared and others. In alignment with the surveillance systems, concept design, best practice surveillance system and standard operating procedures will need to be developed by the civic authorities for effective monitoring in the control room. This will include video retention policies, third party access to video, policies regarding public website and media access, use of video in legal proceedings, and privacy policies regarding issues such as not viewing private property unless there is a traffic-related reason.

2.2. Detecting Violations

Implementing ITS also helps vehicle compliance and traffic law enforcement in addition to a number of advantages for operators. Some of them can be as follows:

- i. Vehicle compliance violations that may include detection of unregistered vehicles (a common phenomenon in developing countries); not meeting the standards and specifications mandated by regulating authorities; unsafe vehicles; roadworthiness; environment compliance; exhaust emissions; uninsured vehicles (another common feature in many countries); vehicles that have been in arrears in terms of taxes and fines, etc.
- ii. ITS also helps in uncovering tax evasions as it will enable creation and integration of databases from stakeholder agencies. Vehicles for which taxes have not been paid will be detected automatically when passing a monitoring station.
- iii. One of the biggest features of use of ITS is finding out vehicle related crimes. It is possible to identify vehicles that have been reported as stolen, vehicles with mismatching vehicle identifiers with different licence plates, and other such wrongdoings which have been reported from urban areas of developing countries.

- iv. The application of ITS can be extended to crime investigation. Police or law enforcing authorities can identify a vehicle in real time while it is occupying road space or from a monitoring station. It is also possible to identify erring vehicles through data analysis and pattern recognition of monitoring data. It has been reported that some road related crimes could be solved through search of probable suspects of hit-and-run cases or eye witnesses to road crashes, etc.
- v. ITS can detect traffic law violations like over-speeding, wrong-side driving; entering one-way streets, unauthorised travelling in dedicated lanes, etc. and many other violations that are common on urban road networks of developing countries.
- vi. In many nations, commercial vehicles violate norms. ITS helps in detecting and identifying vehicles that do not follow traffic regulations for either axle loads or carrying loads that are not within permissible limits, and other regulations.

2.3. Electronic Vehicle Registration

In order to ensure that these problems are minimised, developing countries may consider using Electronic Vehicle Registration (EVR) for better traffic enforcement. Benefits from effective enforcement can include vehicle registration and inspection, making provisions for developing and maintaining databases, etc. In countries where on-street traffic is entirely handled by traffic policemen, EVR will allow on-street police to check driver and vehicle status quickly and efficiently. This, in itself, will be a deterrent to evading driver license and vehicle registrations, which is a very common practice in most of the developing countries. The database of licences issued to drivers should also include details of traffic offences, penalty points, paid and unpaid fines, which would help the enforcement authorities in a big way to plan, introduce and implement traffic regulating mechanisms. The database should be checked to verify whether the vehicle is currently considered to be roadworthy; most countries do not monitor this aspect even after many years, once the vehicle is registered.

2.4. Automatic Number Plate Recognition (ANPR)

Automatic Number Plate Technology (ANPR) is applied to read and recognise the vehicle's registration number plates using principles of image recognition and optical character recognition of images. Its application may include use of existing closed-circuit television cameras or cameras specifically designed for vehicle plate recognition to enforce road rules or for other such purposes. ANPR technology is used by traffic police and transport authorities across many developing countries to check if the vehicle is properly registered and using a legitimate licence. Many countries have started using ANPR for automatic electronic toll collection. With the advancement in image processing techniques that enables storing images and texts from cameras, it can also be used to capture traffic offenders and drivers that flout rules. The ANPR systems commonly use infrared lighting because it allows cameras to take pictures even at night, or when visibility levels are low, or even if it is dark all around.

2.4.1. Application of ANPR Technology for Traffic Control

Recognising the wide applications of ANPR technology in the traffic engineering domain, many cities have developed traffic control systems to enable smooth flow of traffic through regular monitoring. Though the initial expenditure will be high, benefits that will accrue in terms of higher levels of productivity and establishing efficient systems, will be greater. It will be worthwhile for developing countries to consider using ANPR technology in the areas of:

- Classified traffic volumes on urban road stretches;
- Traffic flows that may include congested flows as well as free flows;
- Parking inventory;
- Identifying road works, if any, being undertaken;
- Traffic detours, if any;
- Installation of traffic signals, where applicable;
- Providing pedestrian facilities;

CCTV cameras can be utilised to enable enforcement authorities to analyse real-time data so that solutions can be provided instantaneously. Real-time monitoring also helps to track individual vehicles. Information can be provided automatically with respect to speed violations and congested routes through usage of ANPR footages.

It has been established that ITS technologies help traffic enforcement in a big way. Developing countries may do well if they can consider some of the following suggestions towards better enforcement on their urban road networks.

