

## **Comparative Study of Smart Traffic Offence Ticketing System – Case of Addis Ababa City Traffic Management Agency**

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### **Abstract**

Recent statistical data shows that Addis Ababa City has registered more than 630 thousand vehicles. With that figure in mind it is possible to imagine the amount of daily traffic that the city could accommodate. It is becoming so common to see many drivers being stopped on the road and penalized by traffic officers every day. Since the current traffic offense management systems is almost completely manual, it is tedious and time consuming for a driver to settle an offence ticket and claim their license (whether it is vehicle's registration plate or driver's license) back. In Ethiopia, particularly Addis Ababa City police stations, there is no a comprehensive automated system that handles the document works related to traffic violation ticket system yet. Whenever a driver is caught up by violating the traffic road rules, they have to wait on the roads until the traffic officers write down fine papers manually, and then traffic officers ask to handover the drivers' license and/or vehicle registration plate. In order to claim their license, the drivers need to settle the fine in a bank or some agent, and take the receipt to the dedicated police station, and wait in a queue again. To intervene in this situation, this paper aims to conduct a comparative study of technological solutions for traffic offense ticketing system and recommend to Addis Ababa City Traffic Management Agency. Thus, the main focus is to compare four traffic violation ticketing systems: Traffic Ticketing Systems, E-Tickets, Automatic mobile ticketing system for traffic offences (Mobile Apps), and e-Traffic prosecution system. Based on the findings of the study, the researcher recommends that a customized version of traffic ticketing system and automatic mobile ticketing with integrated payment options best suits for Addis Ababa City Traffic Management Agency.

Keywords: traffic violation ticketing (TVT), traffic offense, e-payment

### **1. Introduction**

According to statistical data, Addis Ababa city had around 150 thousand registered vehicles in 2014. During the period of this research, the city has more than 630 thousand registered vehicles. The increasing number of registered vehicles in Addis Ababa City is creating huge daily traffic flow on the roads. No wonder why the number of road traffic violations is increasing tremendously and so does the tedious manual process of traffic violation ticketing system.

An officer has to issue a manual ticket to the violating driver, and confiscates their license (vehicles registration plate or driving license) temporarily. The driver is supposed to pay the fine in a bank and/or agent, take the receipt as a proof to the concerned police station and claim their license back. This is so tedious, ineffective and insufficient process. It not only takes the time of the violating bodies but also waste a precious time and cumulative resource of all the participating entities.

The current system of traffic ticketing, which is almost completely manual ticketing system (of course,

there is some initiation to settle traffic offence fine though a mobile app, a comprehensive system is not implemented yet), is often bring inconveniences not only just to the deemed ‘violators’ but also one way or another all the traffic enforcers. To assist the police and the people with regard to improving the settlement of traffic tickets, a web-based or automated traffic ticket data information system is required, which can generate traffic ticket information quickly, at any time around the clock. This information system is aimed at reducing traffic violation committed by the people as well as increasing public awareness of safe, orderly and proper driving [2].

The fact that Addis Ababa City is accommodating large number of traffic violations day-in-day-out, there is a need to systematic implementation of traffic violation ticketing system not far from now. In addition, the paper dictates that a sustainable implementation of such systems may contribute a better decision making process based on accumulated traffic data on the long run. Such system implementation will provide an efficient, cost (time and resource) effective and reliable means of traffic offence data management process.

The present system of traffic ticketing, through the manual process, most of the time is totally inconvenient to both the traffic enforcers, the deemed violators, and public at large [6]. In Addis Ababa city, regardless of the ever growing road traffic violations, the TVT still falls under the old manual process. Addis Ababa City’s Traffic Management Agency is also looking for technological solutions that could ease and automate the existing manual TVT systems [4]. The level of enforcement ranges from fine (in money) to driver license suspension and revocation depending on the severity of the traffic offence [1]. The purpose of the paper was to improve efficiency and effectiveness of traffic violation ticketing, to assist the police in addressing and reducing traffic offenses and at the same time speed up the way traffic ticketing process.

