

CITY OF BOSTON: CITY BUDGET - TEAM D

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Introduction

The City of Boston annually determines both its operating and capital budgets. The operating budget is allocated for day-to-day expenses and encompasses various essential services and personnel such as teachers, police officers, firefighters, housing, recycling, and transportation. On the other hand, the capital budget, supported by diverse funding sources like bonds, city funds and grants is dedicated to acquiring or enhancing physical assets. These assets are financed through state, federal, or private grants. The primary focus of this project is to analyze the budget distribution among different departments and neighborhood, aiming to identify trends within funded projects. Through data analysis, we aim to shed light on changes over time in the funding of various departments, geographic areas, and other relevant attributes.

Methods

In assessing the project, we examined a substantial volume of data from diverse sources. These datasets encompass the FY24 Recommended Operating Budget, FY24 Recommended Capital Budget, FY24 Adopted Revenue Budget, the 2020 Census for Boston, along Boston Neighborhood Demographics spanning from 2015 to 2019. Additionally, we acquired an article addressing affordable housing in suburbs, senior housing, and zoning to enhance the clarity and depth of our analysis.

After processing missing values in the datasets, our initial focus was on the operating budget, where we determined the number of departments, programs, and expense categories. We identified the sum of each year's budget and the primary focus departments of the City of Boston

from 2021 to 2024. Subsequently, we conducted an analysis to determine the expense categories - such as Contractual Services, Equipment, Current Charges & Obligations, Personnel Services, Supplies & Materials, and others.

The same methodology was applied to the Capital Budget Plan. We identified the top 10 programs, top 20 projects, top 20 scopes of work with the highest expenses, and the most funded neighborhoods, providing a thorough exploration of budgetary allocations and priorities.

We then worked on the Revenue Budget and delved into the 2020 Census data and Boston Neighborhood Demographics for our extension project to gain a more comprehensive understanding of key economic and demographic factors. This step allowed us to contextualize our findings and establish meaningful connections between budgetary decisions and the broader socio-economic landscape of the city.

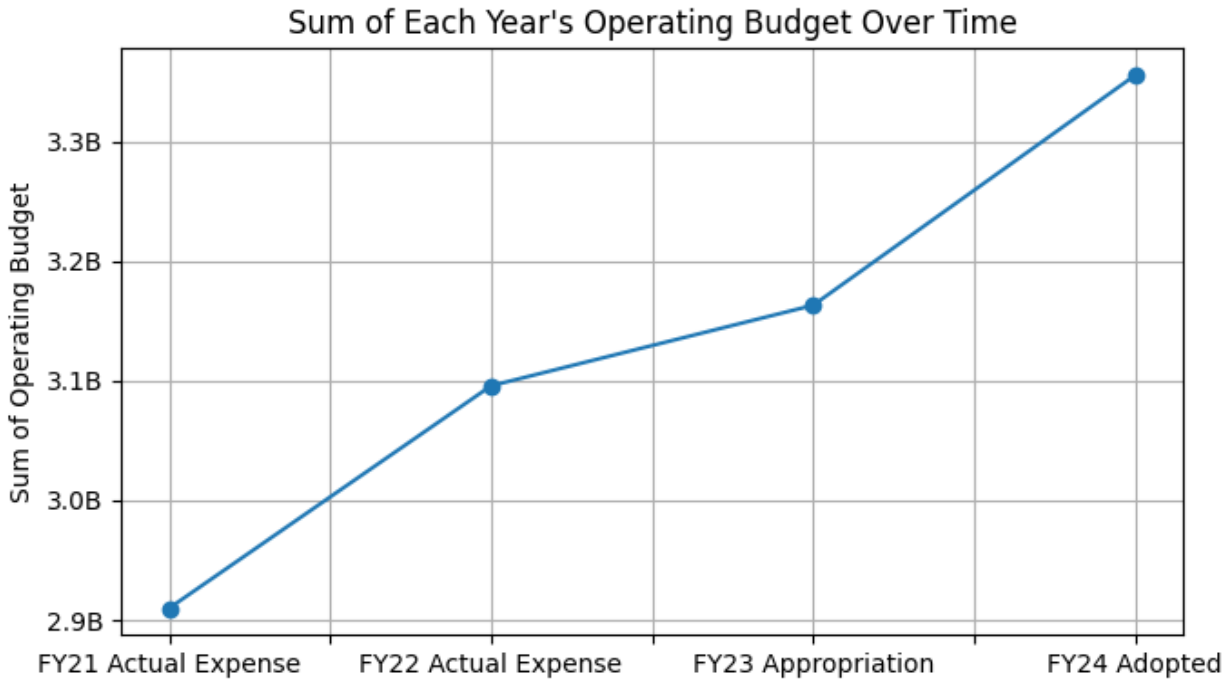
Our analytical processes were implemented using Python. To uphold transparency and facilitate reproducibility, we are including a comprehensive copy of all our Python code along with this report.