3. Funding for traffic enforcement through PPP

Deploying ITS technologies for backend operations of urban traffic enforcement in developing countries is a challenge. The fundamental challenge for countries is to find funding for implementing such projects. Governments around the world, whether in developing countries or even in developed countries, are experiencing resource crunch. In the case of developing countries, priorities of governments are more toward addressing basic amenities. Therefore, it is understandable if these governments are constrained to provide funding to implement newer technologies for traffic enforcement. Many governments are considering private sector participation to ease the financial burden on the government to provide these services to the public.

Therefore, it may be worthwhile to consider different sources of investment. Traffic enforcement can provide a good opportunity for Public Private Partnership (PPP). The private sector may be invited to undertake certain enforcement related aspects that the government may find easier to outsource. Enforcement agencies, including police and civic authorities, as the case may be, could use funds from the private sector for implementing various backend operations of traffic enforcement. This would help governments to divert the surplus resources resulting from this initiative to other needy and priority areas.

3.1. PPP in Traffic Enforcement

Public Private Partnership (PPP) can be broadly explained as a task taken up by the governments in order to procure funding, services and operations by entering into a partnership. This arrangement can be two-way or three-way between a public sector authority and a private sector company with or without an overseeing government authority/agency by agreeing to certain guidelines and performance standards to be decided by a public party. In the domain of traffic enforcement, the PPP model typically involves the private party investing and installing enforcement equipment and carrying out backend processes. The investments made by the private sector party are expected to be recovered through revenues collected in the form of fines and penalties from traffic offenders over specified concession agreements. The success and sustainable implementation of PPP model largely depends on gaining public support, and their acceptance. In PPP models, the initial investment is high, and repayment is gradual, and hence, public-private-partnership agreements must be spread over longer periods depending upon each government's fiscal strength and priorities. PPP initiatives will help in easing traffic congestions in many cities around the world and will enable establishing improved urban traffic conditions.

3.2. Outlines of PPP Agreements for Traffic Enforcement:

Some broad pointers in PPP agreements that can be helpful in traffic enforcement in urban areas are listed below:

- It may be considered to engage a private party to supply equipment for usage at no upfront charge to police or any other government agency.
- Governments may enter into contractual arrangements with private parties allowing them to recover their investments over a period of time that may range from 10 to 20 years based on the quantum of investment and operating costs involved.

- The revenue sharing may be on the basis of mutually agreed terms and conditions depending upon the likely profits to be accrued through deployment of ITS processes.
- Where applicable and where administrative convenience is merited, government agencies can decide to involve a third party. This third-party agency may be mandated to give permissions and sanctions. However, it may be worthwhile for the government agencies to regularly monitor this party agency.
- PPP agreements may consider having in place an independent private party so that it can assist in monitoring, auditing and verifying the enforcement processes in urban environments.
- PPP agreements must be explicit in defining rights and liabilities of all the parties.
- Private parties involved should not be burdened with expenditures or costs arising due to legal complications, arbitration, audits, strikes, vandalism, and other situations that are not under the control of any of the parties, as this will have a serious detrimental impact on any future PPP initiatives.

4. Recommended interventions for better enforcement

4.1. Legislative Measures

- It has been observed that some of the developing countries follow the Laws and Acts that date back to their former colonial rules. For example, there are nations whose relevant Acts are so old that they do not even mention traffic signals or speed violations. In the absence of such provisions, it becomes difficult to penalise for traffic violations. Therefore, nations must enact or amend laws making adequate provisions to equip enforcement authorities to deal with traffic offenders and penalise them accordingly.

4.2. Application of Technology Tools

- World over, all agencies that deal with urban road traffic must adopt technology for effective

enforcement.

- All the processes that deal with the transport sector including licenses, permits, and all other activities must be made online, eliminating human intervention at every stage. It will achieve multiple benefits for poor and developing countries in terms of improved efficiency of systems, eliminating corruption, and will contribute towards productivity of already short-staffed and overburdened government bodies in most of the countries.
- The registration process must be made paper-less for all future registrations and driver licensing. This will indirectly help in better enforcement backed by a strong database.
- All developing countries must ensure that their traffic regulating agencies are well augmented with infrastructural and other support mechanisms. In many countries, government agencies outsource testing facilities. This is understandable as governments do not have adequate funding for such facilities. One probable answer could be reforming the process by allowing private licensed garages to test the vehicles for roadworthiness under the supervision of competent authorities.
- Governments should consider introducing newer technologies like Electronic Vehicle Registration (EVR) in order to achieve higher levels of success in vehicle registrations.
- Regulating agencies and authorities must make it mandatory for insurance companies to provide details of insured drivers onto a database that can be accessed by courts, Police, Driver Vehicle Licensing Authority, etc. Unlike in developed countries, most developing nations don't have a database of licensed drivers.
- One of the biggest challenges for traffic regulating authorities in developing countries is the heterogeneous nature of traffic. In some countries, there are as many as 20 types of vehicles that are recorded as registered motor vehicles. If non-motorised traffic like bicycles,

cycle rickshaws, animal drawn vehicles to transport men and material on urban road networks are also added to the number, the matrix becomes nearly unmanageable. Efforts may be made to bring down the number of categories of vehicles which would not only ease the registration process but will also help in better monitoring and enforcement.

