Final Report: Boston Police District Analysis

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Introduction

Given the public sentiment on Boston police department corruption and large increase in overtime/overspending as seen in the articles on the right, the purpose of this report is to use exploratory data analysis to provide insights into the city of Boston spending trends, a deep dive into the Boston police department, as well as examine if the city crime incidents have changed given all the spending. Future scope of work would involve expanding the exploratory analysis and report to find correlations as well as provide inferences if the spending is justified.

Greater Boston area police double their base pay with overtime, detail work

Emma Plante, Reporter
March 15, 2021

In 2020, Capt. Richard McCusker of the Quincy Police Department made $263,000. The other top nine earners on Quincy's payroll were members of the police force and all made more than $225,000. Mayor Thomas Koch made $160,000.

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FOR IMMEDIATE RELEASE — Friday, June 4, 2021

Former Boston Police Sergeant and Officer to Plead Guilty in Overtime Fraud Scheme

BOSTON – A former Boston Police Sergeant and a former officer have agreed to plead guilty in connection with an ongoing investigation of overtime fraud at the Boston Police Department's (BPD) evidence warehouse.

Research Question Focus

With the exploratory data analysis, we seek to answer the following questions:

1. Understand Boston spending
    a. Where do most of the money in Boston get allocated to?
    b. What does the city employee pay over the years look like including overtimes?
2. Understand Boston police department spending
    a. What does the police department spend money on?
    b. Which department is taking the most overtime?
3. Understand Boston crime data
    a. How does the crime in the city of Boston look like over the last few years?
    b. Is there a relationship between crime volume and police department spending patterns?
4. Understand Boston shooting data
    a. What are the shooting trends in Boston?
    b. Is there a relationship between policing and shootings?
5. Narrow into a particular police district
    a. Similar or different trends when compared to the overall city?

Our Data

The two primary datasets we used are:

1. **Boston city spending data (employee earnings report)** Link: This dataset contains employee names, job details, and earnings information including base salary, overtime, and total compensation for employees of the City.
2. **Boston crime and shooting data (data.boston.gov)** Link: This dataset contains crime incident reports provided by Boston Police Department (BPD) to document the initial details surrounding an incident to which BPD officers responded to.

Both data sets are published by the department of Innovation and Technology.

Additional dataset to aid in the analysis:

- Boston Police District Map - Link: This data set contains city of Boston police districts Geospatial data.

Sample DataSet for Employee Earnings 2015-2020

NAME	DEPARTMENT_NAME	TITLE	REGULAR	RETRO	OTHER	OVERTIME	INJURED	DETAILS	QUINN/EDUCATION INCENTIVE	TOTAL EARNINGS	POSTAL	YEAR
Abadi,Kidani A	Assessing Department	Property Officer	44006.26	0.0	275.00	324.12	0.00	0.0	0.0	44605.38	2118	2015
Abasciano,Joseph	Boston Police Department	Police Officer	886.20	0.0	8088.35	544.83	81996.78	0.0	20667.8	110411.56	2132	2015
Abban,Christopher John	Boston Fire Department	Fire Fighter	101468.29	0.0	550.00	15146.51	0.00	5168.0	0.0	122332.80	2132	2015
Abbate-Vaughn,Jorgelina	BPS Ellis Elementary	Teacher	42919.31	0.0	0.00	0.00	0.00	0.0	0.0	42919.31	2481	2015
Abberton,James P	Public Works Department	Maint Mech (Carpenter)##	39768.17	0.0	126.00	13974.97	0.00	0.0	0.0	53869.14	2127	2015

Employee Earnings Field Definition and Description

Field Name, Data Type, Required	Description	Missing Values	Comments
Name, String, yes	Name of the employee working for Boston City	0	
Department_name, string, yes	Department associated with the Employee	0	
Title, string, yes	Title of the Employee	0	
Regular, string, yes	Base Salary and anything that does not fall into one of the other categories	4721	Missing values are cells replaced with 0 (refer assumptions made)
Retro, string, yes	Regular Retro earnings, Retro Overtime earnings	82939	Missing values are cells replaced with 0 (refer assumptions made)
Other, string, yes	Bonus, earnings related to special titles, skills or education and not related to hours worked beyond the normal workday schedule	46419	Missing values are cells replaced with 0 (refer assumptions made)
Overtime, string, yes	Billable overtime, Earnings beyond base salary that are based on length of service to the City	78893	Missing values are cells replaced with 0 (refer

	(career awards, longevity) AND related to hours worked beyond the normal workday schedule, Earnings beyond base salary that are based on specific time periods worked (night, day, weekend) AND related to hours worked beyond the normal workday schedule		assumptions made)
Injured, string, yes	Regular injured earnings	106101	Missing values are cells replaced with 0 (refer assumptions made)
Details, string, yes	Paid detail earnings	101434	Missing values are cells replaced with 0 (refer assumptions made)
Quinn/Education Incentive, string, yes	Renamed to be Education Incentive Earnings for CY2015; Includes Quinn, Edu Earns…Police Uniform EE only	106406	Missing values are cells replaced with 0 (refer assumptions made)
Total Earnings, string, yes	Total Earnings	2	
Postal, int64, yes	Postal/Zip code of the employee's work	99	
Year, int 64, yes	Year when this pay was received	0	

Sample DataSet for Crime 2015-2020

INCIDENT_NUMBER	OFFENSE_CODE	OFFENSE_CODE_GROUP	OFFENSE_DESCRIPTION	DISTRICT	REPORTING_AREA	SHOOTING	OCCURRED_ON_DATE
I100033064-00	2910	Violations	VAL - OPERATING AFTER REV/SUSP.	B2	304	NaN	2016-07-29 18:20:00
I090321958-00	3125	Warrant Arrests	WARRANT ARREST	C11	355	NaN	2016-02-01 01:43:00
I090321958-00	3125	Warrant Arrests	WARRANT ARREST	C11	355	NaN	2016-02-01 01:43:00
I050310906-00	3125	Warrant Arrests	WARRANT ARREST	D4	285	NaN	2016-06-05 17:25:00
I010370257-00	3125	Warrant Arrests	WARRANT ARREST	E13	569	NaN	2016-05-31 19:35:00

Sample DataSet for Shooting Details 2015-2020

Incident_Num	Shooting_Date	District	Shooting_Type_V2	Victim_Gender	Victim_Race	Victim_Ethnicity_NIBRS	Multi_Victim
I152000196-00	2015-01-01 13:30:00	C11	Non-Fatal	Male	Black or African American	Not Hispanic or Latinx	f
I152000879-00	2015-01-04 01:58:00	E18	Non-Fatal	Male	Black or African American	Not Hispanic or Latinx	f
I152001014-00	2015-01-04 18:52:00	E5	Non-Fatal	Male	Black or African American	Not Hispanic or Latinx	f
I152002232-00	2015-01-08 22:45:00	B2	Non-Fatal	Male	Black or African American	Not Hispanic or Latinx	t
I152002233-00	2015-01-08 22:45:00	B2	Non-Fatal	Female	Black or African American	Not Hispanic or Latinx	t

Crime and Shooting Field Definition and Description

Field Name, Data Type, Required	Description	Missing Values
[incident_num] [varchar](20) NOT NULL,	Internal BPD report number	0
[offense_code][varchar](25) NULL,	Numerical code of offense description	0
[Offense_Code_Group_Description][varchar](80) NULL,	Internal categorization of [offense_description]	138,503
[Offense_Description][varchar](80) NULL,	Primary descriptor of incident	0
[district] [varchar](10) NULL,	What district the crime was reported in	2,417
[reporting_area] [varchar](10) NULL,	RA number associated with the where the crime was reported from.	0
[shooting][char] (1) NULL,	Indicated a shooting took place.	351,798
[occurred_on] [datetime2](7) NULL,	Earliest date and time the incident could have taken place	0
[UCR_Part] [varchar](25) NULL,	Universal Crime Reporting Part number (1,2, 3)	138,600
[street] [varchar](50) NULL,	Street name the incident took place	11,207
[shooting_type_v2] [varchar](50) NULL,	Fatal or Non Fatal shooting	0
[victim_gender] [varchar](50) NULL,	Gender of the shooting victim	9
[victim_race] [varchar](50) NULL,	Race of the shooting victim	18
[victim_ethnicity_nibrs] [varchar](50) NULL,	Ethnicity of the shooting victim	24
[multi_victim] [varchar](50) NULL,	Multiple victims	0

Assumptions made for each dataset/analysis

- Boston City Spending data
    - The cells with null values for different earnings subsections were assumed to be 0, dataset from more recent years such as 2018 onwards the null data cells are filled with 0.
    - The *postal code* initially was thought to be postal code where the employee lived, but based on looking at the frequency of the same postal code showing up when compared to different Boston Police districts, it seems to suggest its where the precincts are located
    - *Year* column was added to the spending data from each year, to make the analysis easier to group yearly data and compare to previous and other insights etc.
- Boston crime and shooting data
    - *Offense code group* field was assumed as a good high-level group for offense description; however, given huge missing values we assumed the groupings were incomplete.
    - *SHOOTING* Field had to be cleaned up to Boolean values as there were a mix of integers and strings indicating if a shooting occurred.
    - We only used the shooting data set where there was an incident record available in the crime data set. This excluded 486 (30%) rows of data - Need further investigation into why this exists.

