

The Development of the Ohio State Highway Patrol's Cadet Allocation Model

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ABSTRACT

In July 1999, The Ohio State Highway Patrol decided to modify the method it used to assign newly graduated cadets to the 54 Patrol posts located throughout the state. To this end, the Research and Development Unit was asked to develop a computer-based model to allocate staff using various measures of trooper activity and state demographics. Approximately 30 activity and demographic measures were gathered such as the number of crashes investigated per post and the number of licensed drivers in a post's jurisdiction.

Needing a powerful statistical program, Research staff used the SAS® System for PCs to perform the statistical work in the creation of the Cadet Allocation Model (CAM), a linear regression model. By providing several different model selection options, the REG procedure in SAS/STAT® made choosing the final set of variables to be included in the model in much easier.

The number of troopers already assigned to each of the 54 posts was used as the dependent variable with the 30 activity and demographic measures treated as independent variables. The SELECTION=RSQUARE statement was used to determine which combination of variables accounted for the largest proportion of variance in the number of troopers currently assigned to each post. From the list of models generated by the SAS System, the Research Unit selected a combination of variables that was not only highly predictive, but also made logical sense in a law enforcement environment. A model with 4 independent variables was ultimately selected.

Introduction

The task of allocating sworn personnel across a jurisdictional area is difficult for any law enforcement agency and the Ohio State Highway Patrol is no exception. For the Ohio State Highway Patrol, the difficulty lies in addressing the question of how the statutorily limited number of troopers can be efficiently dispersed throughout the state to provide the most beneficial service to the public. Because of differences in population, miles of rural roadway, and other variables, some sections of the state will require more officers than others. Determining this differential need for officers is the principal difficulty of personnel allocation. Which of the many measures of activity available such as number of fatal crashes, vehicle miles traveled, or calls for service should be used to determine how "busy" a Patrol post is or should be? This article examines how the Ohio State Highway Patrol attempted to answer the question of personnel allocation.

Prior to July 1999, a less structured process for allocating cadets prevailed. Before each class of cadets graduated, post commanders would submit requests for additional staff to each of the ten district commanders who, in turn, would

submit written requests to the Majors in charge of human resources and operations for the Patrol. Each district commander would base his or her request for staff on different service priorities and activity data. Some might focus on crashes while others would concentrate on service calls. The senior staff would then have to decide how to assign cadets based on these written requests. Consistent methods for measuring need were not used across districts.

In July 1999, the Patrol's Personnel Staffing Committee determined that changes needed to be made to the existing method of assigning cadets with some consistent measures of activity being taken into account. The Research Unit was asked to develop a computer-based model using factors determined by the committee. This model was to be used to allocate the members of the 134th cadet class graduating in December 1999. The factors that the Committee considered to be most appropriate were:

1. Total crashes investigated per trooper
2. Total crashes investigated per post
3. Total crashes available to be handled in the post area
4. Number of counties a post is responsible for
5. Five-year average of fatal crashes in the post area
6. Whether or not there are interstate highways running through a post area
7. External factors like cooperation from/with other law enforcement agencies that share jurisdiction like county sheriffs

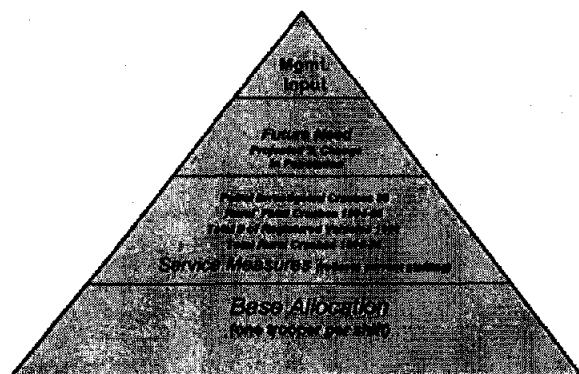
Since several of the factors were correlated, the Research Unit eliminated duplicate measures. Additionally, several measures of demographics were added to those being considered

