EXTRABOARD TEAM SIZING

An analysis of short unscheduled absences among regular transit drivers

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ABSTRACT

Several factors contribute to short-duration unscheduled absences of bus transit drivers. This article aims to understand these factors at the **aggregate level** and to anticipate future total absence that will need to be filled for a large-size transit operator.

The aggregate level is defined as the **total number of regular driver absences** per garage, day of week and time period that need to be covered by the extraboards.

This study analyzes absenteeism data obtained from **OC Transpo,** the transit provider of the city of Ottawa, Canada. **A multilevel regression** model is used to investigate regular drivers' absences.

Furthermore, using the model's coefficients, **sensitivity analyses** are conducted to demonstrate the advantages of this technique over traditional ones adopted by various transit agencies.

INTRODUCTION

The **extraboard planning process**, which is known also as 'sizing,' is an essential exercise related to predicting unscheduled absences among regular-duty drivers. Transit agencies might have to **cancel trips** or decrease frequency along certain routes if the size of the extraboard is insufficient to **deal with these absences**

Previous studies in the literature focused on individuals at the disaggregate level (Shiftan & Wilson, 2001; Strathman et al., 2009), which is more interesting from a human resources point of view. Also prediction will lead to a probability value, which can impose further challenges on transit planners

Since **the goal of extraboard sizing** is to estimate of the extraboards in a particular day in a booking. This estimation can be generated **directly at the aggregate level** to reduce the complexity in the prediction process and to generate **a practical tool** that is easy to use by transit operators.

METHODOLOGY

The data used in this study comes from **OC Transpo's** archived human resource, scheduling, and absence databases. This data was mainly derived from **Hastus' work-scheduling** software package, and it was collected between **April 21st, 2008 and July 31st, 2012.**

The paper unit of analysis is **the total driver absence per garage, day of week, and time period.** Days of the week have been further distinguished according to the booking week number (week 1 and week 2). All variables were summarized according to the previous criteria

After this process **14,305 groups of garage-day-period** observations were generated with an average group size of 69.1 drivers per observation and standard deviation of 48.9 drivers.

The analysis methodology was based on:

1 A multilevel regression model was used to capture and estimate the total absences at the aggregate level of the garage-day-period. Five different time periods and garages were identified in order to determine the amount of daily open work per time period and garage that might occur.

The model specification is:

Absence = f(a. temporal factors, b. drivers personal characteristics, c. assigned work characteristics, d. service delivery characteristics, e. garage interactions)

2 The second part of this analysis used the coefficients from the above model to conduct a sensitivity analysis to estimate the total number of drivers' absences during the random 1400 garage-day-period observations that were excluded from the previous model.

Afterwards, different scenarios are presented in order to provide the agency with a threshold number of required extraboard drivers according to the level of service.

ANALYSIS

1 The Multilevel Regression Model

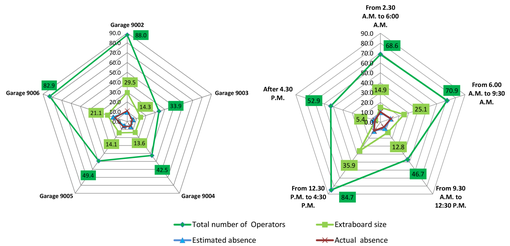
Variable	Coefficients	t	[95% Conf. Interval]	
Constant	77.00 ***	9.56	61.22	92.78
Temporal Factors				
Sunday	0.63	1.52	-0.18	1.44
Monday	0.87 ***	2.03	0.03	1.71
Tuesday	-0.48 ***	-3.45	-0.75	-0.21
Wednesday (base reference)	---	---		
Thursday	0.42 ***	3.09	0.15	0.69
Friday	1.85 ***	5.81	1.23	2.47
Saturday	-2.20 ***	-4.72	-3.11	-1.29
Y2008	-4.20 ***	-20.07	-4.61	-3.79
Y2009	-3.76 ***	-18.57	-4.15	-3.36
Y2010	-1.36 ***	-9.84	-1.63	-1.09
Y2011	-2.01 ***	-13.87	-2.30	-1.73
Y2012 (base reference)	---	---		
January	-2.67 ***	-9.54	-3.21	-2.12
February	-1.98 ***	-7.52	-2.50	-1.46
March	-1.50 ***	-5.65	-2.02	-0.98
April	-1.28 ***	-5.60	-1.73	-0.83
May	-0.58 ***	-2.77	-0.98	-0.17
June	-0.41 ***	-2.12	-0.80	-0.03
July	-1.48 ***	-7.38	-1.88	-1.09
August	-0.86 ***	-4.29	-1.25	-0.46
September	-0.50 ***	-2.37	-0.91	-0.09
October	0.76 ***	3.69	0.36	1.16
November	1.03 ***	5.19	0.64	1.42
December (base reference)	---	---		
Day before a Holiday	-0.68 ***	-2.60	-1.19	-0.17
Day after a Holiday	-0.69 ***	-2.98	-1.14	-0.23
Regular days (base reference)	---	---		
Day after regular day off (%)	-0.02 ***	-4.47	-0.04	-0.01
Day before regular day off (%)	-0.03 ***	-5.68	-0.04	-0.02
Drivers Personal Characteristics				
Drivers with spouse (%)	0.01	0.98	-0.01	0.02
Drivers with child (%)	0.03 ***	5.25	0.02	0.04
Female (%)	0.01	0.70	-0.01	0.03
Average age	-2.80 ***	-8.52	-3.45	-2.16
Average age square	0.03 ***	9.14	0.02	0.04
Probationary status (%)	0.01	0.97	-0.01	0.04
Assigned Work Characteristics				
Total assignments	0.13 ***	60.35	0.12	0.13
Working more than 5 days a week (%)	0.03 ***	6.43	0.02	0.04
With spare assignments (%)	0.09 ***	6.15	0.06	0.12
Time shifting (%)	-0.04 ***	-8.84	-0.05	-0.03
Garage shifting (%)	0.01 ***	3.33	0.01	0.02
Booking second half	0.46 ***	4.18	0.25	0.68
Booking first half (base reference)	---	---		
Service delivery characteristics				
Assignment time spread (min.)	-0.06 ***	-14.86	-0.07	-0.05
Assignment time spread square (min.)	0.01 ***	14.41	0.00	0.00
Assignment from 2.30 A.M. to 6:00 A.M. (base reference)	---	---		
Assignment from 6.00 A.M. to 9:30 A.M.	-1.38 ***	-9.54	-1.67	-1.10
Assignment from 9.30 A.M. to 12:30 P.M.	1.14 ***	5.53	0.73	1.54
Assignment from 12.30 P.M. to 4:30 P.M.	-3.31 ***	-20.47	-3.62	-2.99
Assignment after 4.30 P.M.	-1.70 ***	-7.81	-2.12	-1.27
Garage Interactions				
Garage 9002 (base reference)	---	---		
Garage 9003	0.04 ***	2.28	0.01	0.07
Garage 9004	0.01	1.58	0.00	0.02
Garage 9005	-0.02 ***	-4.50	-0.03	-0.01
Garage 9006	0.09 ***	37.44	0.08	0.09
Number of records	12,905			
St. dev. of constant	1.72		0.85	3.48
St. dev. of residuals	4.48		4.43	4.54
Intraclass correlation	27.6%			

