A STATISTICAL ANALYSIS OF THORNTON FIRE DEPARTMENT TURNOUT TIME

Emma Collins

Background and Motivation

- "Turnout Time" is the time it takes for a firefighting crew to put on the appropriate gear and leave the station after being notified of a call.
- The National Fire Protection Association (NFPA) standards:
  - 80 seconds for complex calls (fire, hazmat, etc.)
  - 60 seconds for EMS calls
- Many factors can contribute (time of call, type of call, apparatus)
- How can Thornton Fire Department improve their turnout time?
  - Identification and magnitude of variables that contribute to turnout time.

Data Overview

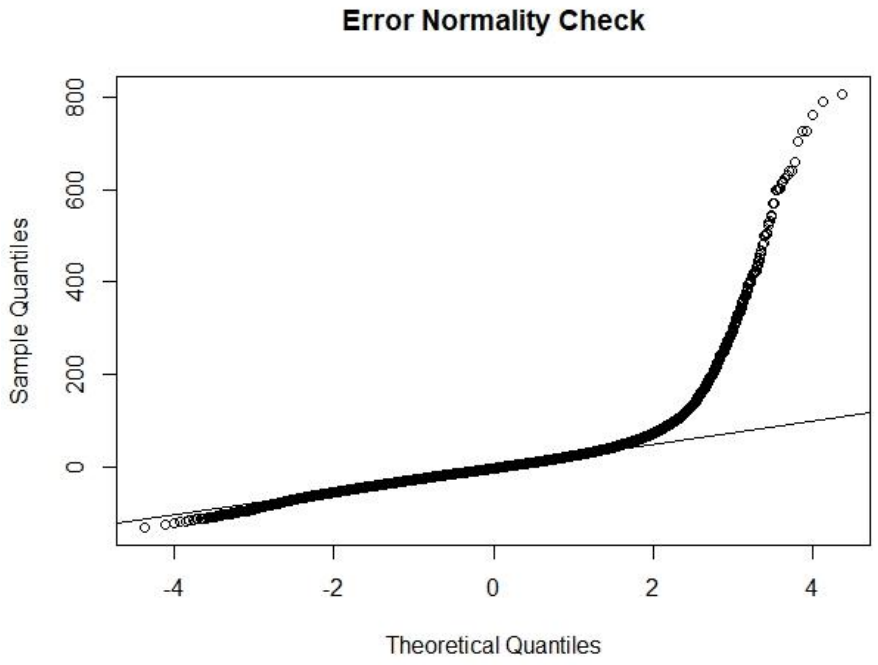
- Data available from Jan. 1, 2014 through Dec. 31, 2018
- Only analyzing Turnout Time between 22 seconds and 900 seconds
- 11 initial predictors (Apparatus, Initial Dispatch Code, Priority Response, Shift, Station, Month, Day, Year, Time of Call, Rest Time between Calls)
- Only Rest Time is continuous, all other variables are categorical
- Potential for many interactions (Shift and Year, Shift and Apparatus, etc.)