Base Analysis

1. Data: fy24-adopted-operating-budget.csv

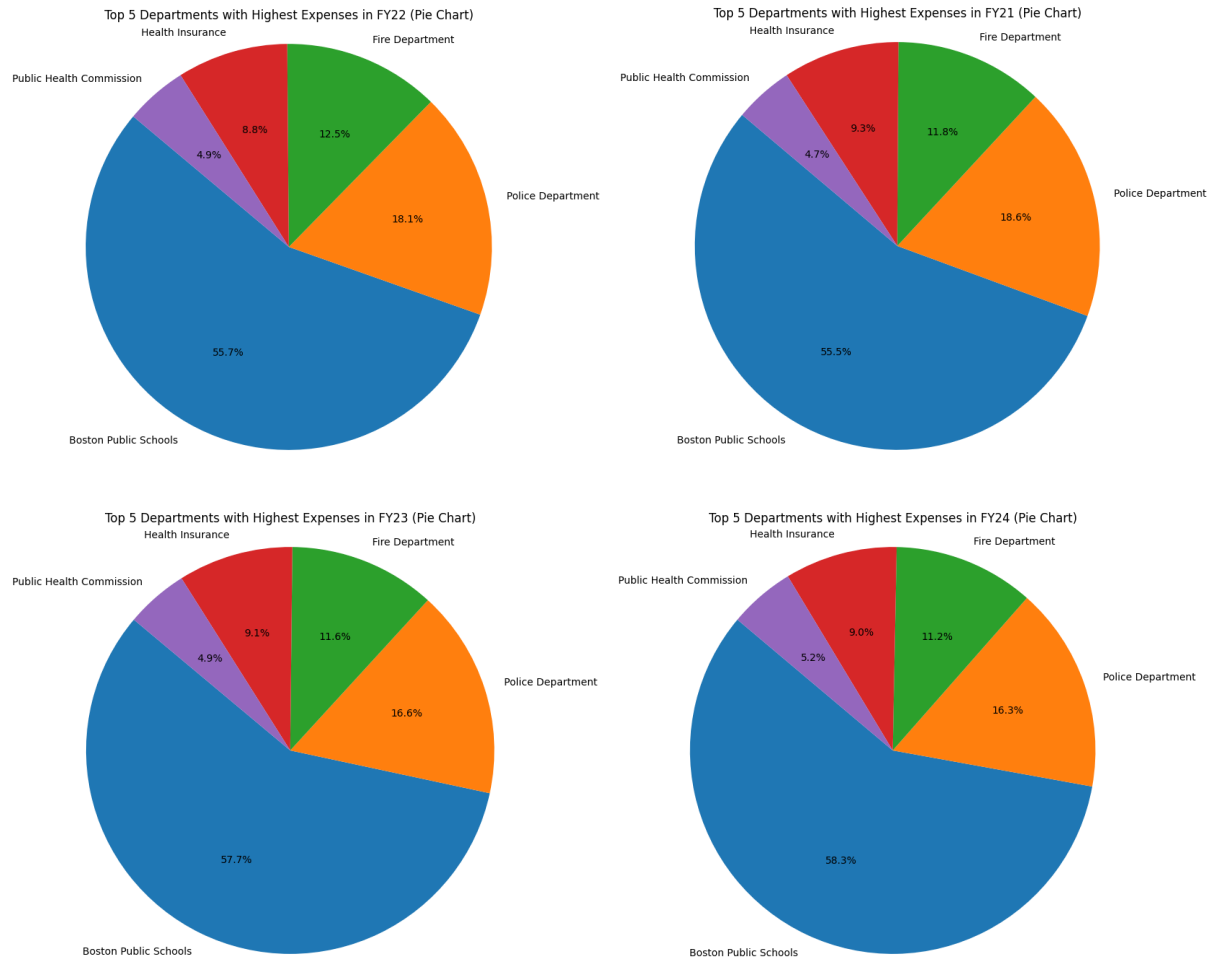
Key question #1: **How does the city of Boston spend its annual budget by department?**

