TRAFFIC CONDITIONS AND CRASH ANALYSIS USING MULTI-SERVER FRAMEWORK: A REVIEW

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Abstract: Toll plaza operation is a critical component of roadway operations throughout the country, as tools provide both revenue for expansions and opportunities for demand management. Electronic tolling has introduced a new form of driver decision making at toll plaza due to the additional payment. Describe the user convince marking at toll plaza due to the additional payment. Despite the user convince these facilities gives to consumers, this form of collection has not come without safety and operational concerns. A multi-server framework may be used to measure the total period and queue duration in the towing region and in the parking spot. Such queuing models estimate the output of several queues of the queuing method. A traffic simulation model representing defined vehicle arrival and services patterns for multiple channel deliveries was extended to many parking outlet design squares in order to learn and appreciate how such a network works.

Introduction
Task financing has been utilized throughout society history to make it feasible to construct long-distance highways. In ancient Greek authors of antiquity, toll roads were established of Asia. The first turntables were installed in America in the 1790s and led to the colonisation of the Midwest. At the start of the 1940′s, the first modern American freeways were funded by tolls which paved the way for Americans to profit from the Interstate network. Now, developed countries such as China create their own superhighway networks and they too foot the bill. The traffic congestion and noise of so many road cars is becoming a increasing problem in many metropolitan centres and yet another advantage of tolling has been seen. In countries such as Singapore and London, taxes are effectively used not just to fund road building, but also to limit cars movement through the urban core, to improve the usage of transport and to clear the crowded streets.

There is an undenied downside to tolling, given its many benefits Bane of vehicles and construction workers alike; when the traffic becomes heavy cars head to the toll booths and vehicles waste time after charging their tolls for place as the various lines leaving the toll booth join together to restore the path to its original width. As the history of transport departments world over suggests, this is a serious challenge. A study carried out at the Institute of Technology in New Jersey reports that the elimination of two toll spots along a 14-mile stretch of the Garden State Parkways could result in a savings of 2 minutes or more of10% on travel time. Both fees are provided from new toll networks, including the 407 Highway near Toronto and the SR-91 Express Lanes in Orange County, Calif., so that the drivers will not have to slow down to pay the toll. Nonetheless, switching to complete online payments in several older forms is not an alternative, since increasing pressure ensures that developers are trying to adapt their new networks to provide the best possible service. The positive interpretation of the term implies, in order to get rid of lengthy queues, that the supply of as many tickets as possible decreases the payment time, however more tickets require further convergence and thus more confusion until the premium is charged.

General Toll Plaza Operation And Configuration
By means of an introduction to the topic being proposed within this thesis, it is important to first have a basic understanding of general toll plaza operation and configuration. The general operation and configuration of a toll plaza is based upon basic elements that may differ across various plazas, including the following:

- Plaza type;
- Lane types;
- Electronic tolling technology hardware; and,
- Electronic tolling technology software.

Plaza Types
Since the 1960′s a barrier toll plazas have made up the majority of interchange installations. As shown in Figure 1, these plazas are typically located on the freeway itself and require a fare in order to proceed on the highway. These tolls are typically flat fee (by vehicle/axle type) to continue on to the next segment of the highway. Some barrier toll systems allow free movement between some exits. In some cases unrestricted access is implemented for intercity facilities where real estate is limited. Toll plazas are often located at the boundaries of urban areas and charge to enter the city from rural and suburban areas. The other type of toll facility, known as a ramp plaza, requires a toll to enter and exit. These tolls are most frequently distance based tolls, meaning the motorists receive a ticket upon entering and pay a toll upon exiting that is related to the distance traveled.
Lane Types

There are five general types of toll plaza lanes in use today within the United States. The most basic lane type is the traditional cash lane where a toll attendant collects a fare physically in the form of currency. This method, while still used today, is a costly and time-consuming form of fare collection. In hopes of automating the collection process, automatic coin counting machines were developed to reduce personnel costs and increase throughput. The next advancement in toll collection came in the form of electronic toll collection with transponders. ETC tolling was originally referred to as automatic vehicle identification (AVI) because transponders have unique serial numbers that link to a patron’s pre-paid account. The vast majority of ETC lanes are exclusive, meaning only transponder subscribers are allowed to utilize those lanes. A hybrid of 4 ETC and cash lanes are referred to as combination or mixed use. These manned booths help reduce complications such as the serious hazard of a motorist backing up during arrival at the collection station in the wrong lane. The final category of electronic collection lanes are termed express because they require minimal to no deceleration allowing fare transactions at high speeds. Express lanes are loosely defined as a segregated expressway for electronic toll users. Known more commonly as open road tolling, express lanes are the most transparent form of tolling as they do not require motorists to exit the highway or reduce speed. Often plazas with express lanes will also have dedicated lanes in the plaza for motorists who miss these separate lanes. Electronic tolling lanes have substantial fare processing capacity over manual lanes as seen in Table 1.