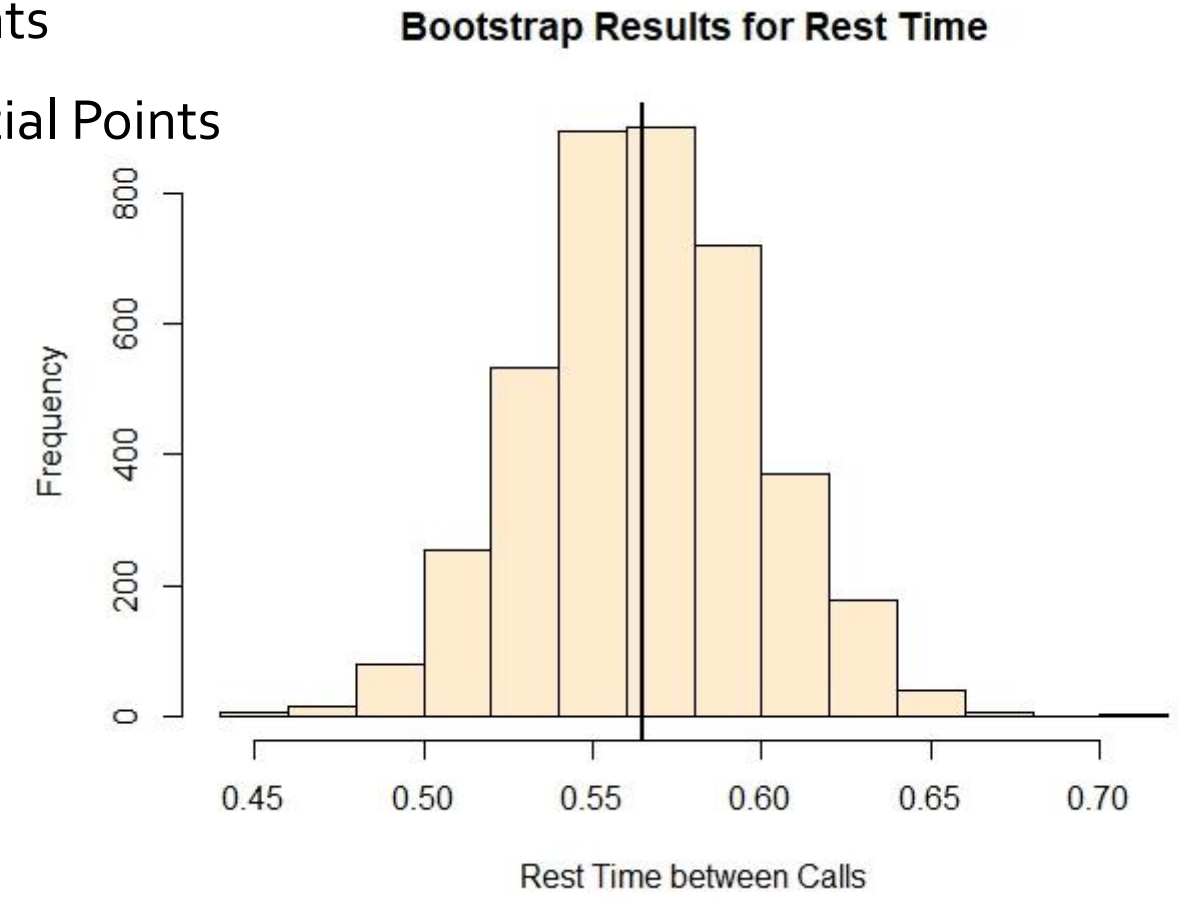
Methodology

- Linear Regression
- Removed Priority Dispatch as a predictor for collinearity
- BIC forward stepwise selection
- Removed BT71, BT74, RSQ73 levels in Apparatus variable

Diagnostics

- Errors are skewed
- Bootstrap "sanity-check" of coefficients
- Sensitivity Check for Outliers, Influential Points





Final Model

105 coefficients, 78499 degrees of freedom

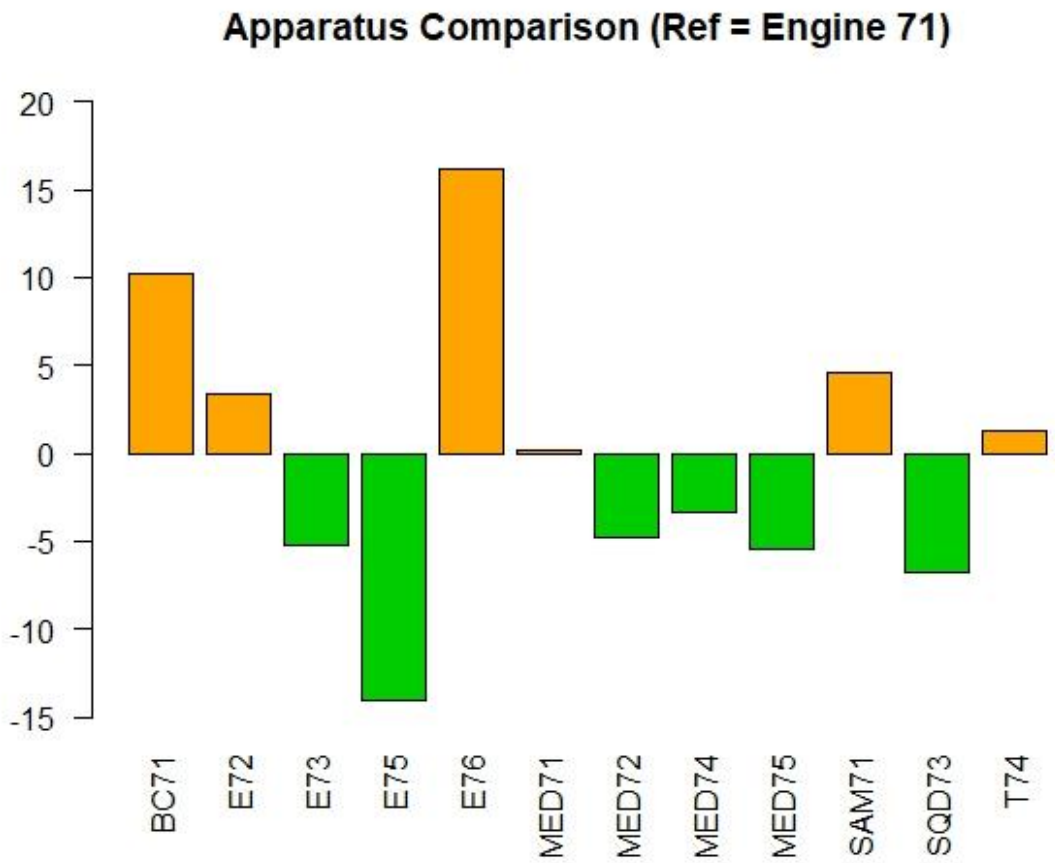
Turnout Time = **0.6***Rest Time between Calls + Apparatus + Initial Dispatch Code + Time of Call + Shift + Month + Year + Shift*Apparatus + Shift*Year