- It is important that governments have the latest and updated record of vehicles. In many countries, older vehicles are not registered, or they are not part of the databases. They may consider writing off vehicles that are older than 20 years and withdraw all such vehicles. As the next step, it should be mandatory for all vehicle owners to bring their vehicles for physical inspection.
- One of the biggest ills in developing countries is drivers driving vehicles without proper licence or authority to drive. Authorities must come down heavily on all vehicles driven by unauthorised drivers and confiscate such vehicles and embark on a mission to ensure that no vehicle is driven by unauthorised drivers.
- Coordinating agencies must integrate their databases and allow on-line exchange of vehicle and driver information with stakeholders like police, insurance companies and others so that all the information can be productively used thereby benefitting all involved agencies.
- Not registering a vehicle to avoid taxes and fees is another major violation that is observed across many developing countries. High registration fee is one of the reasons cited by defaulting vehicle owners. Regulating agencies may rationalise the fee structure in such a way that it must be encouraging for all vehicle owners to register their vehicles.
- Vehicles carrying freight far exceeding legal limits is another major traffic violation. Many countries still depend on off-the-road weigh bridges to monitor legal loads. With many newer technologies available, civic authorities may consider procuring portable weighbridges to enforce legally permissible loads on urban roads.

4.3. Traffic Control

- Developing countries must focus on modernising traffic control with cost-effective technology and tools.
- Ideally, traffic police may be equipped with a modern Traffic Control Centre (TCC) for the purposes of monitoring and controlling traffic flows and incidents under the management of the traffic police though the government may have the option to place the responsibility with civic authorities as being practiced in some cases.
- Traffic control infrastructure should include modern traffic signals. Where possible and if funds are permitting, traffic signals should be vehicle actuated so that they respond to the demand using urban traffic control systems where traffic flows are heavy. However, considering the financial constraints in many developing countries, vehicle actuated signals need not be the primary option, especially on networks where the number of vehicles does not merit them.
- It will be possible to arrive at real-time traffic management decisions by making use of the live data captured from CCTV cameras that are monitored at traffic control centres.
- Monitoring individual vehicles becomes important at times due to reporting of heavy violations. In order to routinely monitor the movement of individual vehicles, ANPR technique can be used as it also enables automatic recording of speed as well as speeding over defined speed limits.

4.4. Enforcement of Traffic Regulations

- It has been observed that many countries still maintain the same levels of fines and penalties that have been set decades ago, as relevant provisions in their respective Acts have not been amended or updated. These fines and penalties are at very low levels and hence, are not a deterrent for drivers in many countries. These should be revised upwards based on growth in prices so that their overall deterrent effect is maintained.

- One of the most glaring gaps in the domain of traffic enforcement around the world is woefully inadequate human resources. More police and law enforcing personnel must be made available to enforce traffic rules and they should be equipped with requisite tools for traffic enforcement. The police require effective modern-day communication systems so that they can process traffic offences quickly and efficiently.
- Overloaded trucks/lorries, apart from creating a revenue loss, will severely damage roads and make the need for repairs more frequent, which implies the requirement for more funds. Traffic enforcement agencies and authorities must be adequately funded. Their systems must be brought online and streamlined to such an extent that they can forcefully enforce specified axle load norms.
- Freeing up the traffic police from manual control of junctions in urban areas of many countries will allow them to be deployed more effectively for better traffic enforcement. It is essential that the traffic police are mobile and that there are

sufficient and suitably equipped vehicles enabling them to reach the site of an incident quickly and efficiently. Police vehicles need to be equipped with on-board cameras to record traffic offences; they should have modern gadgets including laptops with supportive software applications, license scanners, speed guns, etc. They must be synchronised with Traffic Control Centre which would enhance urban traffic enforcement.

Conclusion

Governments in developing countries must recognise the importance of ITS for traffic enforcement, which not only helps to solve many problems, but will also contribute to higher levels of productivity of nations. Traffic and transport departments must be well-equipped with infrastructure and other support mechanisms. It is hoped that implementing the suggested mechanisms for enforcement authorities in urban jurisdictions will help in addressing one of the major urban traffic problems and facilitating safer and smarter mobility in developing countries.

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Rao was the Dean of MPSTME, NMIMS University. Apart from over a three decade experience as an educator and academic administrator in India and abroad, he also has consultancy experience while working for funding agencies like the World Bank, Asian Development Bank, African Development Bank and many other government organisations in India and several developing countries around the world.