Kansas
LTAP Fact Sheet
A Service of The University of Kansas Transportation Center for Road, Street & Bridge Agencies

Using Turning Movement Counts (TMC) at Intersections

By Hemin J. Mohammed, PhD - Kansas LTAP

Traffic data is the foundation of traffic analysis in the transportation field.

Introduction

Many types of traffic engineering studies on intersections and road segments are reliant upon data provided through Turning Movement Counts (TMCs) at intersections. The number of intersection turning movements is an important piece of information for transportation engineers or planners to conduct different traffic operational analyses or design studies. (1)

This article explains what TMCs are, briefly outlines the ASTM International (formerly American Society for Testing and Materials, an international standards organization that develops and publishes voluntary standards for a wide range of materials, products, systems, and services) standards for collecting intersection turning movement traffic data, and discusses the variety of TMC equipment available for use in collecting valuable intersection traffic data, along with the pros and cons of each type.

What are TMCs?

TMCs indicate the directional volume of traffic passing through an intersection over a given period of time. The volume of traffic passing through an intersection is typically documented as vehicles per hour (vph) and usually involves the left, right, and through traffic leaving each approach at the intersection. The TMCs are commonly collected during peak hours and off-peak hours at signalized and unsignalized intersections for a variety of purposes. For instance, to conduct Level of Service (LOS) analysis and Peak Hour Factor (PHF) at an intersection, TMCs are usually collected during peak hours, when heavier volumes of traffic are expected at the intersection. (3)

What Are the Standard Variables for Collecting Intersection Turning Movement Traffic Data?

Because TMC calculations are so important, an ASTM committee has developed standards for quality for collecting intersection turning movement traffic data to improve by specifying the data items to be collected and a procedure for documenting the results. (2)

Kansas LTAP Loans Turning Movement Counts at No Cost

The current cost of an electronic counting board is more than $1,000.

The Kansas LTAP has two electronic counting boards available for loan at no cost, as part of its Equipment Loan Program for local agencies.

For information on this equipment and more, contact Kansas LTAP Road Safety Resource Coordinator Hemin Mohammed at hemin@ku.edu or (785) 864-4663, or go to https://kutc.ku.edu/equipment-loan-program for more information.

These ASTM standards make it possible to compare these data over time within and among governmental agencies.

The ASTM Standard Practice for Acquiring Intersection Turning Movement Traffic Data outlines three variables:

- vehicle movement by lane to and through an intersection
- the total number of vehicles observed or predicted to move by lane to and through an intersection during a specified time interval
- the total number of vehicles observed or predicted to move by lane to and through an intersection during a specified time interval.

What Are the Types of Turning Movement Counts Equipment?

Intersection turning movement counts have changed over the years, from basic methods, some of which we still employ, to current, more advanced techniques. Each method has its advantages and disadvantages. (4)

- **Paper and Pencil**: This was the first method implemented to collect TMC data and continues to be used by many individuals and agencies throughout the world. However, now this method often is used only to count bicyclists or pedestrians, or it is implemented by groups conducting only limited studies. The most significant drawback with this method is the difficulty of recording counts and vehicle classifications based on the size and/or type of vehicles or noting intervals every 15 minutes at busy intersections with multiple lanes. Therefore, multiple people collecting data are often required for this method.

- **Mechanical Counting Boards**: To overcome the challenges of the paper and pencil method, mechanical counting boards were created. Using the mechanical counting boards, the data has to be transferred manually to a worksheet at 15-minute intervals. This method requires extensive labor and risks human error from the observers. (1)

- **Electronic Counting Boards**: Mechanical counting boards were followed by electronic counting boards, which are battery-operated, hand-held devices (see Figure 1). The electronic counting board is the most common method used today to collect TMCs because of its low initial cost, ease of use, and the ability to separate data by different time intervals, reduce and summarize data, and directly download collected data to a computer. All of this saves time. Drawbacks with this device are the innate risks of inaccurate data due to operators needing to collect vehicle classification data based on the type of vehicles (trucks, buses, passenger cars, etc.) at busy, high volume intersections, and the challenge of

