The most common methods used for collecting the toll from the road user are either manual methods, or automatic methods, or a combination of these.

1. THE IMPACT OF TRAFFIC VOLUMES:

One of the main determinants of any toll collection method is the volume of traffic expected to be processed at the toll facility.

<table>
<thead>
<tr>
<th>Traffic Volumes Guidelines on Toll Collection Methodologies</th>
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<tbody>
<tr>
<td><strong>Traffic Description</strong></td>
</tr>
<tr>
<td>Low to intermediate volumes</td>
</tr>
<tr>
<td>Intermediate volumes</td>
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<tr>
<td>High volumes</td>
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</table>

Table 1: Determination of Toll Collection Method

The arbitrage between manual versus automated solutions is also dependent on the cost and availability of the Labour factor (L). In most African countries, this resource is abundant and competitively priced, therefore it makes sense to maximize the use of toll collectors. Thus, toll collection methods in most instances on the Continent will, for low and medium traffic, be predominantly centred on the processing of cash, credit cards, and pre-paid cards (e.g. magnetic stripe and contactless cards) by manual toll collectors.

Generally speaking, the abundance of low-cost labour and value-for-money design principles will drive the development of manned toll collection systems with post-classification controls to verify the accuracy of the collection and classification by the toll collector – since pre-classification systems are essentially premised on the use of automated toll collection systems and result in more extensive toll lane areas.

In automatic toll collection lanes, the toll collection methods used will usually be based on an “account” system linked to an “Account Identification Device”, but both “cash”, via automatic cash payment machines for both notes and coins placed in the lane, and credit cards, via a card reader placed in the lane, can be used.

In both the “manual” and the “automatic” scenarios for collecting the toll, the “Account Identification Device” can take many forms. Some of these are:

- ISO magnetic swipe card (the “reader” will be a multi-track swipe card reader).
- Contactless smart cards and contactless smart card readers,
- RFID (usually “backscatter” chips) and reader, and
- DSRC (usually microwave) Tags and readers.
The use of these devices, other than ISO magnetic cards, is usually loosely referred to as Electronic Toll Collection or ETC.

2. TRAFFIC PATTERNS

Although Table 1 above provides a fair empirical guideline, other parameters also need to be taken into account, such as:

- The nature of the area (that is, urban, peri-urban, or rural);
- The extent of daily commuter traffic, and
- Traffic patterns such as: cyclality, or the spread between light and heavy vehicles.

In fact, two areas with similar traffic volumes in terms of AADT could display very different processing patterns in terms of: (1) “peak traffic hours”, (2) methods of payment requirements, or (3) processing times per vehicle based on their geographical location, traffic origin and destination (namely, commuters will exhibit a different behaviour to lorries transporting minerals) and whether a single or multi currencies are to be processed.

3. PROCESSING TIMES

Different class of vehicles require different processing times at toll plazas, as do various methods of payment (MOP). Based on the minimum vehicle throughput that needs to be complied with at a toll plaza, where mandatory output specifications such as maximum queue lengths and/or maximum service times must be met by a toll operator, or other affordability criteria are prevalent, toll operators and road funds will prioritise certain methods of collection (manned, unmanned, or mixed) and certain methods of payment (such as, cash, cards and tags). Ultimately, these and other factors will also inform the toll collection strategy, plaza layout, and the number and type of tolled lanes.

4. TOLL LANE AREA AND FOOTPRINT

As much as the traffic volumes and patterns, the selected methods of payment, and the manning levels determine the number of tolled lanes to meet the required processing times, any restriction or constraint on the footprint of the toll lane area will also influence the toll collection “mix” and layout at a plaza. For instance, two areas with the same traffic volumes and patterns, and similar penetration of cash and cards, may need different collection methods and/or toll lane layouts if one particular area faces severe width / road reserve / embankment restrictions, thus making it necessary to include more automated collection methods to increase throughput and prevent bottlenecks.

5. CAPITAL AND OPERATIONAL REQUIREMENTS

The balance of manned versus unmanned toll lanes and the proportion of cash versus pre-paid cards/credit cards is also a function of the capital cost associated with the initial investment in the toll collection system, as well as the total operational, life cycle costs. All solutions have to be assessed in terms of their net present value (NPV) cost over the life of the project, and measured against their levels of accuracies, their administrative and management costs, and their ability to be scaled up.