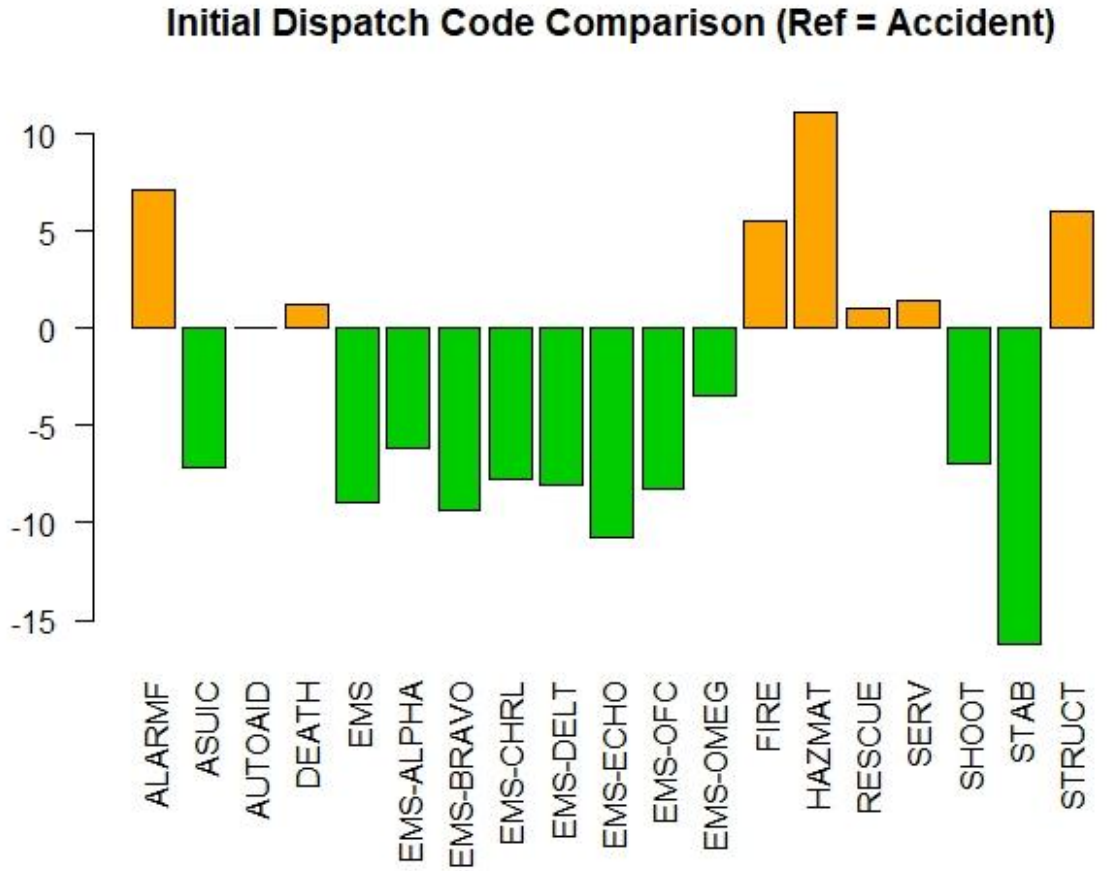
Reference Levels:

Apparatus:	Engine 71
Initial Dispatch Code:	Accident
Time of Call:	07:00 – 07:59
Shift:	A
Month:	June
Year:	2014
Shift*Apparatus:	Shift A, Engine 71
Shift*Year:	Shift A, 2014