First, we calculate the sum of each year's operating budget over time from FY21-FY22. The average annual increase in the annual budget is approximately **5.59%** per year. Specifically, there was a **6.56%** increase from 2021 to 2022, a **3.56%** increase from 2022 to 2023, and a projected **6.65%** increase from 2023 to 2024.



After that, we explore how the city of Boston spends its annual budget. The five departments that experienced the highest increases in funding from 2021 to 2024 were:

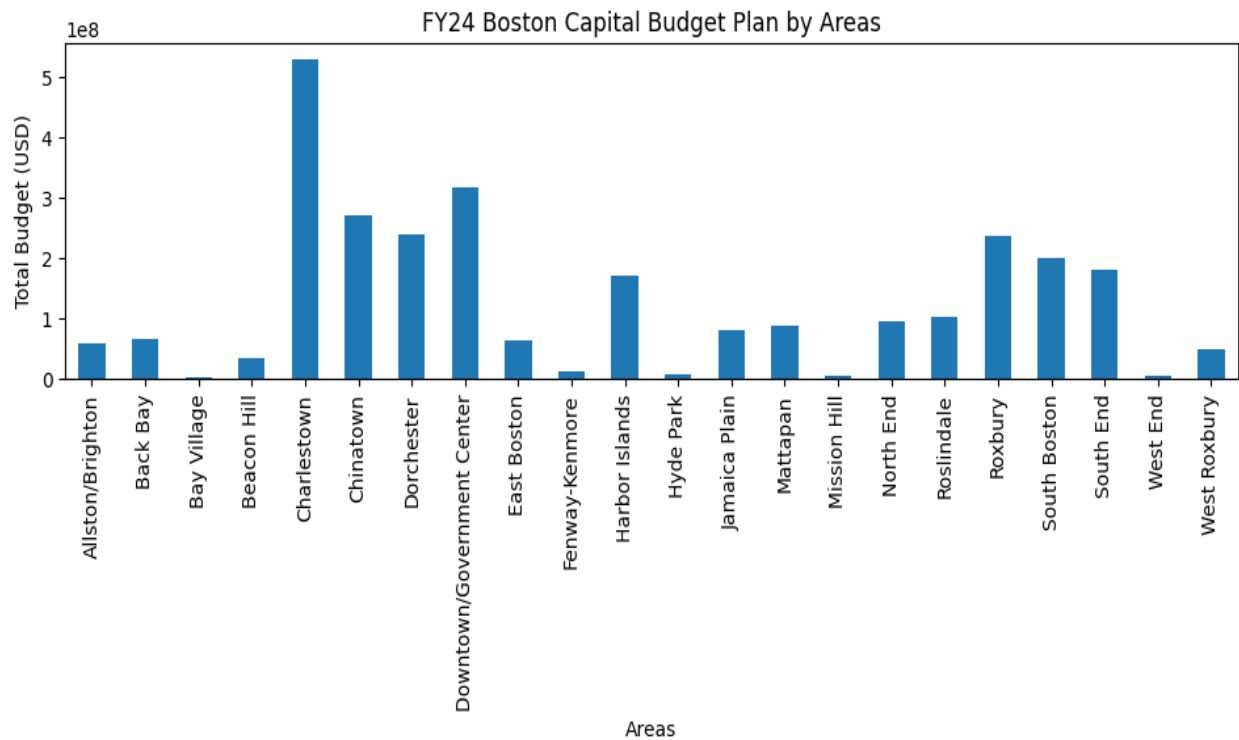
- Boston Public Schools (representing **55.5%**, **55.7%**, **57.7%**, and **58.3%** of the budget during this period, respectively).
- Police Department (representing **18.6%**, **18.1%**, **16.6%**, and **16.3%** of the budget).
- Fire Department (representing **11.8%**, **12.5%**, **11.6%**, **11.2%** of the budget).
- Health Insurance (representing **9.3%**, **8.8%**, **9.1%**, **9.0%** of the budget).
- Public Health Commission (representing **4.7%**, **4.9%**, **4.9%**, **5.2%** of the budget).