<table>
<thead>
<tr>
<th>Tolling Lane</th>
<th>Collection Method</th>
<th>Average lane speed (miles per hour)</th>
<th>Throughput (vehicle per hour)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type Cash</td>
<td>Manual Attendant</td>
<td>Stop</td>
<td>300</td>
</tr>
<tr>
<td>Automatic Combination</td>
<td>Manual Machine</td>
<td>Stop</td>
<td>500-600</td>
</tr>
<tr>
<td></td>
<td>Manual &amp; Electronic</td>
<td>7</td>
<td>700</td>
</tr>
<tr>
<td>Dedicated Express</td>
<td>Electronic</td>
<td>15</td>
<td>1200-1500</td>
</tr>
<tr>
<td></td>
<td>Electronic</td>
<td>55</td>
<td>1800-2200</td>
</tr>
</tbody>
</table>

Table 1 Operational toll attributes

Electronic Tolling Technology

Electronic tolling utilizes several robust hardware and software systems to enable accurate and reliable toll transactions. Utilizing wireline and wireless communications transactions originate at the toll booth and transmit information to a toll authority’s clearinghouse and eventually the customer’s financial institution.

Hardware

Electronic Tolling systems use a series of interconnected wireless and wireline communication devices to facilitate automatic vehicle identification (AVI). Transponders or tags are Radio-Frequency Identification (RFID) units that serve as the basis for
modern electronic tolling. These devices communicate using Dedicated Short Range Communication (DSRC) to the toll reader system which registers identification and completes toll transactions.

**Antennas**

Emitters or antennas are the medium through which DSRC functions and exchanges identification from the passing vehicle to the stationary toll system. Antennas are connected to a lane controller to prevent transaction duplication. Additionally, the lane controller coordinates operations with the axle counter and vehicle enforcement system. Computer servers located on site function as a database and processing unit that connects and records transactions with the turnpike authority and financial institutions. Due to this important role, multiple redundancies are typically employed in nearly every function, (fiber optics, transmitters, and power supplies) at the local and regional level.

**Transponders**

Transponders operate on the 915 MHz radio frequency with an operating range of 32.5 feet. Transponders communicate with antennas using DSRC in a cycle of exchanging ID information and confirmation that lasts sixteen milliseconds. The device attempts to “handshake” ten times before the device is ignored.

**Axle Counters**

Axle counters are electronic circuits shaped in a loop located under the roadway used in violation enforcement and vehicle classification. The counter detects number of axles which is used to adjust vehicle classification and fares accordingly. In its violation enforcement role, the loop triggers cameras used to capture license plate photos used to process transponder misreads or violators.

**Vehicle Enforcement System**

Cameras take still photographs from the front and rear of each vehicle upon loop trigger. The redundancy of photographs prevents non-paying vehicles with only one license plate or those tailgating to escape through the lane unaccounted. The system takes pictures and reads RFIDs simultaneously regardless of traffic density, and speed. In mixed-mode or exclusive ramp lane setups, one antenna is used per lane. In express or open road tolling (ORT) lanes, multiple antennas will be mounted to capture shoulder and mid lane transactions. In open road tolling, antenna systems are more sophisticated to detect cars that may pass under in multiple lanes (6).

**Software & Violator Services**

Violator enforcement uses an image processing technology known as optical character recognition. The system converts license plate photographs to a text string and compares this registration number to the Registry of Motor Vehicle (RMV) database. Success of the enforcement system relies on license plate standardization and cooperation from RMV/DMVs nationwide (7). License plates must use similar font type, size, background contrast and reflectivity. Specially designed software automates this tedious process that must keep up with a log of thousands of potential violations every day.

Current systems can accurately identify over 98 percent of license plates without the need of human review. According to a 2009 Massachusetts Department of Transportation (MassDOT) report, FastLane, the name of Massachusetts E-ZPass compatible ETC system penetration has reached 75 percent around the Boston metropolitan area (8). A high usage rate suggests toll lane configurations should be analyzed for optimal efficiency and safety. The number of patrons using electronic tolling could prompt a change in the number of E-ZPass lanes to provide convenience and access to the large portion of commuters. This large segment of users has spurred an investigation into its role in toll lane selection.

**Review of Literature**

Contrastingly, a 2007 report of the New York State Thruway Authority crash records showed an increase in ETC related crashes as ETC penetration increased from 1992 to 1998 (11). Crashes on an Orlando Florida expressway doubled after installing dedicated ETC lanes. The crash rates involving dedicated ETC lanes and/or ETC vehicles rose from 3.375 crashes per month to 7.5 crashes per month. At the same toll facility, rear-end crashes increased as a result of a adding a dedicated ETC lane. Not even a year later a second adjacent ETC lane was installed, and again rear-end crash frequency increased. Speed was the leading cause of conflict and the culprit in raised accident rates. Prior to toll plaza renovations speed variance was low, but after construction velocities noticeably escalated (4). These results provide strong support to the idea that decision making spurred by ETC lanes may spark conflicts at toll plazas that are leading to additional accident.