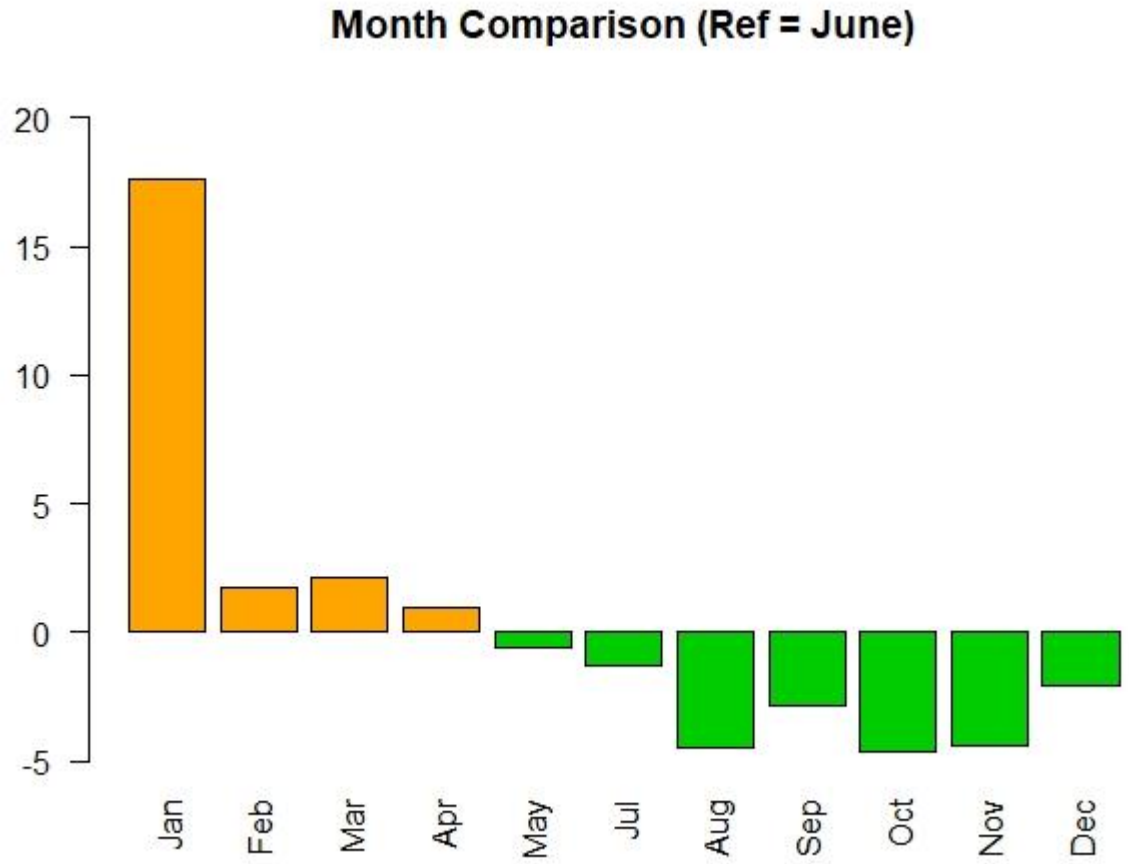
Turnout Time: **103 seconds**

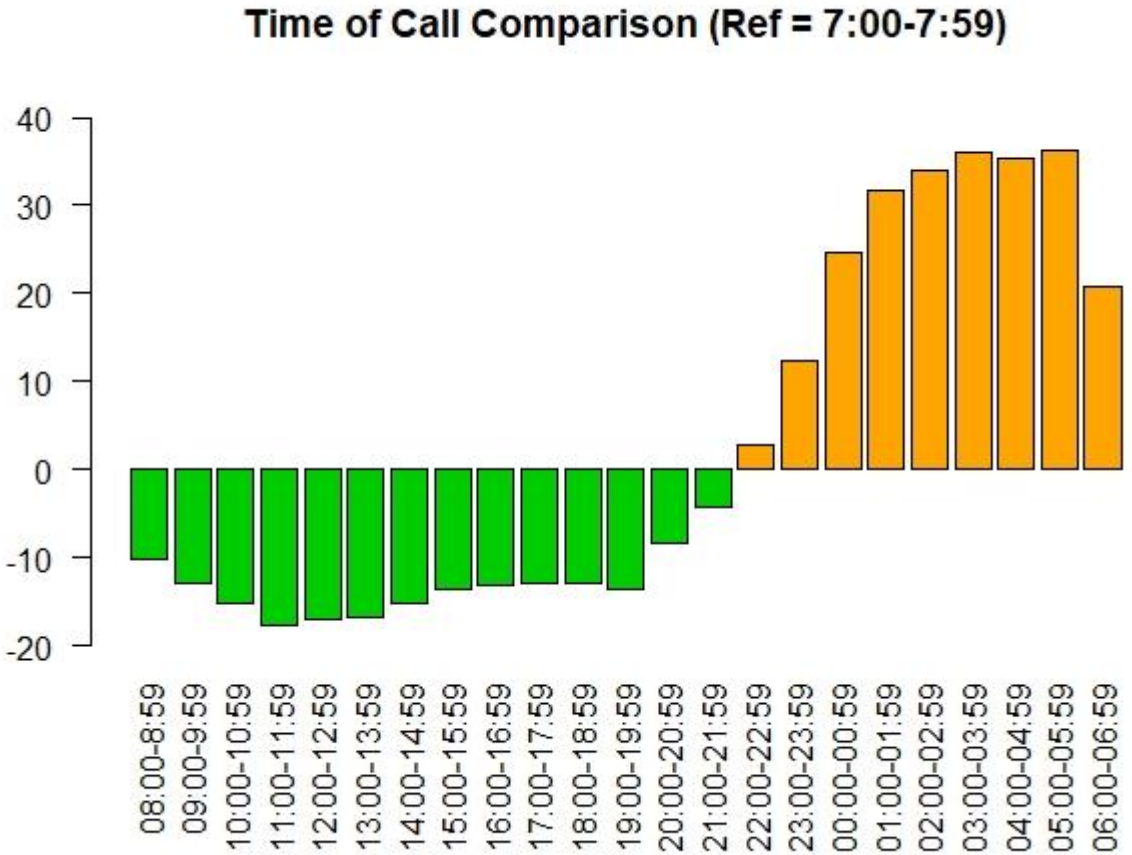
Results


Apparatus Comparison (Ref = Engine 71)
20
15
10
5
0
-5
-10
-15
BC71
E72
E73
E75
E76
MED71
MED72
MED74
MED75
SAM71
SQD73
T74