Data Approach

The picture below shows the high level approach we took.

Data

- **134,968** rows and **13** columns of Boston spending data from year 2015 - 2020
- **491,756** rows and **17** columns of Boston crime data from year 2015 - 2020
- **1,586** rows and **8** columns of Boston shooting data from year 2015 - 2020

Data Cleaning and Methods

Across both data sets, the following actions were performed to get the data ready to be analyzed.

Cleaning Needed	Cleaning Methods
Merging all the files from 2015-2020	Converting the csv files to the correct encoding from UTF-8 to ISO-8859-1 to make all the csv similar type
Filling empty cells with Nan/0	Using fillna
Cleaning needed for converting numerical values in strings to float	Using astype()
Grouping dataframe wrt. To -year, total earnings, overtime, postal code, title, department name	Using group () by and then agg()
Sorting all the data frame from groupby to get the right dataset to plot	sort_values() with ascending=false
Merging all the files from 2015-2020 to create all shooting dataset	Converting the csv files to the correct encoding from UTF-8 to ISO-8859-1 to make all the csv similar type
Filling empty string cells with Not Available (Ex: District, Offense Code Group)	Using isnull()
Create incident year field based on incident date	Using dt.strftime

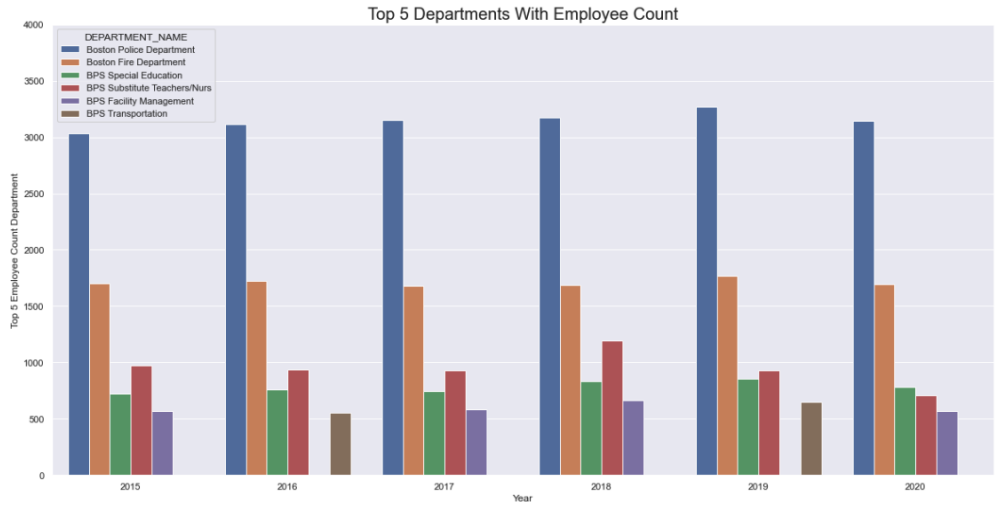
Data Analysis

Boston City Spending Analysis

City of Boston employs over 20,000 employees each year, of that from the data analysis it seems Boston police department, Boston Fire Departments, Boston Public Education, Boston Public School Substitute Teachers /Nurse, Boston Public School Facilities Management and Boston Public School Transportation departments are the top 5 departments with close to 50% of total employee count for the city as shown below.

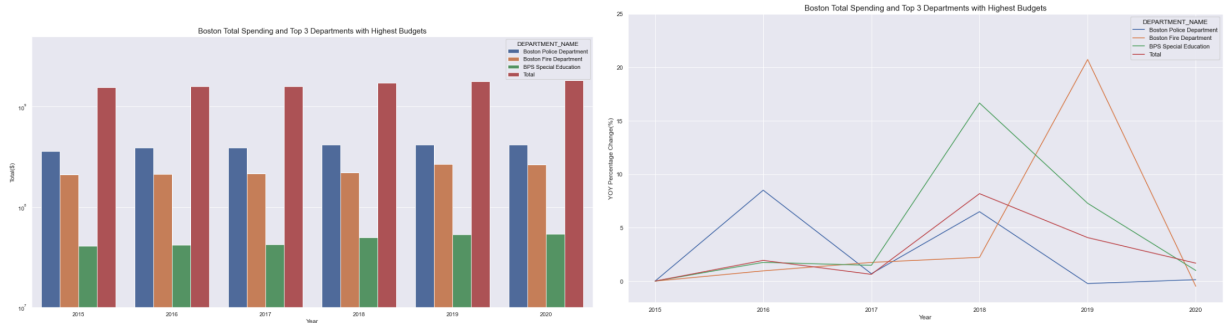
Fig(Total employees by year 2015-2020)

Fig.(Total employees count from top 5 departments with most employees 2015-2020)



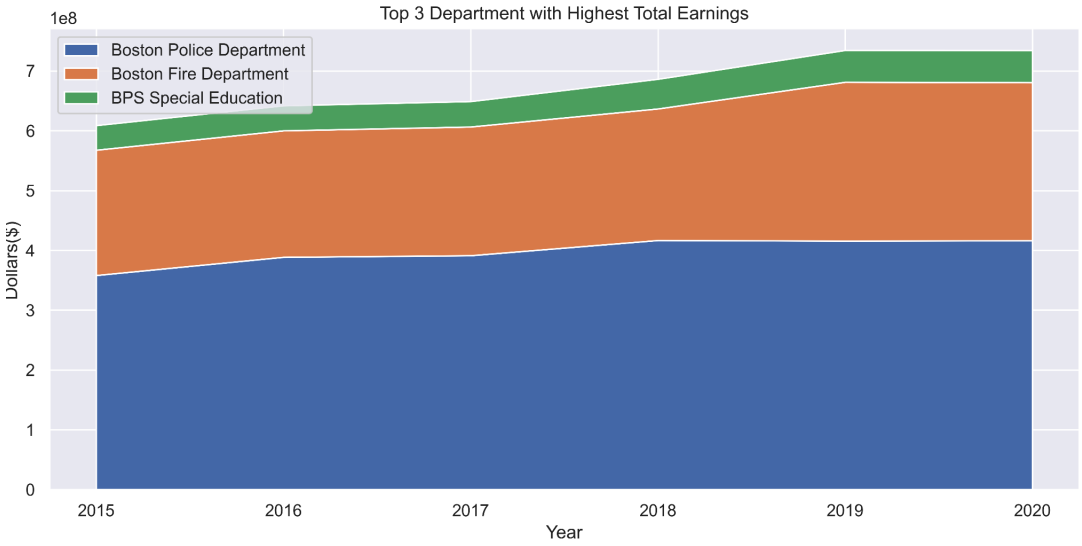
The next step in the analysis was to look at the overall money spent by Boston city over different departments and looking at the distribution of the money spent over the last 5 years. In total Boston has spent over $1.5 Billion dollars every year since 2015 and the amount of money spent does increase from 2017 to 2019 by 12%.

Fig.(Share of spending for top3 departments and comparing with total)



The top 3 spenders of the Boston cities money are Boston Police Department, Boston Fire Department, and the Boston Public School Special Education department.

