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GE PE DN CC OP AM RE

Technical Note on Short Duration Automatic Traffic Count (ATC) Surveys

AM-GEN-00004
February 2023

AM Asset Management & Maintenance

Technical

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TII Publication Title	*Technical Note on Short Duration Automatic Traffic Count (ATC) Surveys*
TII Publication Number	*AM-GEN-00004*

Activity	*Asset Management & Maintenance (AM)*		**Document Set**	*Technical*
Stream	*General (GEN)*		**Publication Date**	*February 2023*
Document Number	*00004*		**Historical Reference**	**N/A**

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TII Publications

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1. Background

In recent years, TII Network Management have commissioned several short duration Automatic Traffic Count (ATC) surveys to support research into the effectiveness of mitigation measures deployed on high friction demand sites. The surveys were carried out by different operators, at different times of the year using both pneumatic tube and radar type devices. In each case, multiple sensors were deployed at each site over the duration of each survey period. The surveys were all of relatively short duration with survey periods ranging from 2 weeks to 14 weeks.

Multiple sensors were deployed during each survey in order to compare driver behaviour at different locations through each site, typically, at bend apexes, transitions, and straights. The presence of multiple sensors across each site facilitated cross-sensor comparison for various parameters including vehicle volumes, vehicle classification and vehicle speeds. While not the primary goal of deploying multiple sensors, this also allowed an in-depth assessment of the quality of the data submitted to TII to be carried out. For all sites and almost all survey periods, the cross-sensor comparisons indicated various issues with the quality of the data submitted. Accordingly, TII commissioned work to compile and review the data from several representative surveys and prepare a Technical Note outlining the data issues encountered and summarising international practice for dealing with such issues.

2. Data Quality Issues Identified

The type and extent of issues identified in the data were wide ranging and occurred at all stages of the process from sensor installation and set-up, sensor operation, data management, data processing and data reporting. Some of the issues could be traced back to specific incidences in the survey. Others could not be linked to a specific failure and indicate a more general gap in the overall data collection and reporting process. A non-exhaustive list of the data issues include:

i. Total or partial mechanical failure of the counting device (Pneumatic tubes only)
ii. Incorrect sensor set-up.
iii. Significant over or underestimation of vehicle volumes
iv. Misclassification of vehicle type
v. Incorrect calculation of vehicle speeds
vi. Excessive duplicate records in the submitted data
vii. Inclusion of data from unrelated sites in the submitted data
viii. Data issues either not being identified or not correctly accounted for in reports submitted to TII

The extent and frequency with which data issues occur indicate that the entire process of short duration traffic count surveys would benefit from formal QA procedures, both by the Service Provider over the duration of the surveys and prior to data submission, and by TII prior to data acceptance.

3. Literature Review

A literature review of international QA/QC procedures for short duration traffic count surveys was carried out. The review focused primarily on the UK, New Zealand, Australia and the USA. For the UK, Australia and New Zealand, it was generally acknowledged that QA/QC of the traffic count data is desirable, however, few details on the specifics of the QA/QC checks which should be carried out appear to be published. By contrast, the US Department of Transportation Federal Highway Administration (FHWA) has published several guidance documents and case studies with varying levels of detail on the QA checks that are carried out.

3.1 FHWA - Defining and Measuring Traffic Data Quality

A white paper by the FHWA, Defining And Measuring Traffic Data Quality, published in 2002 lists 6 fundamental measures of traffic data quality and recommends that these be considered universally when measuring data quality in traffic data applications. The data quality measures defined by the FHWA are:

i. Accuracy – The measure or degree of agreement between a data value or set of values and a source assumed to be correct. It is also defined as a qualitative assessment of freedom from error, with a high assessment corresponding to a small error.

ii. Completeness (also referred to as availability) – The degree to which data values are present in the attributes (e.g., volume and speed are attributes of traffic) that require them. Completeness is typically described in terms of percentages or number of data values. Completeness can refer to both the temporal and spatial aspect of data quality, in the sense that completeness measures how much data are available compared to how much data should be available.