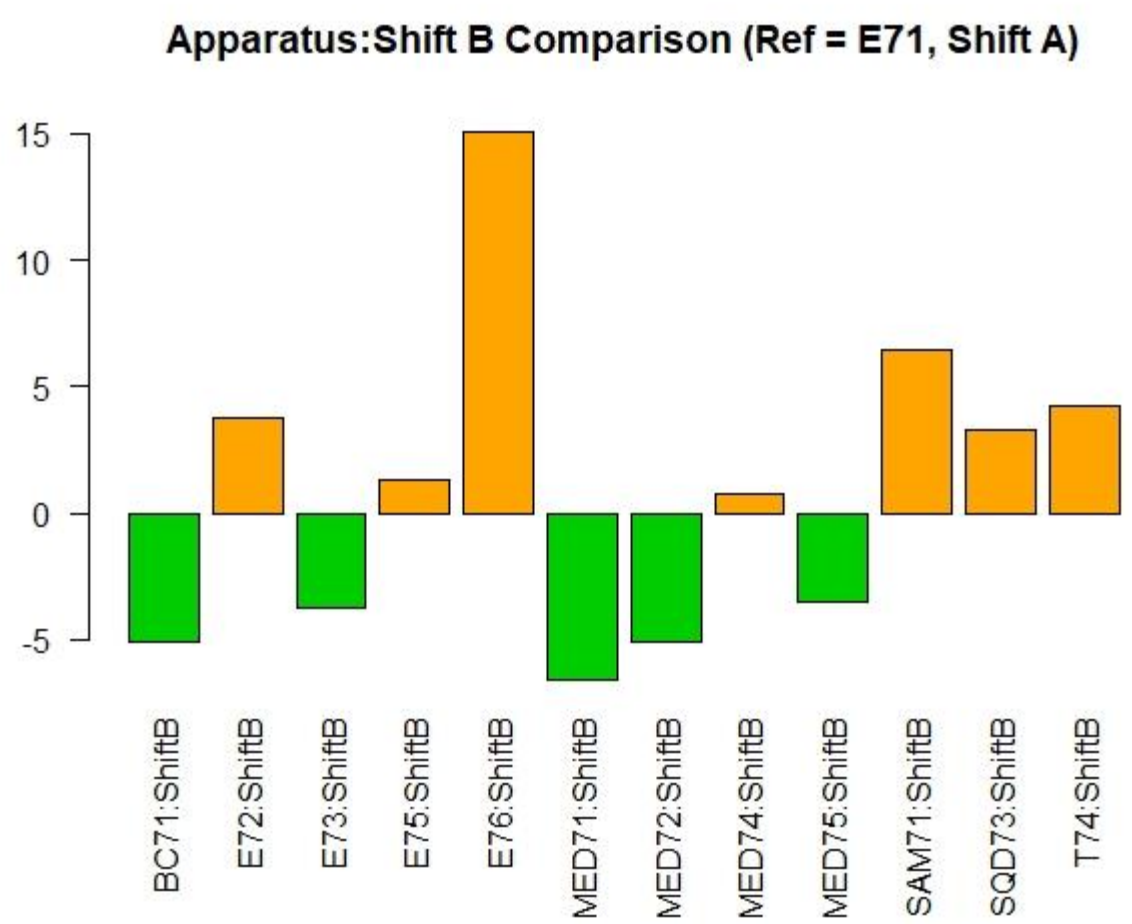

Initial Dispatch Code Comparison (Ref = Accident)
10
5
0
-5
-10
-15
ALARMF
ASUIC
AUTOAID
DEATH
EMS
EMS-ALPHA
EMS-BRAVO
EMS-CHRL
EMS-DELT
EMS-ECHO
EMS-OFC