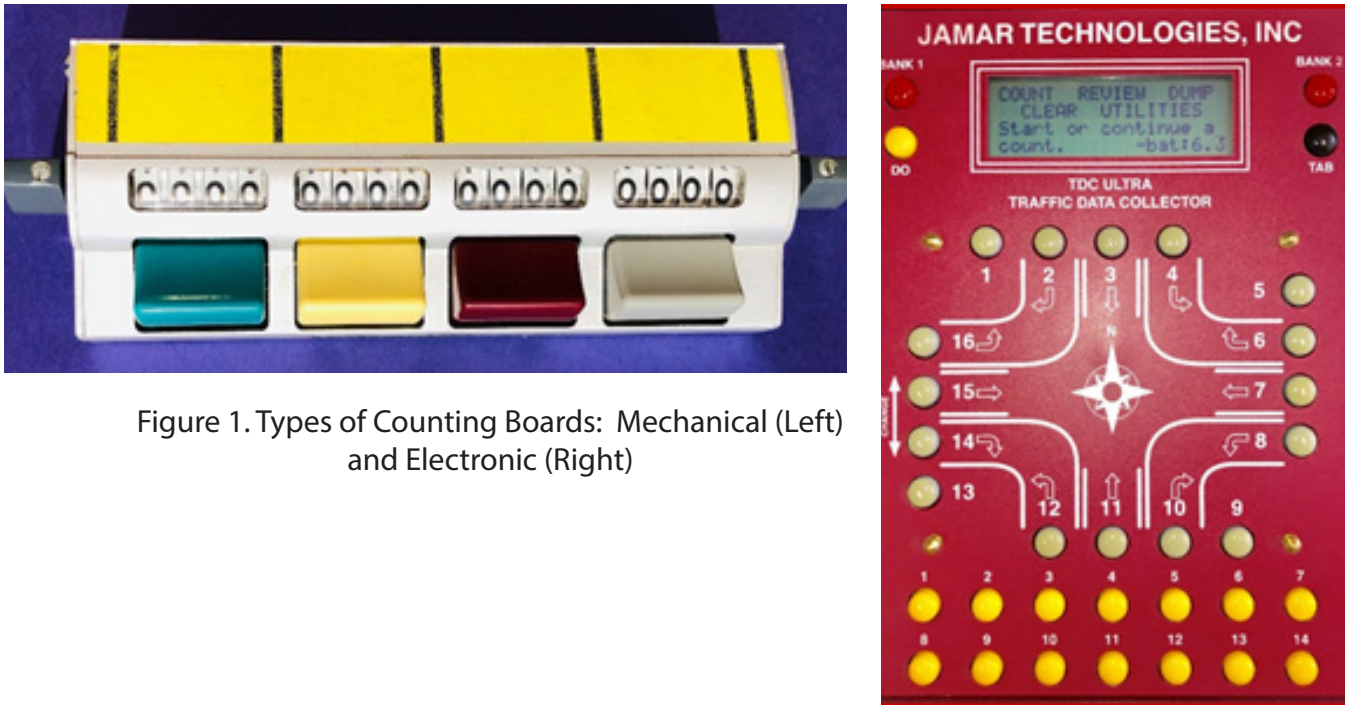

Figure 1. Types of Counting Boards: Mechanical (Left) and Electronic (Right)

continuously watching traffic while occasionally glancing down at the counting board to determine which button(s) to push. For studies such as improving turning movements, and determining the level of service of a heavy volume intersection to evaluate its performance that requires such detailed data, it is probably better to utilize more advanced devices and technics to avoid human error.

How Electronic Counting Boards Work

The electronic counting boards method for TMC is composed of a number of hand-operated counters arranged so that each approach lane to a conventional four-legged intersection is represented by a counter. Operation of a counter board is simple. At the start of the count, each of the dials is read and the reading is indicated on a recording form. As each vehicle passes, the observer depresses the counter mechanism for that particular movement. At prescribed intervals (predetermined by the data requirements for 5-minute, 15-minute, or hourly intervals) the counter is read and the number is recorded. There is no need to set back the counter to zero, although most counters are designed to permit this. The actual traffic volumes are determined by subtracting the initial reading from the final reading (8).

After downloading the collected data, the integrated software connected to electronic counting devices reads, edits and stores data, as well as prints a variety of reports and graphs.

- **Inductive Loops**: These detectors are installed in road pavements, usually at signalized intersections, that use virtual detectors to observe traffic. These detectors can provide accurate data when properly set up, but this method is not always practical given the limited number of turning movement counts needed for a project and limited financial resources.