Therefore, on the course of this, a critical comparative analysis is undertaken in order to implement an effective traffic violation ticketing system through comparison analysis of the selected TVTs based on some criteria, and propose to Addis Ababa City. Hence, the objective of this paper is to compare selected traffic violation ticketing systems and recommend suitable technological solution that best fit for Addis Ababa City Traffic Management Agency (TMA).

## **2. Related Work**

The use of technological solution has an impact on the settlement of traffic violation cases to replace the manual ticket system. With a smart traffic violation ticketing system, the drivers violating the traffic will be recorded through the application of the police. Increased of traffic violation is a huge challenge for the police to be able to implement educational sanctions while still having a deterrent effect [5].

A study conducted in Sri Lanka regarding traffic violation management system [9], points that the traditional paper based system is needed to be moderated and should be transformed using technological solutions. The new TVT systems overcome the drawbacks of the existing system by facilitating report generation as required to the auditing process in a very efficient manner. Moreover, with modern and traffic ticketing systems, future planning and decision making will be much easier. Based on the study, the researcher recommended the concerned authority should plan on modernizing traffic violation management system rather than wasting valuable resources on the current paper based manual process.

Traffic violation ticketing systems (TVT) is a broad concept that is used in wide range of systems for traffic management agencies and provide a centralized access for drivers, traffic police and city

administration. At high level, these services provide several types of traffic violation information such as type of violation, frequencies, area/location of violation and so forth. Beyond handing a violation ticket in an automated way, TVTs play significant role in delivering good traffic violation data management and can be used for further in policing and decision making processes.

Traffic violation management systems help to empower the penalty payment method regarding maintaining a reliable, swift and transparent payment method. As the system helps the traffic police to secure confidentiality of documents, report generation and view preview records of violations in a just a single window [9]. Starting small with just automating the traffic violation ticketing and fine settlement system, then adding more feature such as on-time GPS tracking of the police officer, push notification technology etc....and gradually attain fully automated smart traffic management system could be attained.

According to the research, a deep observation and analysis is undertaken to better understand the possible problems and challenges faced while migrating from a completely manual process to an automated systems. Problems related to skill enhancement and training, awareness creation amongst stakeholders in regard to advantages of adopting technological solutions and resources constraints are majors ones. So, based on the findings, a summarized significance of the system for traffic violation ticketing as a technological management tool has already been deployed in many developed and developing countries and specially those cities that are trending on smart city technology

There are several technological solution alternatives when it comes to traffic violation ticketing system depending on the scope, budget, available resources (infrastructure and man power) as well as interests of all the participating organizations within. Researchers have conducted an intensive investigations on this field and have proposed variety of solutions. A research project conducted in Philippines, presents a solution on how to eliminate the long process of issuing traffic violations whereby a smart driver's license card will be implemented [10]. The research proposed an automated traffic violation apprehension payment systems in was that involves a cloud server with windows application, web based service and android application for users to interact with the system, and this was the effects of effective traffic management and apprehension of traffic violation endeavors.

An efficient and reliable traffic violation ticketing system is needed to create, settle and manage traffic violation tickets. TVT has a wide range of uses such as proper accurate reporting, data management and better decision making processes. A free and open source TVT system would be a good foundation to build a customized ticketing system. The system could provide a means to integrate an online payment options and city specific road traffic policies. Nonetheless, beyond adopting existing system 'as is', a systematic customization of selected system would be more preferable for a compatible and sustainable implementation.

Traffic ticketing systems is a fully automated web-based platform that facilitates traffic violation ticketing process. With its central database, this web-based traffic ticketing system is ideal for a swift and efficient traffic violation settlement process. The new traffic ticketing system provides an opportunity for the administrative settlement of traffic and road offences without having to go through the court system. Although this system takes an electronic approach, it does not totally eliminate the use of paper. Officers will be utilizing both the mobile handheld ticketing devices and the paper-based traffic ticket. There is now a newly designed traffic ticket that alleviates the current challenges experienced by law enforcement

officers when writing paper-based tickets. TTS, simply automates the common paper based process via a web based portal; that is after violation ticket is generated, the driver needs to settle the payment within the grace period of that ticket via bank or available payment option [1].