iii. Validity – The degree to which data values satisfy acceptance requirements of the validation criteria or fall within the respective domain of acceptable values. Data validity can be expressed in numerous ways. One common way is to indicate the percentage of data values that either pass or fail data validity checks.

iv. Timeliness – The degree to which data values or a set of values are provided at the time required or specified. Timeliness can be expressed in absolute or relative terms.

v. Coverage – The degree to which data values in a sample accurately represent the whole of that which is to be measured. As with other measures, coverage can be expressed in absolute or relative units.

vi. Accessibility (also referred to as usability) – The relative ease with which data can be retrieved and manipulated by data consumers to meet their needs. Accessibility can be expressed in qualitative or quantitative terms.

3.2 FHWA - Traffic Monitoring Guide

The FHWA have published a Traffic Monitoring Guide, updated in 2016, covering all aspects of traffic monitoring surveys. Included in the guide are case studies of the Quality Assurance procedures used in 5 State DoTs, namely: Virginia, Vermont, Pennsylvania, Washington State and New York State. The individual state's approach to evaluating the quality measures of Accuracy, Completeness, Validity and Coverage can be seen in each case study. Measures relating to Timeliness and Accessibility do not appear to be addressed explicitly although this may simply be because neither has caused any significant issues.

3.2.1 Virginia DoT

Virginia DoT had the most comprehensive set of QA/QC procedures, with over 95 different rules applied across the entire traffic count workflow. They stressed the importance of designing QA procedures into the traffic data collection workflow. The rules were developed in collaboration with the equipment suppliers. The rules include basic formatting checks, completeness of header information etc., as well as various checks on the measured traffic data e.g., speeds, directional volumes, vehicle class distribution etc. They are applied automatically to assign a preliminary quality level to the raw traffic data and generate messages where appropriate. The messages are grouped in to Advisory, Informational, Warning and Error. Analysts can then review these messages as necessary to determine whether low quality ratings are correct, using additional information (e.g., known construction in the area, social events leading to unusual traffic patterns etc., to determine whether the preliminary quality ratings are correct or if they should be adjusted.

While the Virginia DoT procedures were developed for their permanent traffic counter installations, similar principles could be applied to temporary/short duration surveys.

3.2.2 Vermont Agency of Transportation (VTrans)

VTrans conducts short duration traffic counts on almost 5000 locations in the state. The locations are surveyed over 3 or 6 year cycles depending on the road type. VTrans do not have a formal automated process for the QA/QC of traffic count data however they do have a documented set of checks specific to short duration traffic counts. These are applied to each survey individually. The checks include comparison to historical traffic volumes, proportion of various vehicle classes in the stream, differences in directional volumes and vehicle misclassification. VTrans highlighted the need for documented QA procedures.

3.2.3 Pennsylvania Department of Transport (PennDOT)

PennDOT has similarities to both Virginia DoT and VTrans. The QA/QC checks carried out by PennDOT is extensive and largely automated. It includes basic checks of formatting, section naming etc as well as checks on the measured data including directional volumes, duplicate vehicle records, zero vehicle volumes, high volumes at unreasonable hours (midnight volume vs noon volume). Traffic flow variability and vehicle classification is also examined. Counts failing these checks are included in an error report and manually assessed by an analyst to determine if the underlying data is valid or not. Counts deemed to be correct are manually loaded into the system. Counts deemed to be invalid are requested to be retaken. The retaken data is subjected to the same QA/QC checks as the original data.

3.2.4 Washington State

Washington State performs extensive checks on traffic counter data prior to acceptance into their systems. These include checks on data formatting and header information as well as checks on the traffic measurements. As with the other DoTs, the checks on traffic measures included directional volumes, proportion of various traffic classes in the traffic stream, duration of coverage, day to day variability etc. Counts not passing these checks is reviewed and flagged for deletion if the review does not find a valid reason for the failure.