Model Conceptualization

The first thing the Research Unit did was to devise a concept for the new model. It was reasoned that a powerful model for cadet allocation needed to be based on four elements. The first consideration ought to be the minimum number of troopers necessary to staff each post so that at least one trooper is on the road for each shift of every day during the year. Next, beyond this, differences among the posts on various measures of service should be weighed to determine the allocation of additional officers above this base allocation. These additional officers would allow post commanders to manage the current level of activity in their posts' areas. Third, consideration should be given to the changing demographics (e.g., population, licensed drivers) in the post areas that may require future adjustments to the number of troopers required at a post. Finally, several other important factors must also be considered before making personnel allocations, such as relationships with other law enforcement agencies that share jurisdiction with the Patrol. Unfortunately these other factors may be difficult, if not impossible, to measure or quantify. Because of this

limitation, senior staff and management input is essential to any allocation model. Figure 1 depicts this conceptualization.

Figure 1 - Model Conceptualization



Development of the Model

Minimum Staffing

The Research Unit was able to approximate the number of hours an average trooper will work during a year, by using data from an activity report produced monthly. This report summarized troopers' self-reported hours spent on routine patrol, investigating crashes, investigating other cases, testifying in court, supervising others, time spent sitting at a desk, time spent on special activities and time spent in training. This report did not include any overtime since it is quite variable and, also, voluntary. By using the hours worked to date and extrapolating to an entire year, the Research Unit calculated that the 701 troopers at the 54 Patrol posts considered would work an average of 1,793 hours in 1999.

To have one trooper working each eight hour shift for an entire year (365 days) requires 2,920 hours of work. These numbers reveal that each post would require $2,920 \div 1,793$ or 1.63 troopers to cover each shift's hours. To have one trooper on the road for 3 shifts per day would require 3×1.63 or 4.89 troopers at each of the 54 Patrol posts. This calculation does not take into consideration what the troopers would be doing during those hours. It is simply a bare minimum number of troopers needed to cover a year's worth of hours.

Current Service Levels

The next step in the development of the CAM was to calculate the number of additional officers needed to deal with the current level of activity in each post's area. The Research Unit started by using the various measures of service and post demographics suggested by the Personnel Staffing Committee. Deciding which measures to use and how many of them to use were the primary tasks of this stage of the model's development and the most time consuming.

The Research Unit first had to assemble all of the data to be considered for the model. This required that data be collected from many different state agencies including the Ohio Department of Transportation (ODOT), the Ohio

Department of Development (ODOD), the Ohio Bureau of Motor Vehicles (BMV), and from Ohio's Law Enforcement Automated Data System (LEADS) database among others.

Altogether, approximately thirty different measures were considered. First, posts were listed with their counties of responsibility. In this way, all data that was normally collected on a countywide level could be summed to cover post areas of responsibility. Since, the allocation of personnel to the three posts responsible for the Ohio Turnpike (District 10) is determined contractually by the Turnpike Commission and the Patrol, the data for these posts were not considered. The following data was collected:

- Information about total crashes investigated by each post was summed for the years 1996, 1997 and 1998.
- The total number of rural crashes that occurred in the state during the years 1996 - 1998 was ascertained and divided into post areas.
- Another measure of activity was constructed by dividing the number of rural crashes investigated by each post by the total number of rural crashes occurring in each post area. By doing this, the Research Unit was able to calculate the percentage of crashes that were investigated by each post.
- Next, the number of fatal rural crashes taking place during each of the years 1994 - 1998 was computed for each post area. Each year individually and the total number of fatal crashes for the 5 year period were considered for the model.
- The current staffing of each post was determined. Troopers who were part of drug interdiction or K-9 units were not included. Additionally, information about trooper transfers between posts as well as troopers out on long-term disability was gathered from the Human Resources Management Section of the Highway Patrol.
- The mileage of various types of rural roadway was collected. Totals for interstates, US highways and state routes were taken from ODOD and ODOT was used for county and township road mileage.
- The number of registered vehicles per post area was compiled from the Tax Distribution Section of the BMV's listing of motor vehicle registrations per county. The year 1998 was considered for the model. To see how the number of registered vehicles per post area might be shifting and to determine the percentage change, 1998 numbers were compared to the totals from the years 1995 and 1997.
- The number of licensed drivers per post area in 1998 was taken from the BMV. Again, 1998 was compared to 1995 numbers to learn how the number of drivers changed over time.
- Estimates of daily vehicle miles traveled (VMT) were obtained from the Roadway Information Section of ODOT. This data was produced in 1998.