It is clear that bribery when traffic operations are frequent. That is the reason underlying the Police of the Republic of Indonesia implements a new system called E-ticket. A trusted system can reduce Pungli (extra money) and bribery practices. The E-ticket has been applied simultaneously to the simultaneous launching in Indonesia on December 6, 2017. The E-ticketing system will replace the manual ticket system using blank paper based ticket, where the offending driver will be recorded through the application [5]. Once an e-ticket is generated, the driver could settle the payment via bank, or using an online payment options. This Electronic traffic ticketing app, deals with handling the violation ticket process whereby police officer, issues the ticket and the driver receives the ticket on their phone.

With E-traffic mobile ticketing system, traffic enforcers should use handheld devices so as to issue a violation ticket. And the respective driver gets a ticket notification in real time via notification methods (on application, SMS and/or email). Since the police will use portable handheld devices to issue the violation ticket there is no immediate need connectivity to central database. If internet connection is not available, the system generates and records the ticket on its local database and synchronize it when connectivity is restored. This ticketing system requires drivers to have the client side application installed on their phones and/or alternatively use digital account whereby they can access it in case of penalty settlement process. Automatic mobile ticketing system's main goal is to ease the ticketing process for everyone, regardless of where they are located. However, with the implementation of new technological solution challenges related to users' behavior to adopt new technology and system outages and/or availability issues are expected and should be planned ahead in time.

A flavor of automated traffic violation ticketing system, e-Traffic prosecution system, was launched and been successfully operated in Bangladesh since 2012. Main objective of the system is to bring transparency to the process of collecting traffic fines from vehicle owners and passers-by breaking traffic rules. Under the system, users will be able to check the documentation of their cars, driving license and other such documents through text messages. The traffic police can file cases against offender and the lawbreakers can also pay fine through a Robi (second largest mobile operator in Bangladesh)

With the availability of optional open-source traffic ticketing Systems, it is possible to customize one based on the business goals and agency's directives, allowing to get a best fit towards the needed purpose. Based on best practices and experts recommendations, let us have a look at the selected TVT's pros and cons in Table 1.

*Table 1: Pros and Cons of selected TVT Systems*

| Selected TVT                  | Pros                                                                                                                                                                                                                                                         | Cons                                                                                                                                                                             |
|-------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Traffic Ticketing System, TTS | <ul style="list-style-type: none"> <li>• Easy to use and set up via web</li> <li>• Migration to electronic ticketing from paper-based ticketing</li> <li>• Police need not to confiscate license and/or vehicle plate</li> <li>• Web based access</li> </ul> | <ul style="list-style-type: none"> <li>• Requires Internet Access for synchronization</li> <li>• Parallel paper work</li> <li>• Payment options need to be integrated</li> </ul> |

|                                          |                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                             |
|------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                          | <ul style="list-style-type: none"> <li>Track progress, get reports, share resources, review tickets,</li> </ul>                                                                                                                                                                        |                                                                                                                                                                                             |
| Electronic Traffic Ticketing (E-Tickets) | <ul style="list-style-type: none"> <li>Easy access to setup E-ticket application</li> <li>Virtual license confiscation</li> <li>Monitoring and report generation</li> <li>Supports desktop and mobile devices</li> <li>Avoids the use of fraud licenses.</li> </ul>                    | <ul style="list-style-type: none"> <li>Needs a smart driver's license card in play</li> <li>Payment options need to be integrated</li> </ul>                                                |
| Automatic Mobile Ticketing System        | <ul style="list-style-type: none"> <li>Easy to use</li> <li>Allows for multiple channel access partially</li> <li>Customizable</li> <li>Mobile apps available</li> <li>Custom user interface</li> <li>Simple profile management and data access</li> </ul>                             | <ul style="list-style-type: none"> <li>Drivers' license should be digitally readable via handheld device (RFID, QR Code etc...)</li> <li>Payment options should to be integrated</li> </ul> |
| E-Traffic Prosecution System             | <ul style="list-style-type: none"> <li>Simple process for police</li> <li>Law enforcement officer's labor work minimized to almost 98.9%</li> <li>Good for accessing detail documentation and user data</li> <li>Web based access for both users and law enforcement bodies</li> </ul> | <ul style="list-style-type: none"> <li>Needs an agent/call center for payment handling</li> <li>Payment option should be integrated</li> </ul>                                              |

The advancement of information and communication technology is affecting many aspects of our lives. The internet and the World Wide Web innovations are increasingly promising to provide various tools to increase socio-economic developmental process for developing countries like Ethiopia. Addis Ababa being the capital of Ethiopia, is highly populated city and with more than 600 thousand registered vehicles. It is presumably fair to say that there expected increase to the number of traffic violation occurrence rates.