- **Road Tube Counters**: These are commonly used traffic data collection devices that utilize rubber tubes connected to counters. They can collect highly specific traffic data such as speed, volume, and vehicle classification and with improved accuracy. The tubes are usually installed on road pavements perpendicular to the traffic flow direction, and they send a burst of air pressure along a rubber tube when tires of a vehicle pass over the tube (5). The pressure pulse closes an air switch to produce an electrical signal, which is transferred to a counter for analysis of the passing vehicle's information. Road Tube Counters are portable, quick to install, have relatively low power usage, and are a relatively low-priced device. The drawbacks are that Road Tube Counters must be manually placed on the roadway, and placing them on heavy traffic-volume roadways is difficult, unsafe, and causes some disruption of traffic flow. (5)

- **Video Monitoring**: This method uses pixel tracking technology to observe traffic. It either requires video-based virtual detectors placed at the intersection or a video camera where the video footage is later processed manually with some type of count board device or processed electronically with a computerized tracking algorithm.

The video monitoring method requires higher upfront costs than traditional count board equipment and may require ongoing processing costs as part of data collection efforts. Much like the inductive loops method, this method can provide accurate data when properly set up, but it is not always practical, as a project may not have the number of turning movement counts needed to warrant the cost of this type of monitoring or there may be limited financial resources. The expectation is that video-based tracking technology will continue to evolve and improve and that individuals needing large quantities of turning movement counts will be able to adopt data collection processes based on this technology as further development ensues.

- **Wireless Readers**: Recently there have been some advanced wireless technologies involved in collecting TMCs, such as Bluetooth detecting devices in vehicles. Bluetooth-based turning movement data collection includes some limitations and errors. For instance, vehicles that do not contain any Bluetooth resources or vehicles that contain more than one resource could impact the accuracy of collected data (6).

What Are the Uses of TMCs?

TMC data can be used for different studies such as standard turning movement, enhanced turning movement, manual classification, multi-direction gap, stop sign delay, signalized intersection delay, spot speed, saturation flow rate, roundabout movement, and time-stamped studies (7). These studies can help a local agency decide whether a project is warranted, based on traffic usage.

You can borrow electronic counting boards through LTAP's Equipment Loan Program Electronic counting boards can be utilized to conduct the most common manual traffic data collections. The current cost of an electronic counting board is more than $1,000. The Kansas LTAP has two electronic counting boards available for loan at no cost, as part of its Equipment Loan Program for local agencies. For information on this equipment and more, contact Kansas LTAP Road Safety Resource Coordinator Hemin Mohammed at hemin@ku.edu or (785) 864-4663, or go to https://kutc.ku.edu/equipment-loan-program for more information.

Summary

There are a number of methods for gathering data on turning movement counts. Some of the simpler methods may be appropriate for low volume roads or for counting pedestrians and bicyclists, or when funding is limited. However, at present, the cost-effectiveness, simplicity, and functionality of the electronic counting boards indicate that they are most likely to be used for TMC data collection in the foreseeable future (4).

References

1. Ghanim, M.S., and K. Shaaban. Estimating Turning Movements at Signalized Intersections Using Artificial Neural Networks. IEEE Transactions on Intelligent Transportation Systems, Vol. 20, No. 5, 2018, pp. 1828-1836.
2. ASTM. Standard Practice for Acquiring Intersection Turning Movement Traffic Data. No. E2667 - 09, 2017. https://compass.astm.org/EDIT/html_annot.cgi?E2667+09(2017).
3. Murthy, A.N., and H.R. Mohle. Transportation Engineering Basics. 2001.
4. Shoup, G., S.M. Remias, A.M. Hainen, G. Grimmer, and A.D. Davis. Characterizing Reliability of Manual Intersection Turning Movement Counts Using Modern Data Collection Technology. 2013.
5. Mohammed, H.J.M. Evaluating the Accuracy of Speed and Volume Data Obtained Via Traffic Detection and Monitoring Devices. University of Kansas, 2015.
6. Schrock, S.D. Estimating Turning Movements at Roundabouts Using Bluetooth Technology. No. 13-2265, 2013.
7. JAMAR Technologies. TDC Ultra User's Manual.In, JAMAR, 2019. p. 124.
8. Minnesota Department of Transportation. Traffic Engineering Manual.In, 2007.