

Review of Traffic Monitoring Factor Groupings and the Determination of Seasonal Adjustment Factors for Cars and Trucks

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## Problem

One objective of statewide traffic monitoring programs is to accurately estimate the Annual Average Daily Traffic (AADT) for many roadway segments within the state. The majority of the departments of transportation (DOT) in the United States implement a traditional method developed by Drusch in 1966. According to this method, traffic volumes are collected continuously from automatic traffic recorders (ATRs) and supplemented with shorter duration 24, 48 or 72-hour coverage counts in areas where there are limited or no available ATRs. Once the short-term counts are recorded. adjustment factors including daily, weekly, monthly or seasonally are then used in concert with the short-term counts to estimate AADT. One criticism of this approach is the number of steps required which increase the overall error within the final AADT estimate.

# **Objectives**

There are four objectives in this study.

- Objective One A comprehensive literature review on the state-of-the practice.
- Objective Two Develop seasonal adjustment factors for cars and trucks.
- Objective Three Develop innovative factor groupings for cars and trucks
- Objective Four Develop a unique approach for assigning short-term counts to factor groupings.

# Description

There are three main research areas within this study.

• Research Area One- Develop seasonal adjustment factors (SAF). New methods for AADT are

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developed and compared with traditional approaches in order to select the most effective SAF. The main part of this research area includes five formulas to estimate AADT and seven SAFs. These SAFs are then applied to 13 individual vehicle classes and the aggregation of the vehicle classes. This aggregation is conducted in order to determine the most effective SAFs per vehicle class and compare the AADT accuracy of individual vehicle classes against groups of classes.

- Research Area Two The examination of the most effective way of grouping permanent stations. To complete this area of research there are three steps. The first step is the development of eight grouping methods which include the current practice, other traditional methods and new statistical techniques. The second step is the development of performance measures used to assess the overall performance of each method and the third step is the selection of the most effective method for grouping continuous stations.
- Research Area Three Assignment of Short-Term Counts to Factor Groupings. Three techniques are examined and used in the statistical development of the assignment of short-term groupings to factor groupings, the traditional method, discriminant analysis, and the coefficient of variation approach (CoV).

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# **Conclusions & Recommendations**

Seasonal adjustment factors are applied to 13 individual vehicle classes separately as well as to groups of vehicle classes. This study developed more than 1,600 SAFs for light-duty and heavyduty vehicles. The individual vehicle classes in comparison to aggregated vehicle classes have higher mean absolute errors. The most accurate single class AADT estimates are obtained for vehicle class 2, passenger cars, and vehicle class 9, standard semi-trucks. Other vehicles classes that did not perform well are vehicle classes 1, 7, 10, 11, 13, 14, and 15. The results from the analysis show that grouping all trucks into one group produces the lowest heavy-duty mean absolute error. In general, the more groups of vehicle classes examined results in higher predicted errors.

Temporal analysis for monthly short-term data collection is used to determine the best and worst months to collect truck data. The comparisons show that the worst months are November and December, while spring and summer months produce lower mean absolute errors. August and September are the best months to collect truck data. The results show that there are no consistencies with the overall best individual roadway functional classification. Other temporal analysis which influence the AADT are the duration of the short-term count and day of the week. The results of the short-term data collection analysis show 24-hour durations produce the highest mean absolute errors, followed by 48-hour and then 72hour sampling durations. In general, the largest decrease in the mean absolute error occurs between 24 and the 48-hour counts and there is little improvement in the mean absolute errors when short-term counts are longer than 48-hours. The day of the week also influences the change of the mean absolute error, in addition to the sampling duration. The findings show Mondays produce the highest mean absolute errors, followed by Tuesdays and Thursdays. Wednesdays have the lowest errors of the week.

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There is a significant debate between researchers and practitioners on what is the most effective method to group continuous recorders. This study examines four traditional and four cluster-based grouping methods in order to identify advantages and disadvantages within each approach. The non-cluster methods include geographical and/or functional classifications of ATRs. The remaining four techniques combine cluster analysis with traditional approaches. The overall findings using Analysis of Variance show cluster methods produce lower errors than non-cluster methods. The lowest errors are generated when clustering is used alone. As more classifications of a data set are combined with cluster analysis, Methods Six through Eight, the variation within each cluster and the required computational time increase. The advantage of the combined grouping techniques is an easier to interpret grouping used in assigning short-term counts to cluster groups. Although clustering exclusively provides the overall best result, the assignment of short-term counts in some cases is hard to justify. It is recommended to use Method Seven which includes clustering with the geographical location in the assignment of shortterm counts to cluster groupings.

The second set of results is developed to evaluate how many cluster groupings are sufficient for accurate results and where ATRs should be added or removed. In general, the overall accuracy improves as the number of clusters increases. There is however, a point

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in which the addition of new cluster groupings provides little benefit. This range is between eight and twelve clusters. There are two main disadvantages with higher cluster numbers. The first disadvantage is the inability to populate all the clusters with the minimum suggested number of stations. The second main disadvantage of clustering is the temporal instability within each cluster. ATRs have different cluster memberships from year to year. The greater number of clusters provides a higher likelihood that the ATR will change on a per annual basis. A practical solution may be to monitor the stations typically grouped together. ATRs with similar characteristics are only required to have one of the stations online. New factor groupings are recommended to be created every year.

The assignment of short-term counts to factor groupings is the final step of the AADT estimation process. There are two new innovative techniques that are developed to assign short-term counts to factor groupings. The first technique is called the discriminant analysis and the second technique is called the coefficient of variation approach. In each case the two techniques are compared with the traditional method for assigning short-term counts. The final comparison between the traditional method, the discriminant analysis and the coefficient of variation approach, shows the coefficient of variation approach is the most efficient method for estimating AADT. The overall best model is developed directionally using 24 onehour time-of-day factors. This model form improves the accuracy over the traditional method by 52% and 66% for the mean absolute error and the standard deviation of the absolute error.

The overall significance of the results from this study show the range and the percentage of the absolute difference of the AADT estimates obtained from the coefficient of variation approach and the traditional method. For 65% of the short-term counts the predictions between the two methods differ by less than 250 vehicles, 15% of the predictions fall within a range of 250-500 vehicles,

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whereas the remaining 20% of the short-term counts have a difference greater than 500 vehicles per day. These results express the real absolute difference of the outcomes produced from the traditional and the proposed method.

## **Implementation Potential**

The results of this research are based on guidance from the traffic monitoring guide as well as findings from this research. The implementation potential from this research is feasible since the data are already collected and the process for the estimation of heavy-duty and light-duty AADT has been extensively researched. The main challenges for the implementation of this research are the sheer volume of data, the introduction of new protocols into the current software platform, and the yearly requirement to update SAFs, factor groupings and short-term counts required for the prediction of AADT.

To ensure the future success of this research, the research team will continue to work closely with the technical liaisons to address any questions as to when such factors are appropriate for use. Page 4