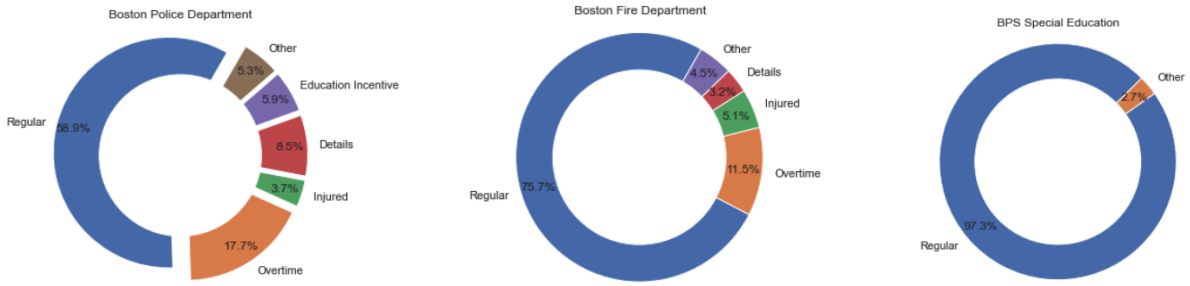
Fig.(Share of spending for top3 departments YoY comparison)



Key Highlights about spending of the top 3 department:

1.) Top 3 departments combined spend over 50% of the total cities budget
2.) Boston Police department is the largest share of the total money spent by the Boston City
3.) Boston FD and Boston public schools share are less than 50% of the total of Boston PD

Fig.(Share of spending for each department for total earnings)



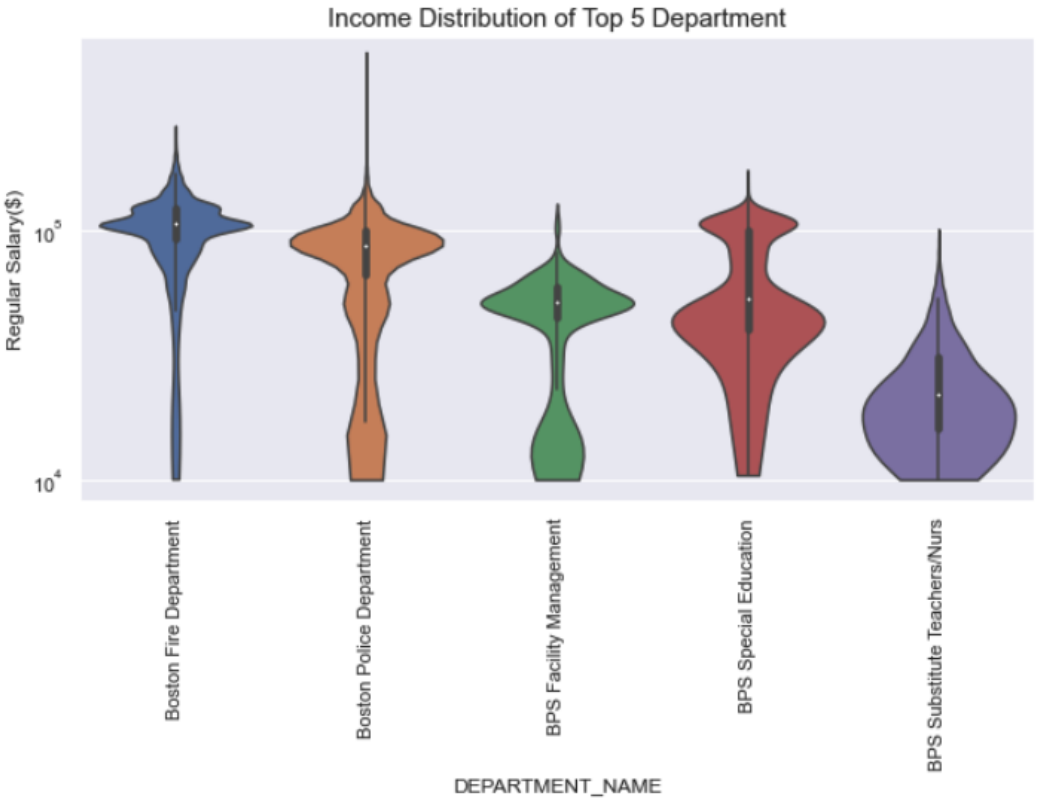
We wanted to get further insights into where is the money being spend on BPD, BFD and BPS special education departments

Key Highlights:

1.) Boston Police Department
    a.) Majority of the split in the money for BPD comes from the regular pay, which is also the base pay for the employees
    b.) BPD does have over 17% of the total income coming from overtime charges, which is the highest among all the other departments compared to in this analysis
    c.) Third largest share of the income comes from details, which are income received from detailing services which the BPD provides such as security, special events etc.
    d.) BPD is the only department which seems to offer education incentive, this incentive is part of the BPD program for the police force to learn and grow to more senior roles
2.) Boston Fire Department
    a.) Big share of the income received by the BFD employees are in the form of the regular or base salary and accounts for over 75% of their total income
    b.) BFD shares the second highest overtime pay share compared to BPD at 11.5%
    c.) BFD does have higher incidence of injury pay, Fire safety is a dangerous job, and it seems few BFD fire fighters are getting injured in the job.
3.) Boston Public School Special Education:
    a.) BPS special education department's majority of the pay is in the form of regular pay, it seems the employees in the BPS special education department does get paid higher wages (more analysis in next few pages)
    b.) Rest of the income stream for BPS special education is in the form of others which refers to supplies, mileage etc.

Having seen how Boston's city is spending its money, we want to dive deeper into understanding the income distribution of the top 5 departments of the city of Boston. The key inspiration behind this analysis is to understand what the income distribution is, and what are the different bins of the incomes coming in from different departments. And compare their averages to each other.

Fig.(Income distribution for top 5 departments)



Some of the key insights from analysis of income distribution for the top 5 departments in terms of overall Boston city spending in the last 5 years

Highlights:

1.) Boston Fire department has the highest mean salary among all the departments average at $135,181 with 75% of the employees making over $114,987. The top lieutenants in BFD max out at $332,626.

2.) The Boston Police department comes a very close second in-terms of mean salary at $126,393 compared to BFD. Majority of the BPD employees make over 75% makeover $75,654, which is slower compared to BFD, the police department doesn't shy away from the max payout at $684,441 which was received by a police officer who was injured while on the duty. BPD does have higher percent of police employees making over $172,553

3.) Though it looks like Boston public school maintenance department is third highest in-terms of the mean salary, the average salary was $47,362 for the maintenance department. The BPS special education department does have a higher mean salary at $59,906 compared to the maintenance department. It seems the bimodal distribution of the salary data shows a second peak around $97,485, which are mainly grouped with the teachers involved with the special education department. An interesting fact is it seems the teachers in the BPS system are well paid compared to the national averages.

After looking at the overall distribution of the total salary for the top 5 departments in Boston city, it is pertinent to look at who are the employees in-terms of job title who are making high salaries. We take 2 steps into this analysis, 1st step is to look at the top 5 titles with total salary over $100,000 and comparing it to the total population of the respective titles, following are the key takeaway from the 1st step

Highlights:

1.) Police officers, police detectives, Fire lieutenants and fire fighters make up most employee titles with total earnings over $100,000. YoY we see an increase for all this top positions
2.) Over 50% Police officers, police detectives from the Boston BPD make salaries over $100,000. Which is quite interesting, as national averages for police officers is around $65,000-$70,000.
3.) Almost 100% of Fire lieutenants from Boston Fire departments makeover $100,000, whereas the majority of the BFD's firefighters make over $100,000.
4.) Boston is known for its very good schooling districts, one data which corroborates this finding is the percentage of teachers who are making over $100,000, this is much higher than national averages, also we saw a jump in the total number of teachers making over $100,000 in 2018 and the number is growing ever since.