EMS-OMEG
FIRE
HAZMAT
RESCUE
SERV
SHOOT
STAB
STRUCT

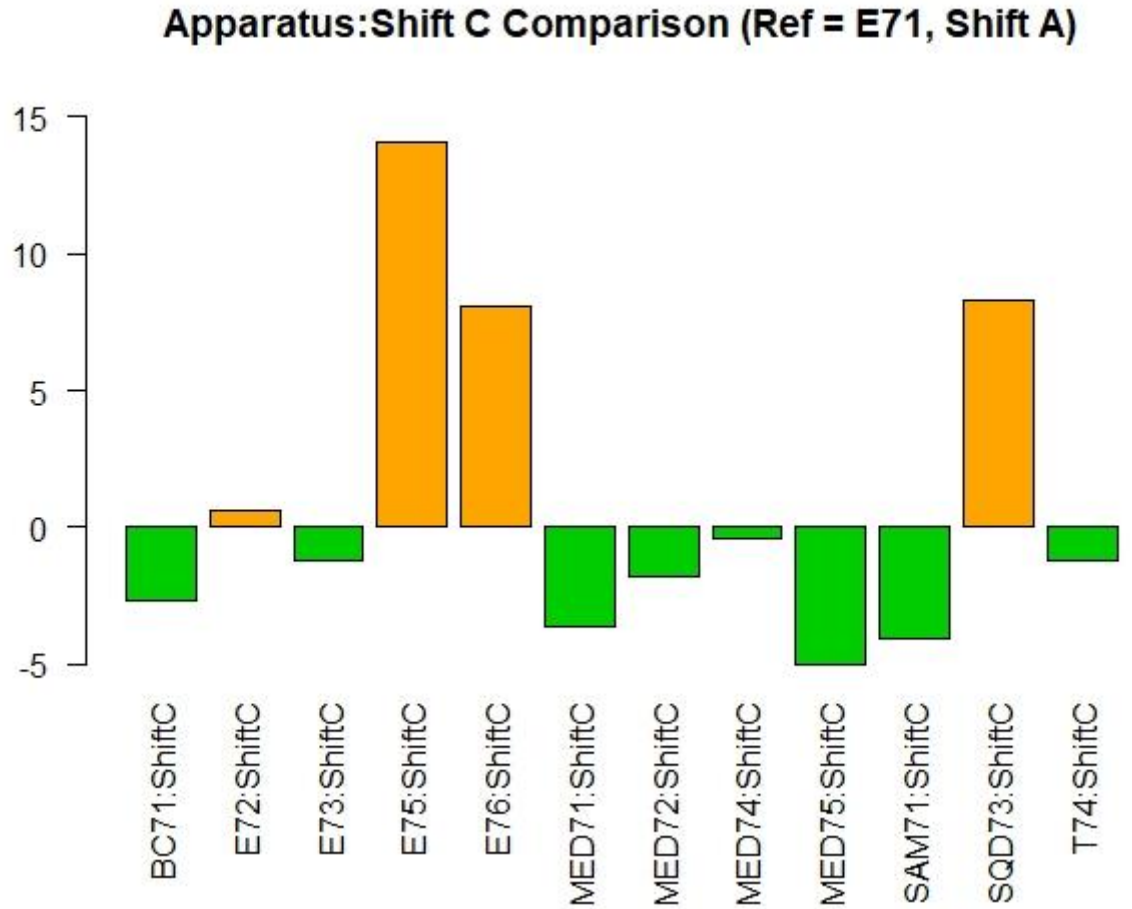
Results


Month Comparison (Ref = June)
20
15
10
5
0
-5
Jan
Feb
Mar
Apr
May
Jul
Aug
Sep
Oct
Nov
Dec