Traffic violation has become an ever growing event and with the frequency of violations, there is a demand perhaps forced one, to change the way ticketing of traffic offences are handled. Improving speed, information management, reducing operational costs and human errors, and enhancing accountability of receipted money. Automatic ticketing system is the automation of the manual ticketing process currently used by the police traffic officers [7].

Based on the current traffic flow and observation made on the means traffic ticketing system in Addis Ababa, there definitely is a need to intervene with currently existing technological solutions, but of course with some adjustments to comply with the city's traffic management policy. The information technology development in Ethiopia, together with the fast growing mobile adoption and usage reaching over 56 million achieving more than the subscribers based target, brings an easy way to adopt technology based applicable solution to the traffic ticketing system. However, adopting a new technology is not primarily a technical problem but rather a social problem, where customers' acceptance plays an important role [8]. Thus, adopting and/or developing a solution that provides accurate, timely and efficient process of traffic

violation ticketing is a need, rather than just a trend to glare at.

Although literature is rich with e-business solution, e-traffic solutions have been overlooked [8]. The spread of traffic violations are accompanied in service provision, control monitoring, fine ticketing, changes in driver behavior, and changing relations between citizens and the police officers. Generally, cities with high population and great number of vehicles, like Addis Ababa, should normally have a greater capability to increase the economic productivity of the society.

Smart traffic violation ticketing, TVT, is the process whereby users (the traffic officers, the violating drivers and/or the traffic management office) depending on their role can order, pay for, obtain and validate tickets from any location and at any time using mobile phones or other handheld devices. TVT, could be defined as a method by which law enforcement agencies use in-car computers to generate traffic citations in the field, and the print an electronic or a hard copy for the offender [8]. This way a better and swift way of traffic ticket and later report generating means would be attained. Later on data generation, aggregation, management and decision making process would more accurate and help on making crucial traffic policies.

An investigative study focused on mobile traffic violation ticketing services in Egypt [8] reviewed several possible technological solutions available and intuitive to modernize traffic violation ticketing system using analytical tools. It persuades that a significant relation has been found between the new service ease of use, perceived usefulness, compatibility, mobility, and drivers' perspectives with regards to their intension to adopt the mobile traffic violation ticketing services. In Egypt, with more than 100 million population and large number of registered vehicles, the interviews believe that the ministry's perspective shows adopting TVT service will help to improve the ticketing system immensely. It is a way of developing all traffic departments, helps drivers an immediate notice of violation and an immediate deterrent, may reduce irregularities and facilitate traffic violation ticketing service for drivers. However, there is no such smart traffic violation ticketing system for nationwide implementation, yet.

Rino et al [12] studied factors affecting users' acceptance of e-billing states that the level of acceptance of the user to use the new system determines the success or failure of these systems. As a result of their findings two important factors; performance expectancy and social influence affects system usage significantly. Therefore, understanding the factors that affect system acceptance can help the government/administration to formulate appropriate measures to promote better e-billing services to the public. This won't be much different when it comes to adopting new technological solution for traffic violation ticketing system.

By the comprehensive report generation module authorized personnel can get detailed information about the traffic violation such as district, location, area wise etc. In general such TVT system, as expected, facilitates all the requirements from each and every stakeholders' perspective. With an integrated secure payment method through the system to the redeemed violators, reduces his/her responsibility and facilitates the payment process to be quick. Almost all of these system database follows well known standards to secure user information that brings confidentiality of relevant user details. Proposed system mainly improves accessibility of users specially police officers and guilty parties to make ease of their process. The proposed system has a great advantage in report generation as required and overall auditing process [9]. Forecasting process, auditing and future planning are the commonly expected added features of such a system.