Fig. (Employee titles making over $100,000)

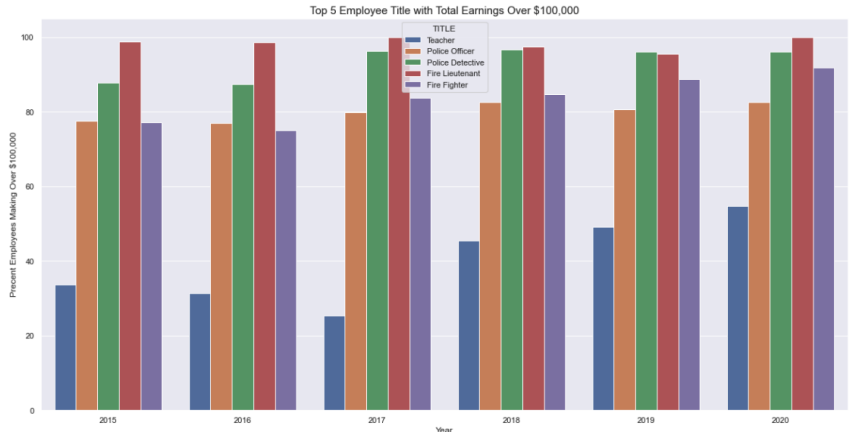
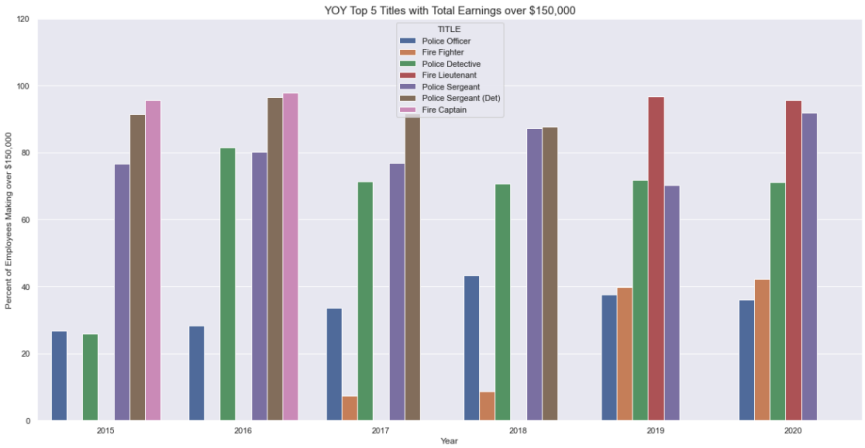


Fig.(Employee titles making over $150,000)



Second part of this analysis was to look at employees making over $150,000, as we noticed departments such as Boston Police and Boston Fire did show higher distribution of salaries in the higher ranges >$150,000. Following are the key highlights.

Highlights:

1.) Over 20% of police officers make salary over $150,000, and this fraction goes up YoY from 2015 to 2020, we need to analyze the data in depth to understand what fraction of it comes from overtime
2.) Vast majority of police detectives make over $150,000, and this number increased in 2015 and from 2016 onwards over 70% of the detectives make $150,000. We will need to do further analysis of the data to understand what fraction of this is coming from overtime
3.) Majority of the employee making over $150,000 comes from the Boston police department

It seems key distinction from departments which are well funded vs may not be attributed to how much overtime payment each department gets, as we dissect into the data to better understand this, the next step in the data analysis process for the Boston city spending is to look at overtime payments, since that is the key research interest for us in this data analysis project. We want to glean at the overtime payment data and understand which departments are the key patrons.

Fig.(Top 5 departments with highest overtime YoY)

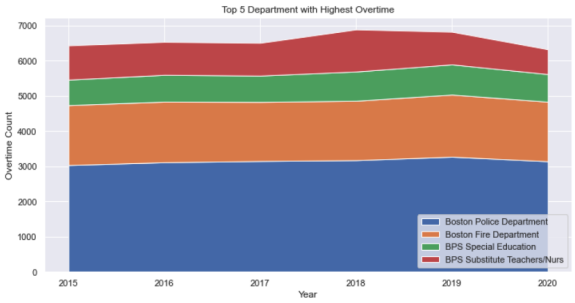


Fig.(Employee titles with most overtime)

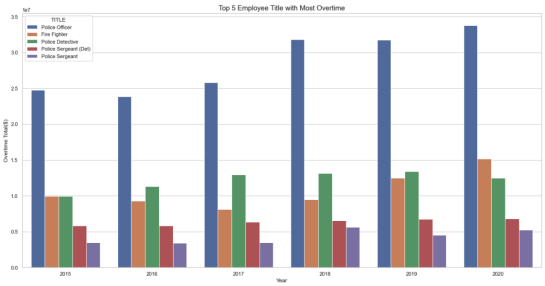


Fig.(Top 5 departments with highest income from OT)

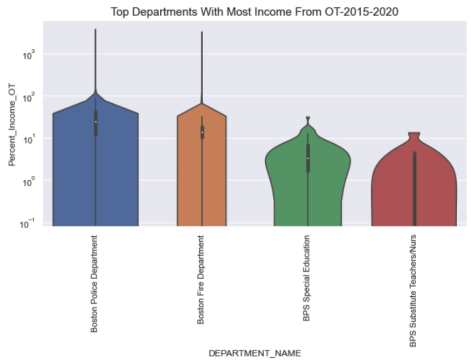
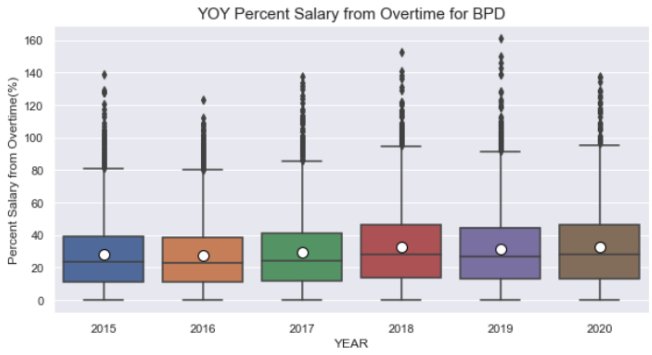


Fig.(YoY salary from OT for BPD)



Highlights:

1.) Boston police and Boston Fire departments are leading in terms of the total overtime counts (this is count of total overtime each employee received in the respective departments YoY), looking at the fraction of the Boston police department vs Boston fire department, it suggests these two-department combined consume majority of the overtime pay, Boston public school system

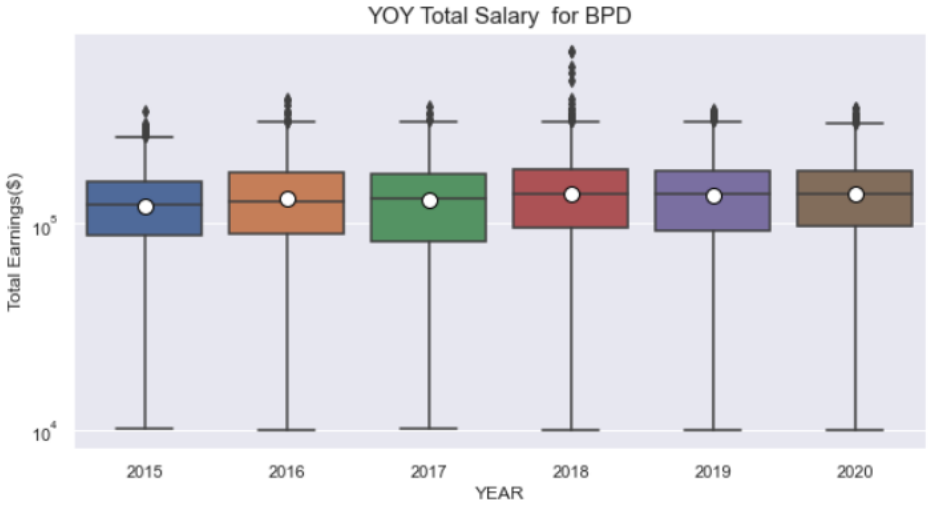
combined makes up fraction of the total overtime compared to Boston police department and Boston fire department

2.) To better understand the fraction of the total income earned from overtime, we created a new column in the data frame which would calculate the amount of overtime pay for each department, Boston police department averages over 30% YoY in percent of the income stream from overtime pay, and over 25% of the employees make over 43% of the total salary in overtime for the BPD

3.) There is an increase in percent pay YoY for Boston Police Department overtime, especially the year 2018 & 2019 there seems to have been higher instances of employees making OT over 100% of their regular pay.

So, from the analysis it seems Boston Police Department is the key player in terms of overall spending, we find that the Boston police department tends to have the one of the highest budgets, highest overtime pay and highest count in terms of employees making over $150,000. A YoY look at the police pay suggests there is overall increase, which is evident from the total overtime pay and year 2018 seems to have particularly higher instances of higher total earnings.