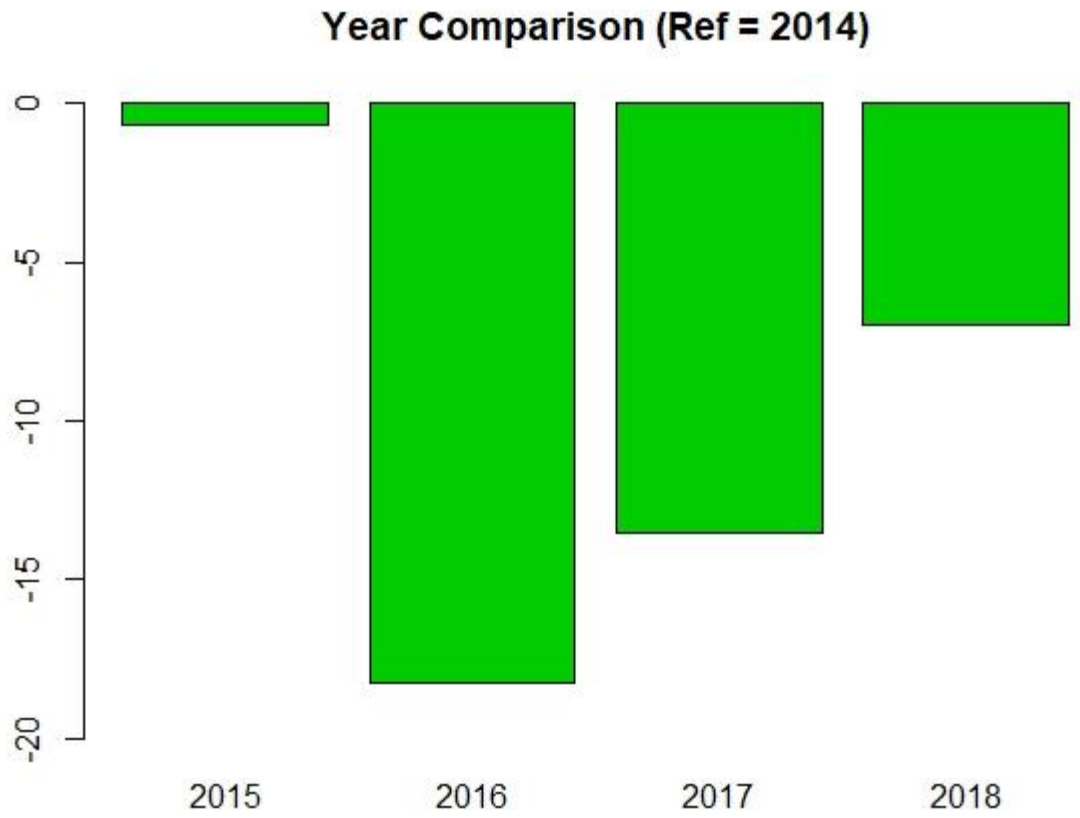

Time of Call Comparison (Ref = 7:00-7:59)
40
30
20
10
0
-10
-20
08:00-8:59
09:00-9:59
10:00-10:59
11:00-11:59
12:00-12:59
13:00-13:59
14:00-14:59
15:00-15:59
16:00-16:59
17:00-17:59
18:00-18:59
19:00-19:59
20:00-20:59
21:00-21:59
22:00-22:59
23:00-23:59
00:00-00:59
01:00-01:59
02:00-02:59
03:00-03:59
04:00-04:59
05:00-05:59
06:00-06:59