6. PREVALENCE AND PENETRATION OF VARIOUS METHODS OF PAYMENT

All toll collection operations are based on the following actions/activities:

- Classify the vehicle to be tolled according to an official Vehicle Classification System for toll purposes,
• Determine the Toll due from the Vehicle Class and the applicable toll tariff table(s) for the toll plaza,
• Validate the payment offered for the toll, and
• An “audit”, preferably automated, with little human intervention that ensures the vehicle that paid the toll is the one that leaves the lane and that the vehicle class of the departing vehicle is correct according to the Vehicle Classification System and the vehicle classification used to determine the toll paid.

Manual toll collection methods typically collect toll payments from road users using the following types of Method of Payments (MOP) to validate the transactions:

a) Cash,
b) Prepaid Account,
c) Credit Card
d) Electronic Toll Collection (ETC),

Cash that is, Notes and/or Coins is typically the most widespread MOP. The cash MOP can include payment in local and foreign currency.

Alternative payment methods that can be used are Credit Cards and Prepaid Accounts where the account is linked to an Account Identification Device which is used in the toll lane and will pay the applicable toll provided there are sufficient funds in the account to cover the cost of the toll. These MOP’s can be used depending on prevailing economic conditions in and around the toll plaza, and the availability of these payment methods in the target area.

The Prepaid Account MOP is activated on the toll collector interface when an Account Identification Device is presented to the appropriate device reader. The Account Identification Device is commonly a magnetic stripe swipe card and the “reader” will be a multi-track swipe card reader. Contactless smart cards and contactless smart card readers can be used, as can e-Tags and DSRC ETC readers. The information “read” from the Account Identification Device identifies the account number to the TLC which is then able to access the account details stored in a list in the TLC memory.

Electronic Toll Collection (ETC) is a subsystem of the Prepaid Account MOP described above that uses “electronic” identifiers, such as contactless smart cards and e-Tags and appropriate reader devices.

The Credit Card MOP is activated on the toll collector interface when a Credit Card is “swiped” through the ISO magnetic swipe card “reader”.

**PAYMENT OPTIONS**

<table>
<thead>
<tr>
<th><strong>Cash:</strong></th>
<th>Notes/coins accepted</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Card:</strong></td>
<td>Credit/Debit/Fuel (inc. contactless)</td>
</tr>
<tr>
<td></td>
<td>VISA, Mastercard, AMEX, Diners</td>
</tr>
<tr>
<td></td>
<td>(automatic lane - receipts available)</td>
</tr>
</tbody>
</table>

| **Credit Card:** | Visa and MasterCard contactless credit/debit cards accepted - look for the contactless symbol on your card. |
|                 | (automatic lane - receipts available) |

| **Tag:** | Electronic pre-payment discount dedicated Express Tag lane - no need to stop |
|         | (automatic lane - no cash or cards) |
**B - CREDIT CARD AND PREPAID CONTACTLESS CARDS (TAP-AND-GO)**

The penetration of each method of payment must be carefully ascertained and inform the proposed toll collection method. An opportunity can also be seized to incrementally promote the migration towards "dematerialised" methods of payment which could have beneficial effects to both the road users and the toll operator in some instances.
Furthermore, toll plaza manual toll lanes should be designed to allow toll collectors to process cash and other Methods Of Payment and all classes of vehicles in the lane, as opposed to dedicating lanes to certain classes of vehicles, which is inefficient from a manning level perspective.

At a plaza where high throughput traffic volumes must be processed, or to accommodate future traffic growth, a hybrid mix of toll collection methods, and un-manned and automated toll lanes, focusing on prepaid accounts, can be introduced.

CONCLUSION

We hope the points raised in this article can contribute to raise the awareness of key stakeholders in the tolling environment as regards the relatively complex set of parameters informing the definition of a robust Toll Collection strategy (the “mix”) and the underlying Methods of Payments.

Therefore, in-depth quantitative, technical and operational investigations are of paramount importance in developing an unbiased model for a specific tolling environment. Intertoll Africa, as an integrated tolling services and concession operator, can assist your organisation and develop a tailored solution addressing your specific needs.

IN OUR NEXT ISSUE...

In our next Quarter 2 2016 issue, we will present Intertoll Africa’s new toll plaza offering developed specifically for the needs of our clients in Africa. The offering seeks to provide solutions that balance affordability and functionality criteria for all our Clients on the continent, from urban highways to peri-urban trunk roads and secondary-network, low-traffic roads. The offering includes a temporary solution developed in a factory environment that can be implemented in 3 months. Furthermore, all the solutions presented can be project-financed by Intertoll.

See you next time!

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