### 3. Comparative Analysis and Recommendation

For many cities, the successful deployment of traffic violation ticketing system has been the foundational element on the course of overall traffic flow management. For developing cities like Addis Ababa, this is not that case, rather opt to deal with the old resource intensive manual process. At some point there is a need for change so as to catch up with ever growing demand of all the involved parties be it the deemed traffic violators, enforcing officer or supplementary traffic related offices. When it comes to choosing a suitable TVT systems, there are several factors that should be considered such as infrastructure, work flow automation, responsiveness & speed, availability, interface/usability, and importance of the system/collaborative.

While the usage of these systems gains recognition and acceptance in many cities, there are new problems arising that need to be solved. Because of multiplicity of platforms and approaches for systems implementation, it becomes increasingly difficult to manage or compare them. Each new TVT presents its own learning curves.

Comparing different traffic violation ticketing systems, and on what criteria to opt the most suitable one, is a task of ever-increasing importance. With the E-ticket, it is easier for the public to pay a fine through the bank. However, not all communities can follow the E-ticket procedures provided by the agency, especially those people that deter from using such technology [5]. This paper studies and compares some widely known traffic violation ticketing platforms: Traffic Ticketing System (TTS), E-Traffic, e-Traffic Prosecution System and Automatic Mobile Ticketing System. The final results show that the operation of the traffic ticketing system in reducing the cost of ticketing, improving information management, improving the speed of ticketing process and reducing in human errors potential be improved.

Whenever there is a need to an automated solution, the fundamental task is to decide on the kind of deployment whether it should be cloud-based or on premise /standalone ones. Essentially, the fundamental difference between the two is where it resides. On-premise software is installed locally, on your business' computers and servers, where cloud software is hosted on the vendor's server and accessed via a web browser. Cloud service has several advantages like reducing IT staff's responsibilities, adjust to your budget, regular data backups, adjustable to needs, and eliminates capital expenses. However, cloud based service has disadvantages cause data is less secure, access is based on connection (fast and reliable internet is required), cost can balloon with little warning, and even litigation.

Unlike cloud based service, on premise service relies on own infrastructure, meaning you have to own all of the equipment, and be responsible for the lifecycle and operational management. On premise storage is preferable the fact that it can operate without internet, lower monthly cost, greater security, control over server hardware, data confidentiality and so forth. Nonetheless, it requires extra IT support, adherence to industry compliances, increase maintenance costs, risk of data loss, less scalability and requires greater capital investment. Thus, the decision remains to be which way to go depending on the implements requirement and IT policies of the concerned organizations and authority.

When adopting new technology for traffic violation ticketing and management system, it is critical to compare each and every feature and available services even though there may not even a comprehensive framework to do so. With the best available TVT systems availability, an organization can adopt any of the mentioned alternatives as is and/or with some customization, to best fit their traffic offense ticketing

process.

Based on the needs and policy based requirements of organizations (scope of implementation) and the fact that most TVTs share common core features, it would be challenging to choose one over another. Nonetheless, Table 2 shows a tabular compiled illustrations of fundamental features and components that should be present in a decent traffic violation ticketing system that are selected in this study.

*Table 2: Comparison of selected TVT systems*

|                       | Traffic Violation Ticketing | Electronic Traffic Ticketing | Automatic Mobile ticketing | E-Traffic Prosecution System |
|-----------------------|-----------------------------|------------------------------|----------------------------|------------------------------|
| Collaborative         | Yes                         | Yes                          | Yes                        | Yes                          |
| Responsive and Quick  | Yes                         | Yes                          | Yes                        | Yes                          |
| Self-help             | Yes                         | No                           | No                         | No                           |
| Search friendly       | Yes                         | Yes                          | Yes                        | Yes                          |
| Reports & Analysis    | Yes                         | Yes                          | Yes                        | Yes                          |
| Workflow Automation   | Yes                         | Yes                          | Yes                        | Yes                          |
| Multilingual Support  | Yes                         | No                           | Yes                        | No                           |
| Custom user interface | Yes                         | Yes                          | Yes                        | Yes                          |
| Payment Integrated    | No                          | No                           | No                         | No                           |

According to [8] the traffic violation management system demand is a hundreds of million dollars project when applied in full scale. Developed nations have already deployed smart traffic management systems, fully automated and integrated systems. In this paper, however, the scope limited to traffic violation ticketing system (TVT), and when you choose the right TVT for your city or country, you ease the overall traffic data management which in return facilitates in data reporting, monitoring, policing and decision making process.