Fig.(BPD YoY salary distribution)

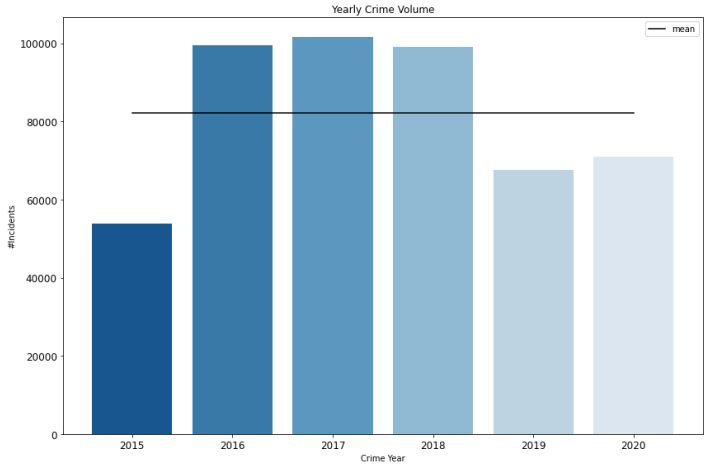


Since we have established Boston police department and Boston fire department combined take up over 50% of the total budget for the city, it be interesting to understand the key reasons behind some of the overtime, or other spending attributed to each of them. For the sake of time and scope of the project we only plan to focus this assignment on Boston's overall crime statistics and shooting data, to glean more insight into the whys of the increased pay and overtimes, since looking deeper into Boston fire would be beyond the scope of this work.

Boston City Crime Analysis

We began our incident analysis by looking at the trends in Boston. There were 491,756 various crimes reported in Boston from 2015 to 2020. Over that time the yearly average number of crimes was 82,094.

Fig: Yearly (2015 to 2020) Number of Incidents Reported

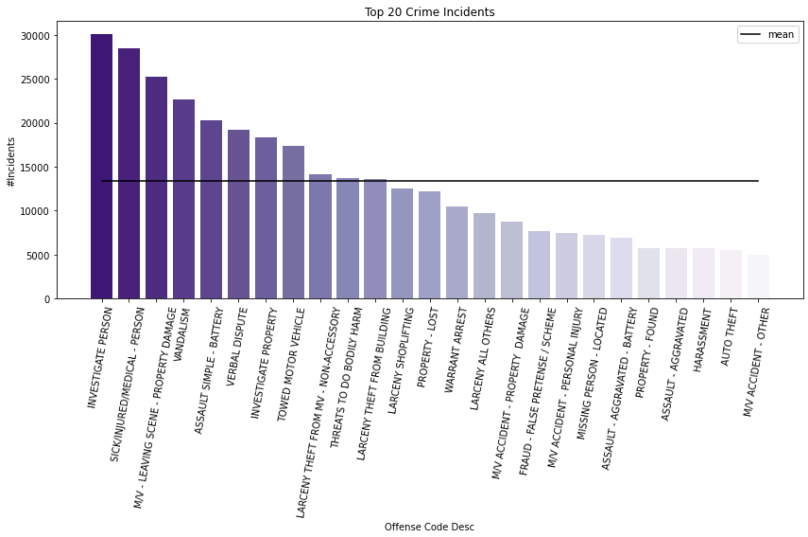


Key Highlights

- As seen in the chart above, the year 2016 to 2017 had the top 3 number of crime incidents reported which accounted for 60% of the total volume.
- The year 2017 was the highest number with 101,536 incidents reported.
- Following the large drop in reported crime incidents in the year 2019, the number of crime incidents reported went up again slightly in 2020
- The crime incident volume growth rate (CAGR) was 4.6% between 2015 and 2020

Next, we looked into understanding the various types of incidents within the period. The chart below, shows the top 20 incidents reported.

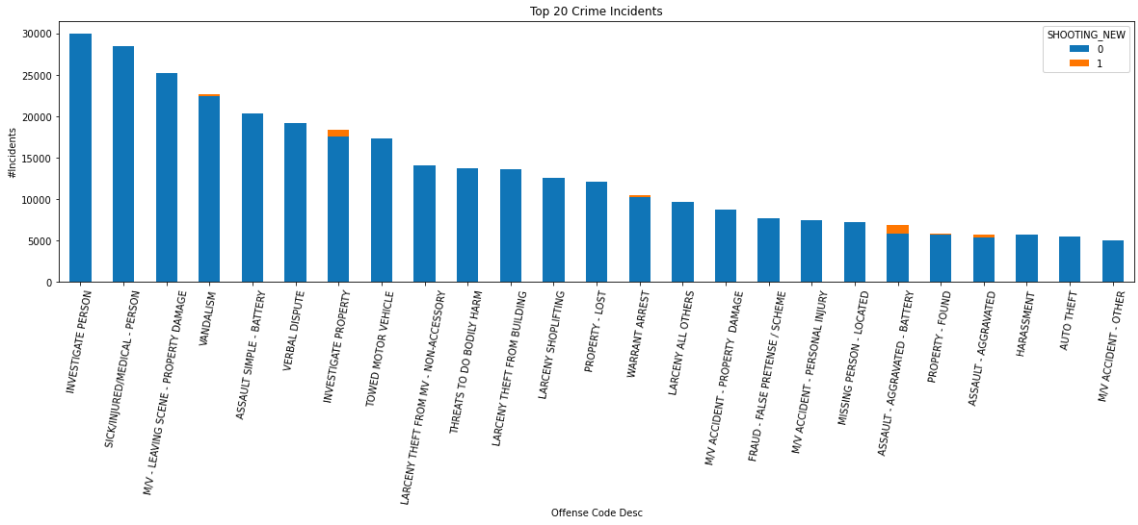
Fig: Top 20 Incident Description Volume



Key Highlights

- The average number of incidents per description was 13,346
- The top 5 incidents were: INVESTIGATE PERSON, SICK/INJURED/MEDICAL - PERSON, M/V - LEAVING SCENE - PROPERTY DAMAGE, VANDALISM, ASSAULT SIMPLE - BATTERY which were over the average number of incidents.
- A few of the incidents reported resulted in a shooting as shown in the chart below

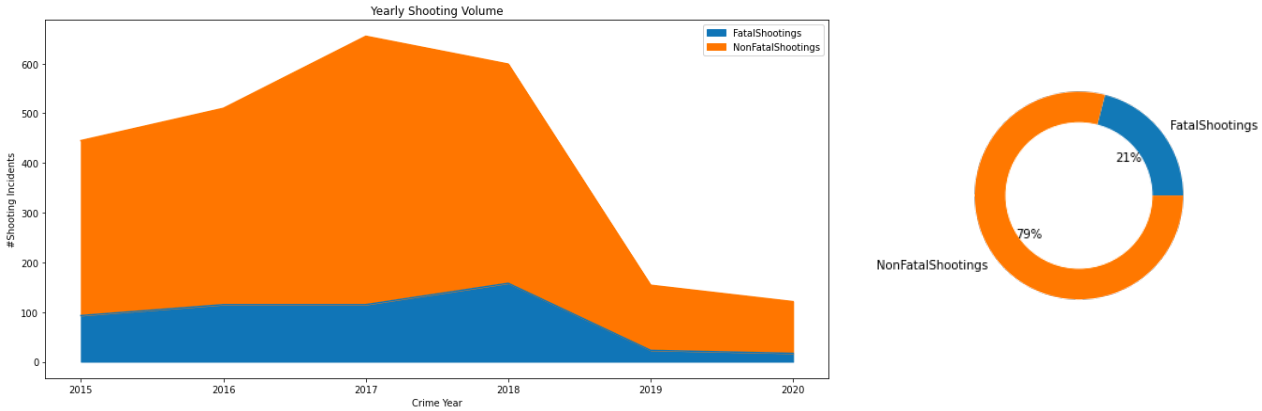
Fig: Top 20 Incident Description with Shooting Occurring



Boston City Shooting Analysis

There was a total of 4,028 shooting related incidents from the overall number of incidents reported. This makes up about 1% of the total number of incidents. To understand the impact and trend of the shooting related incident, we utilize the shooting data which had 2,484 details (60% of the total shooting incidents) on these shootings.