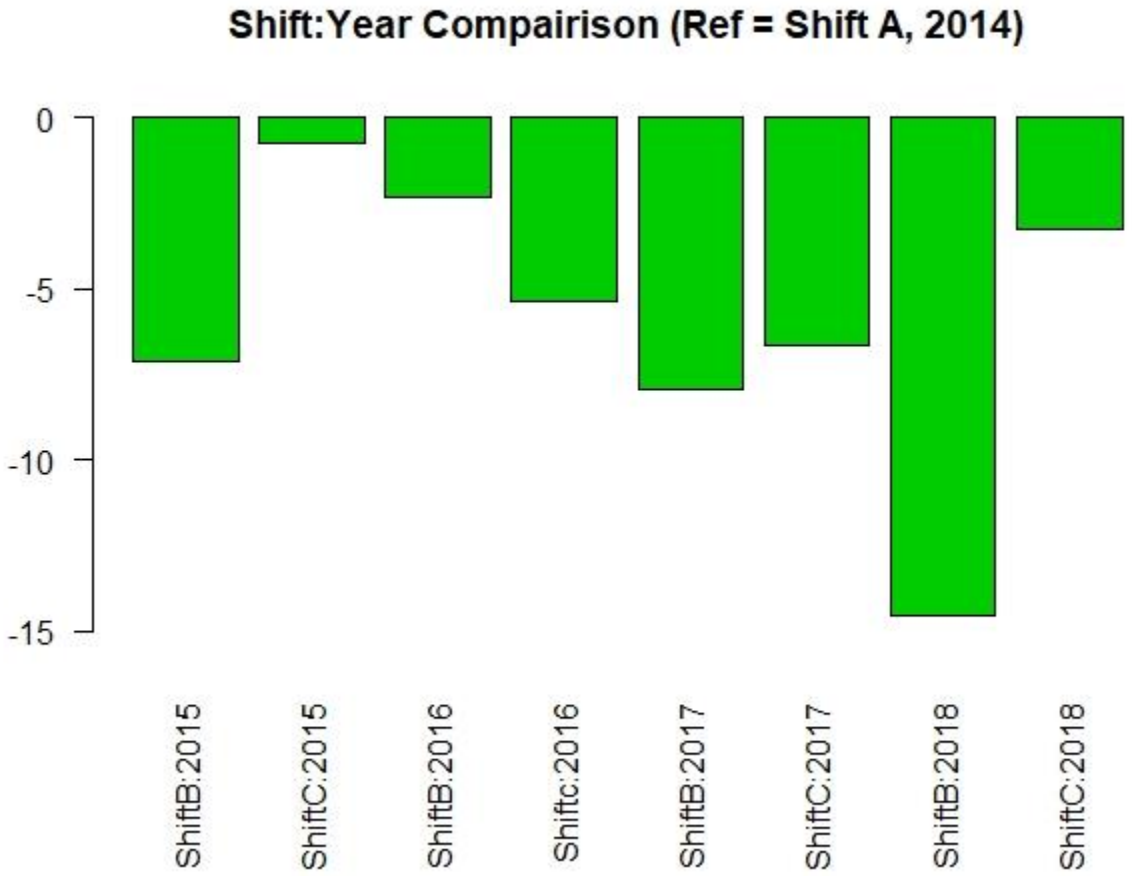
Results


Apparatus:Shift B Comparison (Ref = E71, Shift A)
15
10
5
0
-5
BC71:ShiftB
E72:ShiftB
E73:ShiftB
E75:ShiftB
E76:ShiftB
MED71:ShiftB
MED72:ShiftB
MED74:ShiftB
MED75:ShiftB
SAM71:ShiftB
SQD73:ShiftB
T74:ShiftB


Apparatus:Shift C Comparison (Ref = E71, Shift A)
15
10
5
0
-5
BC71:ShiftC
E72:ShiftC
E73:ShiftC
E75:ShiftC
E76:ShiftC
MED71:ShiftC
MED72:ShiftC
MED74:ShiftC
MED75:ShiftC
SAM71:ShiftC
SQD73:ShiftC
T74:ShiftC

Results


Year Comparison (Ref = 2014)
0
-5
-10
-15
-20
2015
2016
2017
2018


Shift:Year Compairison (Ref = Shift A, 2014)
0
-5
-10
-15
ShiftB:2015
ShiftC:2015
ShiftB:2016
Shiftc:2016
ShiftB:2017
ShiftC:2017
ShiftB:2018
ShiftC:2018

Results

- Turnout time has improved since 2014, but is increasing over the years
- Across the 5 years, Battalion Chief and Engine 76 are much slower than other Apparatus while Engine 75 is much faster.
- Across all years, Engine 76, Shift B and Engine 75, Shift C are 15 seconds slower than Engine 71, Shift A
- In 2018, Shift B was about 10 seconds faster than Shift C, 14 seconds faster than Shift A
- Rest time between calls has a positive association with turnout time, although not large in magnitude