There are plenty of ways that a traffic violation ticketing system could be selected and deployed for action. But just before selecting such a system, it is crucial to choose the best suitable deployment for that specific TVT to be preferred. Technological experts argue that self-hosted and/or standalone systems are becoming less popular over their cloud based counterparts. Yet, self-hosted systems have their own advantages as compared to cloud-based ones. Thus, type of deployment is essential for factor when comparing the available systems as it impacts the overall working process one way or another.

Considering the current internet connectivity coverage and accessibility situation in Addis Ababa, it would be wise to use on premise deployment type over cloud services. Even though on premise systems demand higher infrastructure and running cost initially, it would more advantages for a reliable and available systems to be operated. When it comes selecting a suitable TVT system, for several reasons mentioned in previous sections, features that make life easier for both the administration and driver could be compromised in consideration of the city's traffic management policy as well as digital payment regulations. Most TVT share similar features but differ in their way of logical implementation. Some are web-based, some are APIs and mobile apps, and some are software as a service platforms. Traffic violation ticketing system, mentioned above, is so intuitive and easily customizable for web based access. The other

technologies orchestrate their own flavor.

When looking at the type of system deployment, from the researcher's point of view, on premises hosting may bring frequent downtimes of servers due to the cities frequent power outages, service interruption and related factors as a challenge to a successful TVT deployment. In the case of cloud-based system implementation, higher cost for hosting and technical support and information confidentiality might be the challenges to be concerned about. Thus, there will be a need to careful planning and compromising on how to deploy the system when adopting it in the first place.

Based on [11] with the emergence of e-governance and e-service, many cities has adopted traffic violation ticketing system, even able to attained fully automated traffic management system that integrated with their smart city. When it comes to new adoption of a technological solution, users tend to resist e-service if the providers do not ensure the accuracy and reliability. Users will be reluctant to adopt e-governance systems if they do not trust governments and their provided services. Since traffic violation ticketing includes sensitive information such as transactions and involves the disclosure of personal information, trust is believed to be a plausible determinant towards a long term use. Moreover, users do not want to invest on new devices and/or resources whenever there is a new technology to be used.

Based on this comparative study approach, a TVT system that is based on mobile app with web service support and integrates various payment options is presented. Integrated database driven and web based access features from traffic ticketing system and standalone mobile application depending on the OS (whether for android, iOS or others) would bring more convenient way of system implementation. In addition to that, payment means needs to be integrated to this system so that the drivers could easily and access their traffic offices and overall transactions from a single window. Thus a customized version of Traffic Ticketing System, TTS and Automatic Mobile Ticketing System, i.e. a hybrid solution, is suitable for traffic violation ticket system for Addis Ababa City. Making the system accessible via multiple channels like web-based, smartphone apps and so forth will be an advantage for the users (drivers) to get them easily fall into the system.

To summarize all the above comparisons, a custom TVT system that is a hybrid of traffic violation ticketing and automatic mobile ticketing system with an integrated online payment options, is suitable for Addis Ababa City Traffic Management Agency.

#### **4. Conclusion**

With the ever growing need of humans for mobility and use of vehicles, traffic management authorities are using various traffic violation ticketing systems to issue and manage violation tickets in a swift and efficient way. Most countries in the world have deployed different advanced traffic violation ticketing systems effectively. In Addis Ababa, Ethiopia, regardless of the ever growing road traffic violations, the TVT still falls under the old manual process. Addis Ababa City's Traffic Management Agency is also looking for technological solutions that could ease and automate the existing manual TVT systems. Observing the above challenges, the research conducted comparative study and recommended TVT system that best suits to the city's traffic violation ticketing process. As a result of the possible technological solutions amongst of the selected tools: a hybrid solution of Traffic Ticketing System and Automatic Mobile Ticketing System with an online payment options integrated, is recommended.

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