3.2.5 New York State

The QA/QC Procedures provided by New York state in the FHWA report were very high level and lacked detail on the type and extent of checks that are carried out on their traffic count surveys.

3.3 Southeast Michigan Council of Governments (SEMCOG) Case Study

In 2017, SEMCOG published a case study on Innovative Traffic Data Quality Assurance/Quality Control Procedures and Automating AADT Estimation. As with the other case studies, SEMCOG have a comprehensive suite of checks to assess the quality of traffic count data. For data provided by local agencies, 15 validity checks are built into the database system, developed by both SEMCOG and the equipment providers. These procedures check for such things as missing count intervals, duplicate counts, tolerance compared to previous counts, directional split, and vehicle classification percentages. For data provided by third party software and additional 46 checks are carried out to automatically ensure compatibility with SEMCOG's systems.

3.4 Austroads - Guide to Traffic Management Part 3: Transport Studies and Analysis Methods

Part 3 of the Austroads Guide to Traffic Management references Data Integrity in Section 3.4. Data procedures and travel time survey management have been through the process of quality certification to AS/NZS ISO 9001 on requirements in quality systems for design, development, production, installation and servicing. A detailed list of checks to be carried out is not provided, however the data quality issues that need to be addressed are given as:

a) accuracy

b) timeliness

c) accessibility

d) completeness and relevance

e) comparability and compatibility.

This list is similar to the fundamental traffic data quality measures contained in the 2002 FHWA Publication. The FHWA Traffic Monitoring Guide is explicitly referenced in the Austroads guide as promoting good data collection practices. The guide also stresses the benefits of pre-planning traffic studies. If a survey brief is prepared for the project it should include:

i. general outline of type of survey to be undertaken and purpose

ii. details of field survey and survey design (if included)

iii. competencies required and field instruction detailed

iv. criteria for data acceptance

v. structure of data outcomes

vi. provision of the method for conducting the survey, data quality plan and training proposed by consultants.

Of particular importance are items **(iv)** and **(vi)** of this list.

3.5 Transit New Zealand – SN052 Traffic Monitoring for State Highways

The Transit New Zealand manual provides little detail on the types or extent of QA checks to be carried out on survey data. It does however stress the need for appropriate site and equipment selection and links this to the quality of the resulting data. Different types of equipment have different operational constraints and data outputs. The emphasis on site and equipment selection accords with the Austroads recommendations on survey planning and preparation of a survey brief.

3.6 Literature Review Summary

The various organisations examined have developed QA methodologies independently, however, they generally accord with some or all of the FHWA fundamental measures of traffic data quality. Both the Australian and New Zealand roads authorities emphasise the need for good pre-survey planning, dealing with site and equipment selection, and having a clear understanding of data types and quality that can reasonably expect to be achieved. The US publications contain a high level of detail on the specific data checks carried out before data is accepted for analysis. While the QA processes were developed independently there is a large overlap across all DoTs in the range of checks being carried out.

4. Application to TII Traffic Count Surveys

Based on the recent experience of TII Network Management, and the literature review, it is clear that a formal system of QA/QC of short duration traffic count data would be beneficial to TII. Data quality must be assessed in the context of the site but in general the following items should be considered for inclusion in a QA/QC process for short duration traffic count surveys.

4.1 Pre-Survey

A project brief should be prepared by the client. This does not need to be very extensive, but it should include:

i. the proposed site location and extents
ii. the timeframe over which the survey is to take place
iii. the type of data required and it's intended usage (e.g. volume only, volume + class, speeds etc)
iv. the level of accuracy required in the data
v. the level of completeness required in the data
vi. the deadline for final data submission

All responses from service providers should indicate the type of equipment they propose to use and the reasons for proposing it e.g. pneumatic tubes are unsuited to locations where frequent turning or acceleration/deceleration occurs, radar need a minimum line of sight to capture vehicles etc. The nature of the site and the recommended equipment may also impact on the level of accuracy and completeness that can reasonably be achieved. Should this be the case, the achievable level of accuracy should be agreed between TII and the Service Provider prior to any survey commencing.