Fig: Yearly Shooting Incidents Reported (With Details)

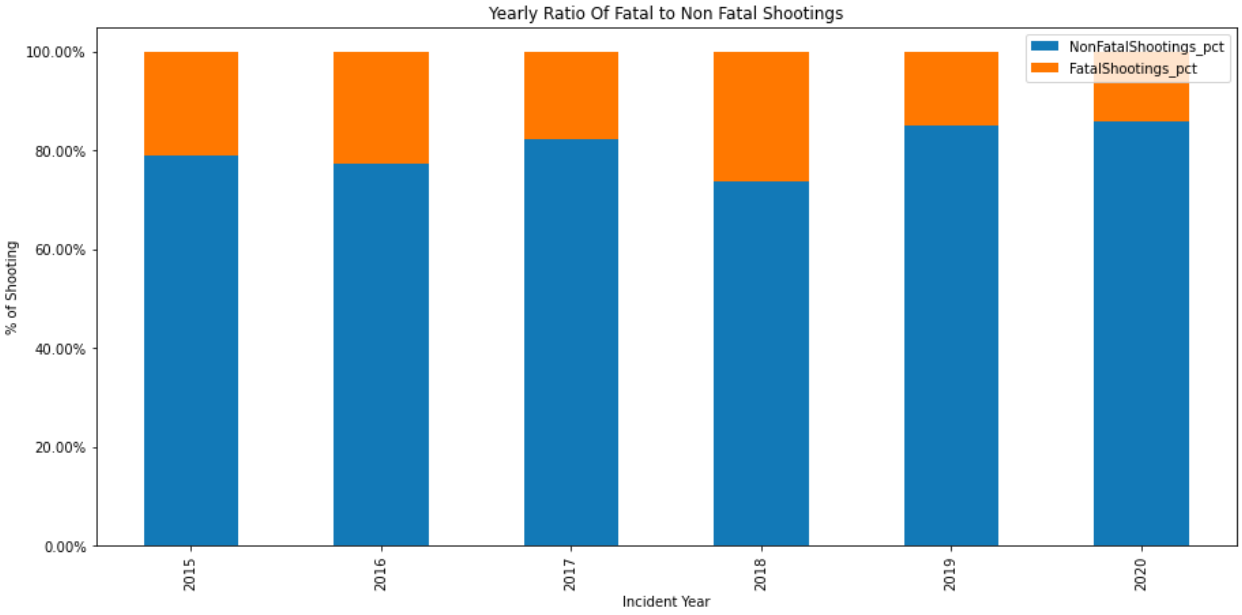


Key Highlights

- 2,484 shootings reported with details
- 21% (521) of shootings were fatal, resulting in a death
- 79% (1,963) of shootings were non-fatal
- Like the volume of incidents reported, the top 3 years with the highest volume of shootings were 2016, 2017 and 2018 respectively
- Year 2017 had the highest number of shootings with 655 incidents
- The average number of shootings was 414 incidents per year
    - 86 fatal shootings on average
    - 327 non-fatal shootings on average

Looking at the shooting data from a different perspective, we look to see if the rate of fatal shootings over the years has noticeable change. How deadly are Shootings over time?

Fig: Year over Year Ratio of Fatal to Non-Fatal Shootings



Key Highlights

- With 35% of shootings reported as fatal, Year 2018 was the deadliest year with 158 fatal shootings reported.
- Year 2020 had both the lowest volume of shootings as well as the year with the highest percentage of non-fatal shootings at 16%

What has Changed in the city of Boston over this time?

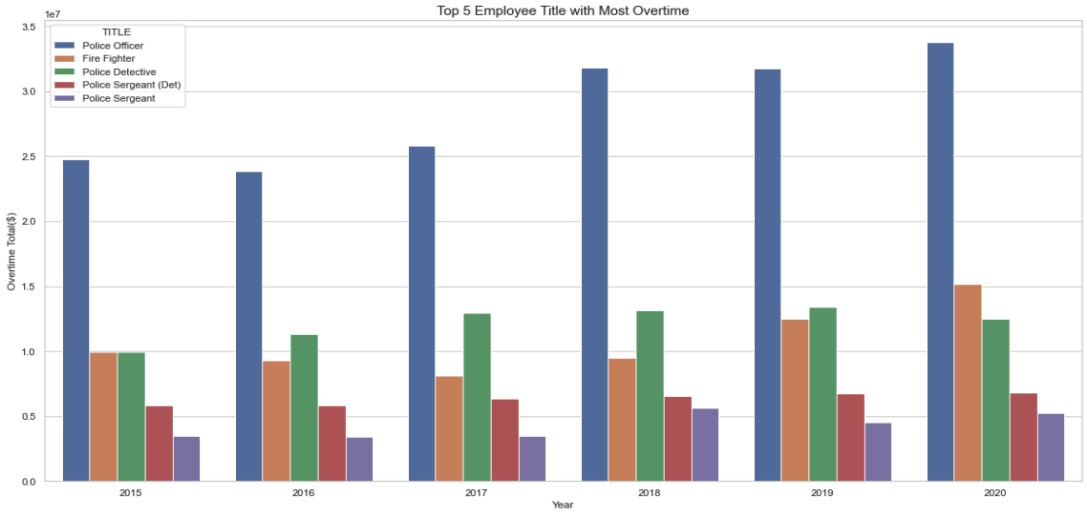
As seen in the first section, the Boston police department grew in both number of employees as well as spending through overtime during the year 2017, 2018 and 2019. We seek to understand if there were impact/changes in the volume of incidents and shootings reported for the same time period.

Fig: Year over Year Boston Police Department Employee Count

Key Highlights

- The police officer's employee growth rate (CAGR) was 1.6% between 2015 and 2020
- The police detectives employee growth rate (CAGR) was relatively flat at 1% between 2015 and 2020
- The average number of police officers was ~ 1300 and ~300 detectives

Fig: Year over Year Boston Police Department Overtime Spending

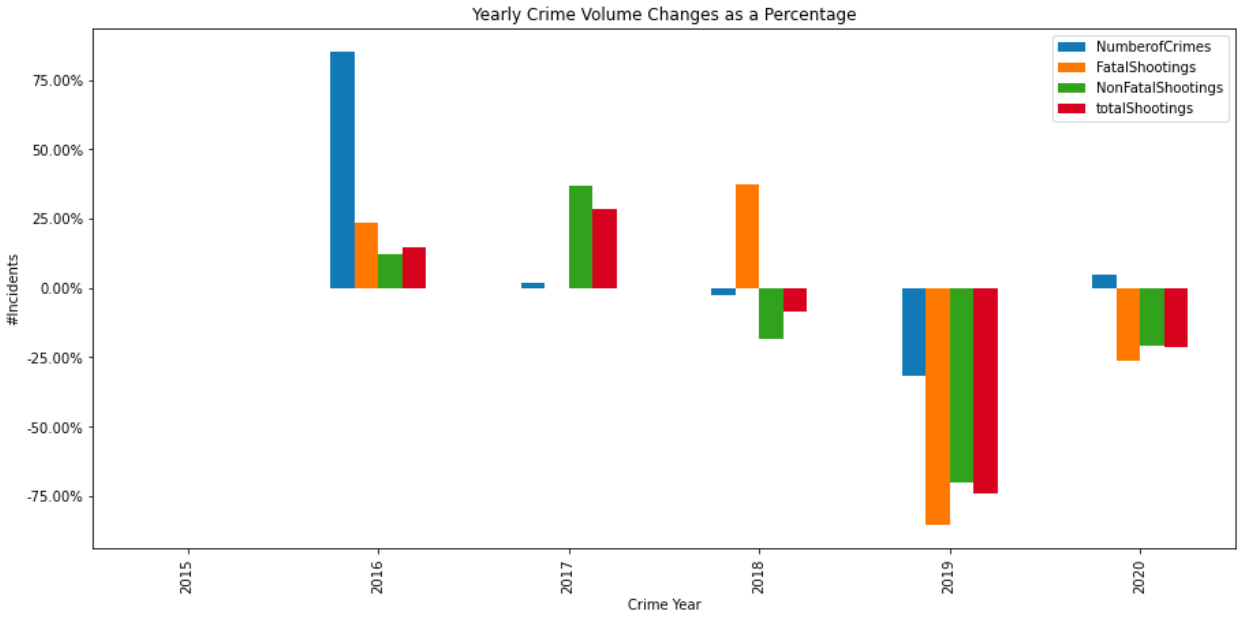


Key Highlights

- The police department overtime growth rate (CAGR) was 6.5% between 2015 and 2020
    - This was ~ 5x more than the employee count growth rate
- In the year 2018, we see a large increase in overtime spending. With the number of police officers staying relatively the same, overtime spending went up ~20% for police officers in 2018 compared to 2017.