*** Significant at 99% ** Significant at 95% * Significant at 90%

2 Sensitivity Analysis

- The **actual total driver** absences was 9.8 drivers, while the average for **estimated number** of absences was 10.0 drivers per garage-day-period, with a mean difference of 0.19 drivers.
- The **Pearson correlation** test shows a statistically significant positive correlation **of 0.9** between the actual and estimated absence. A t-test revealed that there is no significant difference between them.

Figure 1: (A) Drivers per garage and (B) Drivers per time period



- **Seven scenarios** are used to size the extraboard teams. Then, They were compared to the **current transit agency practice**

SENSITIVITY ANALYSIS

	Scenario 1 (± 0%)	Scenario 2 (+ 20%)	Scenario 3 (+ 40%)	Scenario 4 (+ 60%)	Scenario 5 (+ 80%)	Scenario 6 (+100%)	Scenario 7 (+120%)	Current transit agency practice
Totally covered periods (%)	**70.6%**	**81.9%**	**92.5%**	**95.8%**	**99.0%**	**99.7%**	**100%**	**90.6%**
Average difference between estimated and actual absence*	1.1	3.2	5.4	7.6	9.8	11.9	14.1	**11.3**
Ratio of total extraboard to actual absence	1.5	1.8	2.2	2.4	2.8	3.1	3.3	**3.6**
The extraboard percentage**	15.5%	18.3%	21.9%	24.7%	28.3%	31.0%	33.8%	**33.2%**
Maximum number of drivers needed to be overtime	27.0	16.0	7.0	5.0	3.0	1.0	0.0	**34.0**
Frequency and (%)	1 (11.1%)	1 (6.6%)	1 (7.3%)	1 (5.2%)	1 (3.1%)	4 (0.5%)	0.0	**2 (25.2%)**

* The average of (the estimated absence minus the actual absence recorded by the agency). This calculation is done for every day during the random 1400 garage-day-periods, and then the average outcome has calculated. For the *transit current practice* column it was calculated as the provided extraboard drivers minus the actual regular drivers absence
** The estimated extraboard size divided by the total number of regular drivers.
*** Frequency is the number of incident that the maximum number of drivers needed to be overtime occurs
**** The percentage of the needed number of drivers to be overtime compared with the total number of regular drivers per related garage-day-period.

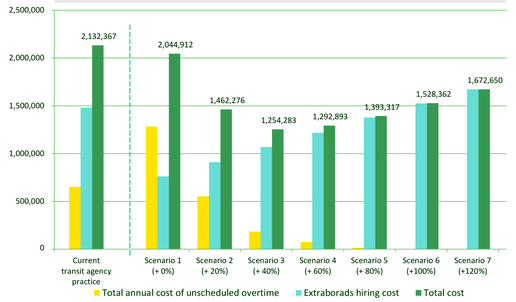
CONCLUSIONS

This article aims to understand the factors that contribute to the **short-duration unscheduled** absences of bus transit drivers at the aggregate level, and **to anticipate the future total absences** that will need to be filled by an extraboard team.

The research suggests **various levels of service** for the extraboard teams that can be applied by the agency in order to cover their regular drivers' absences.

For example, using the third scenario, **93% of the total absences** per garage-day-periods will be covered while **saving the agency 6 extraboards** and achieving an additional 2% coverage of the total absence per garage-day-periods compared to the current policy adopted by the agency.

Finally, comparing the third scenario to the current practice shows a **total savings of** around $ 900,000, in favor of the third scenario, while covering 100% of the absences.



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