The Service Provider should also provide a QA/QC plan that details:

i. How the accuracy and completeness of the traffic count will be assessed, including specifically what checks will be carried out.
ii. What tolerances will be used in this assessment to indicate whether or not the data has reached the agreed level of accuracy and completeness
iii. Policies and procedures for dealing with data that is not of acceptable quality, including details of any adjustments or corrections made to the submitted data.

4.2 Post-Survey

After surveys have been completed, all Quality Assured raw data and summary reports should be provided to TII as soon as practicable and no later than 2 weeks after survey completion. For short term traffic count surveys (< 2 weeks duration) the data quality and completeness should be provided in an overall summary table. Where multiple counters are used each counter should be summarised separately. For longer term traffic surveys (> 2 weeks duration) weekly summaries over the entire survey period should be provided. Again, where multiple counters are in use each counter should be summarised separately.

Prior to data acceptance, TII should run a series of checks on the data to confirm that it meets the required levels of accuracy and completeness. In most cases a local "ground truth" of traffic volumes, speeds, classification etc will not exist. For surveys where a single sensor is used, comparison with historic surveys at the same location, contemporaneous surveys carried out at nearby locations and/or engineering experience or judgement will be required to assess the data.

For multiple sensor surveys, sensors can effectively be used to QA each other via cross-sensor comparisons. Outliers in the group of sensors should be relatively easy to identify.

The nature of the site must be also considered in selection of appropriate checks and tolerances. The application of some of the checks and specification of tolerances will vary depending on local site conditions. For example, on low AADT sites (< 2000) day to day variability may reasonably be as high as 50%. With higher AADT sites (> 25,000) day to day variability of over 10 % would be considered unusually high. Local conditions may result in an abnormal direction volume split or peak hour traffic times.

Based on an analysis of a number of representative surveys, and the literature review of international practice, a list of minimum checks to be carried out is given in Table 1. This list is non-exhaustive and other checks may be beneficial and/or necessary depending on the site. These checks should be carried out for each day of survey data. Any parameter falling outside acceptable ranges should be investigated and either explained or removed from the final dataset.

When all checks are complete, and a final dataset is available the overall completeness and accessibility of the survey data can be assessed. If the overall completeness falls beneath the standard agreed pre-survey, then an extension to the survey period or an additional survey may be required. Accordingly, for surveys running for more than 2 weeks it is important that traffic count data is submitted weekly to ensure any extension to the survey can be agreed in a timely manner.

Table 1 List of Recommended Checks

Parameter	Checks
Vehicle Volumes	Reasonable overall volumes
	Consistent with historic and/or nearby counts
	Internally consistent for multi-sensor surveys
	Similar volume in each direction
	Peak volumes are reasonable and occur at consistent times
	Reasonable weekday day to day variability
	Low proportion of duplicate records (identical time, speed and class)
Vehicle Classification	Reasonable distribution overall
	Proportion of Heavy vehicles is reasonable
	Low numbers of unclassified vehicles
	Consistent with historic and/or nearby counts
	Internally consistent for multi-sensor surveys
	Directional class distribution reasonably similar
Vehicle Speeds	Reasonable Mean & 85th Percentile Speeds overall and by vehicle classification
	Consistent with historic and/or nearby counts
	Internally consistent for multi-sensor surveys i.e. speed differences between counters are consistent with site geometry, speed limits, merging traffic etc.
	Reasonable differences in directional speed

References:

i. Defining And Measuring Traffic Data Quality, FHWA 2002

ii. Traffic Monitoring Guide, FHWA 2016

iii. Innovative Traffic Data Quality Assurance/Quality Control Procedures And Automating AADT Estimation, Southeast Michigan Council of Governments, 2017

iv. Traffic Monitoring for State Highways, Transit New Zealand, 2004

v. Guide to Traffic Management Part 3: Transport Studies and Analysis Methods, Austroads 2020

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