Next, we looked at the changes in crime incidents reported over the same time period. Comparing the volume of crime incidents, shooting incidents and fatal shooting incidents from one year to the immediate previous year. (Ex: Compare volume of 2016 vs 2015, 2017 vs 2016 etc).

Fig: Year over Year Change in Crime Incident and Shooting Count



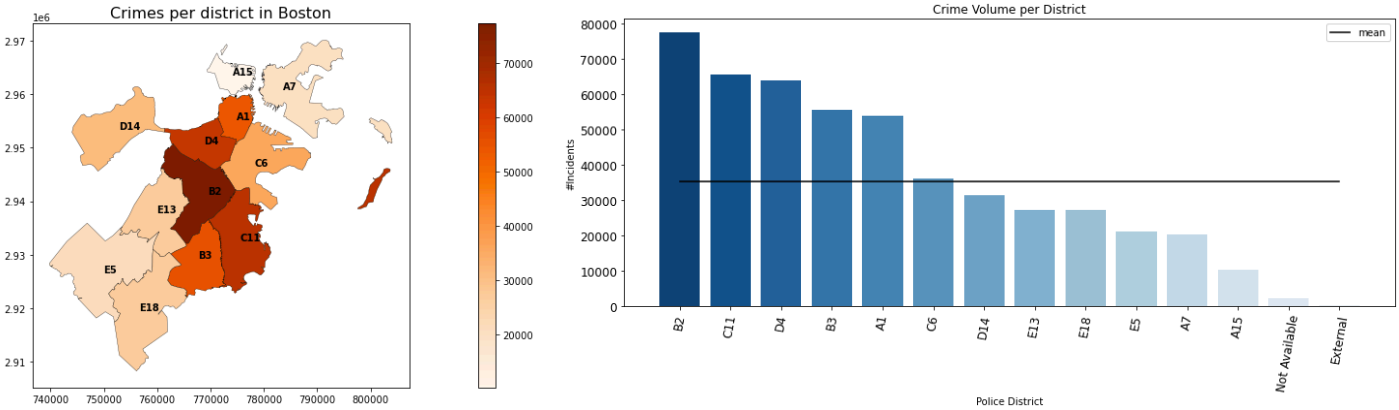
Key Highlights

- Year 2016 from 2015 saw an increase across the following categories:
    - 85% increase in reported incidents
    - 24% increase in fatal shootings
    - 15% increase in overall shootings
- Given the increase in police officers' overtime spend in the year 2018, we see the first decrease in the number of incidents reported and overall number of shootings since 2015.
    - 2.5% decrease in incidents but a 20% in overtime spending and relatively same number of police officers
    - However, as stated earlier, the highest increase in fatal shootings was also in the year 2018
- In the year 2019, we saw a sweep of reductions in incidents reported, shootings, as well as fatal shootings.
    - To recall, in 2019 the department sustained the number of police officers as well as overall overtime spending from 2018.
- However, in the year 2020, although this year had the highest spend in overtime payment, we only see a 5% increase in incidents reported.

Police District Analysis

We decided to look at a specific police district in Boston, to see if the overtime spending and reported incident/shooting volumes described above are consistent. To select the police district to focus on, we looked at what district responded the most to the incidents from 2015 to 2020.

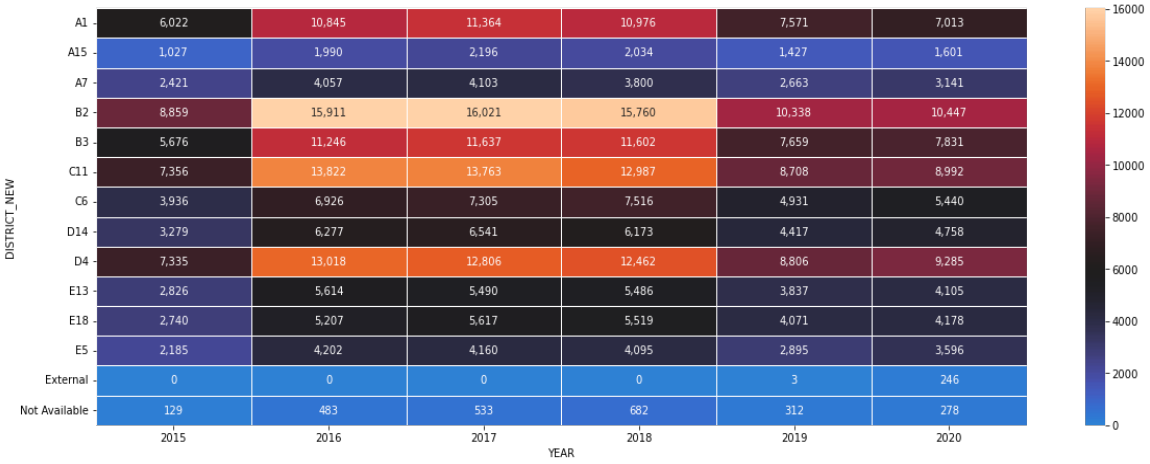
Fig: Count of Incidents by Police District



Key Highlights

- There were 5 police districts with incident reported counts higher than the average of 35,000 incidents per police district. These were:
    - B2 - Boston Police District B-2 Roxbury
    - C11 - Boston Police District C-11 Dorchester
    - D4 - Boston Police District D-4 Back Bay/ South End/ Fenway
    - B3 - Boston Police District B-3 Mattapan/ North Dorchester
    - A1 - Boston Police District A-1 Downtown

Fig: Year over Year Count of Incidents by Police District



Key Highlights

- District B2 has the highest number of incidents reported year over year
- Year 2016 to 2018 district B2 had the greatest number of incidents reported ever.
- The crime incident reported volume growth rate (CAGR) was 3.3% between 2015 and 2020 for B2

District B2 Analysis

Given the clear winner in terms of overall count of incidents reported, we focused on understanding both the trend in the number of police officers, overtime spending and incidents reported specifically for police district B2.

Fig: Year over Year Count of Police Officers in District B2

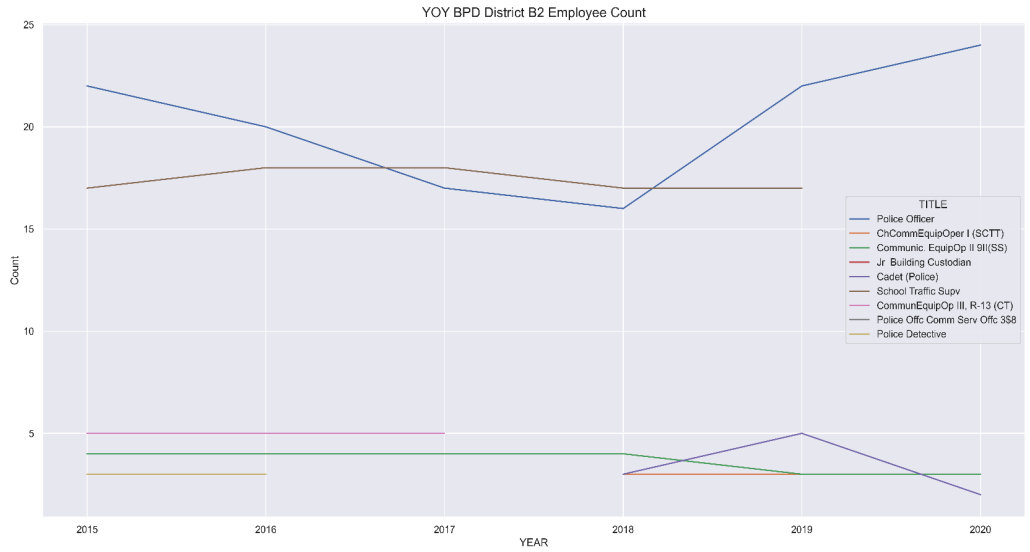
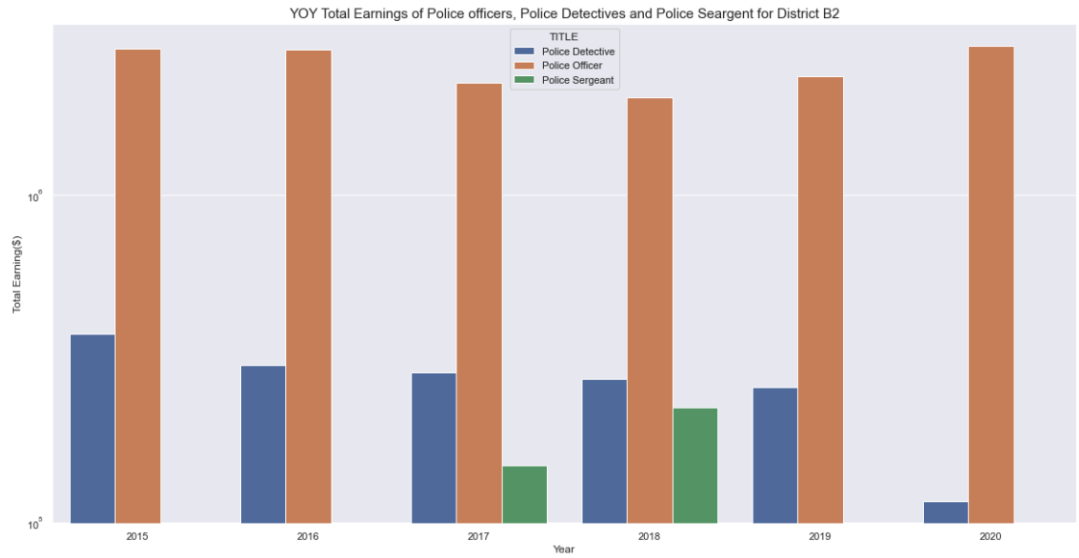