Another model, TPSIM, built by Correa et al. (2004) was able to reproduce typical toll plaza operations with lane decision based on queue length (14). This stochastic model was created to simulate the Holland East Plaza. The deterministic toll plaza software SHAKER created by Florida Department of Transportation out puted most efficient plaza configurations by assigning approaching traffic to shortest queue lanes (15). TOLLSIM toll plaza model, developed by Wilbur Smith, now CDM Smith, estimates traffic characteristics such as delay and queues at a plaza (14).

Few studies have developed toll plaza micro simulations with widely available traffic simulation programs (AIMSUN, VISSIM, Paramics, CORSIM). The model produced by Mudigonda et al. (2008) revolves around maximizing user utility based on three parameters for ramp plazas was programmed into an API by Nezamuddin (16). The model validated mainline plazas on Orlando Orange County Expressway Authority (OOCOA) toll facilities. The study found success in modeling field observations with correlating lane assignments on the order of 0.98 (3).
Fuller et al. worked with CORSIM developers to add a toll plaza module to CORSIM version 6.3 (17). CORSIM models in the past had used Stop and Yield Signs to emulate cash and manual payments. Previous attempts at modeling were deterministic and used shortest queue for lane determination.

VISSIM toll plaza simulation was configured using OOCREA mainline plazas with substantial success (18). Russo (2008) created a deterministic model that used stop signs as cash lanes and reduced speed zones for dedicated ETC lanes.

A laboratory driving simulator study in Illinois compared seven experimental open road tolling signs. The simulation collected driver reaction and comprehension time for a series of proposed signs. Participants were assigned a role as a cash or ETC customer and drove through a toll gantry with the freedom to change lanes without repercussions. Conflicting results did not clearly pinpoint an optimal sign layout but eliminated options for the subsequent field study. The driving simulator proved to be a cost effective method of trial and error (19).

The initial research task, which was introduced at the onset of the research development, was a thorough review of the literature related to this topic. The systematic review of pertinent background research articles began with journal and database keyword searches. More specifically, studies on lane configuration, simulation and driver decision making were the focus of the literature review. Several databases were examined based on relevance to human factors and transportation peer-reviewed journal research. The National Transportation Library, a branch of the Research and Innovative Technology Administration (RITA) and Transportation Research International Documentation, and Transportation Research Board’s database were selected as primary search engines. Other journal catalogs used were Engineering Village, Web of Knowledge, LexisNexis Academic, SciVerse, and Ebscohost.

Search keyword logic was developed after subsequent search engine explorations. Toll plaza safety, electronic toll collection, plaza configuration and sideswipe crashes were the initial search terms. This rationality provided an exorbitant amount of resources. Search terms were refined and tweaked to minimize the weight of articles into a useful collection. Keywords were found to be too broad, and were replaced with specific terms. Using electronic tolling system names (e.g. E-ZPass, SunPass) served as an excellent filter. Changing the logic from the “OR” operator to the “AND” operator and separating the differentiating keywords provided much needed discriminating power. The key filter terms after trial and error included safety, crash, merge, sideswipe and queue. The final search revision used the following logic where articles must return one term from each column.

**Crash Data Analysis**

The data used for crash analysis was derived from the UMassSafe Traffic Safety Data Warehouse. The warehouse utilizes several datasets linked together to create a robust collection of information. Datasets are united through several linkages including matching material 38 from medical, citation and motor vehicle data sets. The research task began with an SQL query was performed on the database to extract data from 2010 through 2012. These years were the three most recent years of data available to the data warehouse. However, if should be noted data from 2012 has not been officially closed by Mass DOT so the data herein is not complete and some reporting agencies may still have not submitted all reports.

Datasets provided by the SQL query include crash level and driver level attributes. Crash level details include items on the Commonwealth of Massachusetts Motor Vehicle Crash Report form. These items include an identifying crash number, date, time, city, road surface, weather, traffic control, light conditions, injury status, and manner of collision, harmful events, XY coordinates and narratives. The driver level details include age, sex, driver contributor code and vehicle type. These attributes were used in data analysis to identify trends.

**Conclusion and Future work**

The review and contrast in this essay suggest that it is a positive idea for the readers. In using analytical models, caution must be applied as the findings can differ from the real location service greatly. The drawbacks are necessary to consider and The functionality selection of the devices involved. At the one side, single queue structures of multi-server tend to optimistic findings may lead to incorrect estimates when the toll plaza is obtained Specifications or measurement of their service. Further single-server architectures will, on the other side, be used produce figures similar to real operational values, however these figures could be the number of servers ranges from positive to somewhat negative for 8 to extremely negative. Less computers.-Further machines. Under both situations, it can be avoided to use the empirical methods when analyzing peaks Low demand action (0.90 < v / c < 1.0), despite their asymptotic behavior.

**References**