- Finally, several different estimates of population were used. The ODOD's Ohio County Profiles was used for 1996 estimates, and 2000 and 2005 projections of county populations. 1998 estimates of population were taken from the US Census Bureau as were the final figures from the 1990 US census.

After entering all of this data into a spreadsheet, the REG procedure in SAS/STAT, was used to perform the multiple regression analyses on these various measures of service and demographic information collected. The dependent variable was the number of troopers already working at each post taken from the activity report minus 4.89 troopers per post.

The `SELECTION=RSQUARE` statement was utilized because this model selection method considers each of the variables one at a time and constructs the optimum combination of 1, 2, 3, etc. variables that produces the "best" model (e.g., the model that predicts the best).

From the list of models generated by the SAS System, ranging from 1 to 7 variables per model, the Research Unit selected a combination of variables that was not only highly predictive and met the criteria set by the Personnel Staffing Committee, but also made logical sense. This was a model consisting of four variables

The variables selected for the CAM model were: (a) the number of rural crashes investigated by the post in 1998; the previous year, (b) the total number of rural fatal crashes that occurred in the post area over the last 5 years; (c) the number of registered vehicles in a post area in 1998; and (d) the total number of rural crashes that occurred in a post area during the last three years regardless of which agency handled the investigation. Together, these four variables accounted for 75.5% of the variation in the number of troopers assigned to each post above the minimum number required (4.89).

Combining the first two parts of the model, the minimum number of troopers required for full-time coverage (4.89) and the number of additional troopers predicted by the regression model, gave an assessment of the total number of troopers needed at each post. Subtracting this estimate from actual staffing at each post reveals which posts were over-staffed or understaffed. The Research Unit was then able to rank order the posts from most to least deficient.

Future Need

In order to be proactive in the assignment of cadets, the Research Unit felt that consideration should also be given to the changing demographics in the geographic areas that posts have responsibility for. Of the various demographic measures collected, it was decided to use the change in population projected by the Ohio Department of Development for the 2000 to 2005 period. The percentage of the total state increase in population that was projected to occur in each post's area of responsibility was calculated. This variable was selected because it accounted for the most variance beyond that explained by the first 4 variables.

Other Considerations

Certainly no model for personnel allocation is perfect. The Ohio State Highway Patrol's CAM model attempts to quantify and formalize a process for allocating cadets to a statewide system of services. Important considerations that do not lend themselves to measurement could not be included in the CAM, but surely need to be taken into account when allocating cadets. For example, the level of cooperation between the Highway Patrol and a county sheriff may play a substantial role in the number of crashes investigated by the Patrol in a particular county. This level of cooperation is difficult if not impossible to quantify and may be constantly changing. These intangibles are a significant area in which management's input and experience are invaluable assets.

The actual assignment of the cadets from the 134th academy class was left to the Majors in charge of operations and human resources. In reviewing these final assignments, approximately 72% of the posts that were short at least one trooper actually received at least one trooper.

CONCLUSIONS

The Research Unit of the Ohio State Highway Patrol set out to develop a computer-based model to allocate cadets. As a part of the model's development, it was necessary to determine the number of troopers needed to handle the current level of activity in each post area. To accomplish this, the SAS System for PCs and specifically the REG procedure were used. The Research Unit was able to synthesize a great deal of data and develop a useful and logical multiple regression model to allocate its newly graduated troopers.

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