Fig: Year over Year Spending for District B2 Police Department

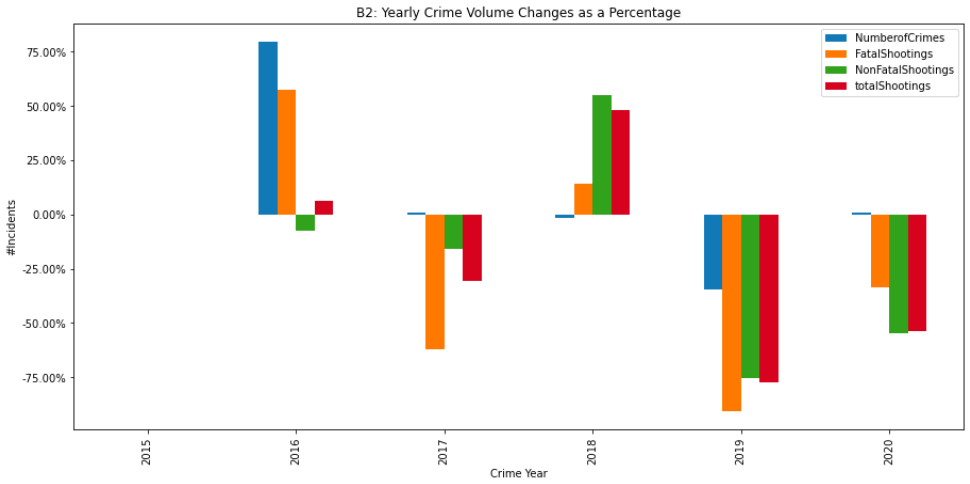


Key Highlights

- From 2015 to 2018, District B2 had year over year decrease in the number of police officers
- In the year 2019 and 2020, District B2 had a 9% increase in police officers respectively
- In the year 2018, District B2 had the fewest number of police officers seen from 2015 to 2020
- Spending in District B2 also showed similar trend as the number of officers

The next question became, given the trend in police officers and spending in district B2, what was the impact on incidents reported at district B2?

Fig: Year over Year Change in Crime Incident and Shooting Count for District B2



Key Highlights

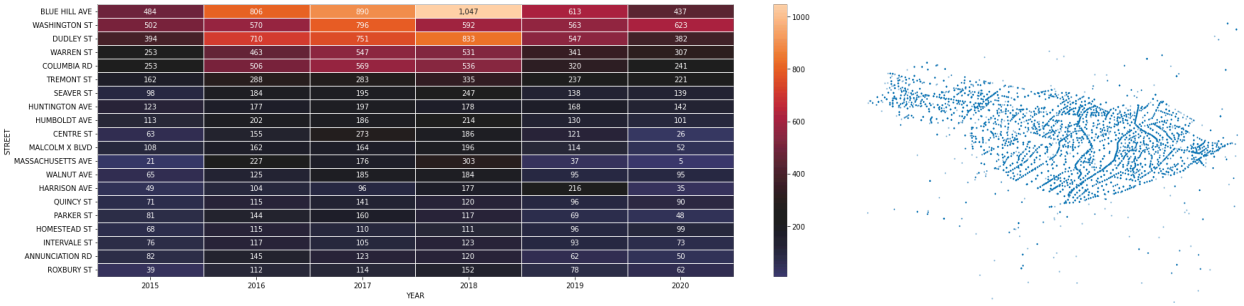
- Year 2016 from 2015 saw an increase across the following categories similar to Boston overall:
    - 79% increase in reported incidents
    - 57% increase in fatal shootings
    - 15% increase in overall shootings
- With the increase in police officers' numbers and overtime spending in the year 2019 and 2020. We noticed the opposite trend in incidents and shootings:
    - Decrease in the number of incidents, shootings and fatal shootings from 2018
    - These findings are similar to the sweep of reductions in incidents reported for the overall city of Boston

District B2 Incident Occurrence - Where it happened.

A quick look into the streets most incidents reported by district B2 police offices highlights Blue Hill Ave, Washington St and Dudley St as the top 3 locations over the years. The charts below are the top year over year incident occurrence street as well as a draft representation on street location on a longitude and latitude geo map

(Note: Data quality issues with the geo data - Needs further investigation and cleaning).

Fig: Top 20 Year over Year Incident Count by Street Occurrence for District B2 Police Department



Conclusion

Boston city spends on an average over 1.5 billion dollars each year on its public departments, of which Boston Police department (BPD), Boston Fire department (BFD) and Boston Public Schools (BPS) take up majority share in-terms of overall available funding. Between BPD and BFD, the city of Boston spends over 50% of its total budget on these two departments. YoY analysis shows among all the departments the BPS received a boost in its funding starting 2018, overall, there was an increase in the total spending for the year of 2018 and it drops off for 2019 and 2020.

Overtime pay is a big portion of the total earnings for both BPD and BFD departments, which is the cause for the very high total pay for the majority of the police officers and firemen for respective departments' YoY increase in salary for most of the BPD and BFD employees come in the form of increased overtime, as there is a steady increase in total overtime YoY for either department.

One key finding from this study has been the percentage of employees making over $100,000 for each department. Teachers, police officers, police lieutenant and fire fighters make the majority share in this sample, dissecting the data to understand the highly paid employees (>$150,000) majority are Police officers, police detectives, police lieutenant, fire chiefs etc. this is important finding as national averages are far below these levels. Employees who make over $150,000 majority share of their total earnings come from usage of overtime; this may suggest that the overtime usage is being abused by certain employees of the BPD.

The police officer's growth rate (CAGR) was relatively low at 1.6% between 2015 and 2020. However, we saw a 6.5% overtime spending growth (CAGR) within the same time period which was ~ 5x more than the employee growth rate.

Incidents reported on the other hand had a 4.6% volume growth rate (CAGR) between 2015 and 2020 with the Year 2016 having the biggest increase in incidents reported. The year 2018 also represents a big shift in Boston as we see a 2.5% decrease in incidents reported but a 20% increase in overtime spending and relatively the same number of police officers. However, to accompany the long hours worked, the year 2018 was also the highest number of fatal shootings for the city.

Future work for the spending analysis could be conducted to dive deeper into police district wise analysis, and which employee titles in each of the districts are the cause for increased spending for the police. Since there was a large increase in YoY spending for Boston public schools and Boston fire department, it would be insightful to understand where the extra spending went into. Another aspect which can be looked into is looking at the 99th percentile data analysis for overtime to understand who the employees are who are requesting a large share of overtime pay.

Further analysis to establish a correlation between the number of police officers, overtime spending and incidents should be conducted. The reason is to understand what the overtime spending is for given the YoY reduction in incidents responded/reported. Is the high overtime spending mainly related to general patrol given the reduction in incidents reported by police officers in Boston or is this part of the public sentiment of erroneous overtime charges with no reported crime/incident response.

Given we see opposite trends in overtime spending vs incidents reported by the Boston city police department, it prompts the question: what were the overtime spending for?