Key question #2: **How is spending allocated to different locations in the city?**

We observe that Charlestown stands out as the neighborhood with the highest investment, receiving roughly \$500 million dollars. Following Charlestown, we also observe significant investments in Downtown/Government Center, Chinatown, Dorchester, and Roxbury.

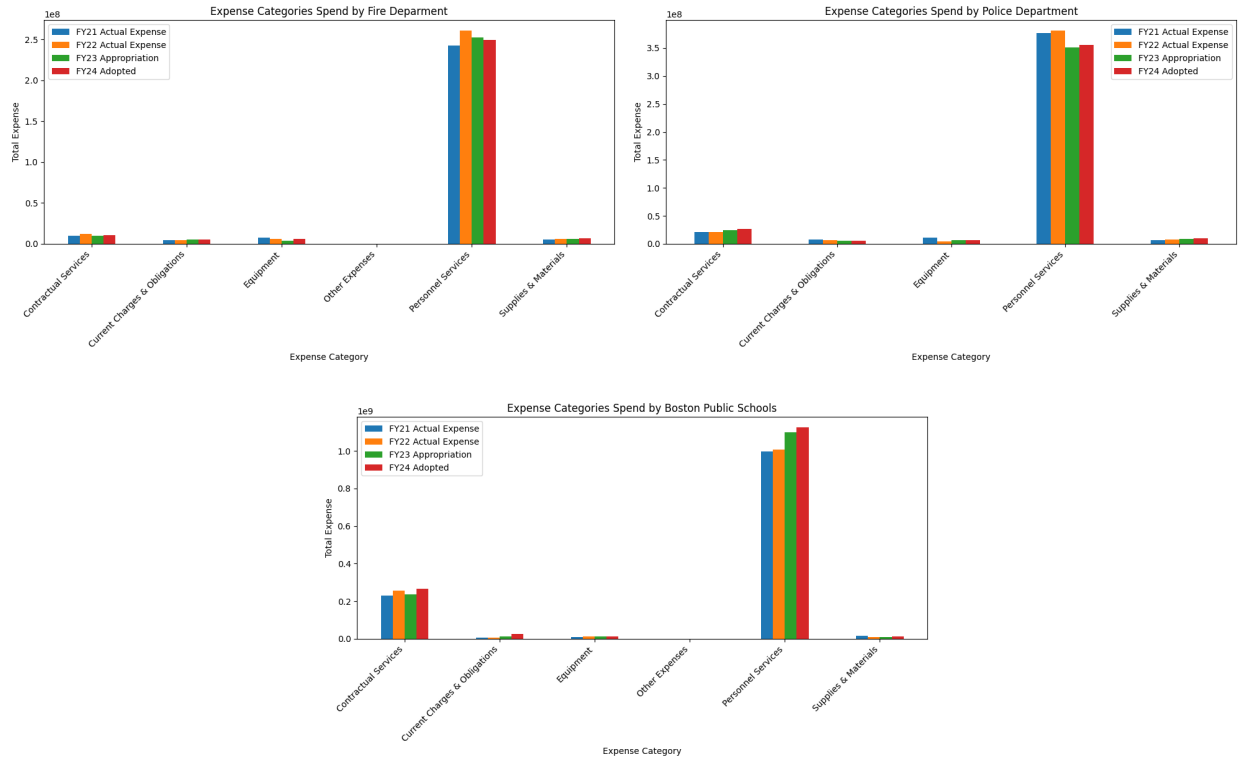
The exceptionally large number of investments in Charlestown may be due to the following reasons: 1. There are many budgets categorized as ‘citywide’ and due to the lack of data, we cannot determine the exact share by different neighborhoods of such budgets. We excluded all such data in our analysis. Charlestown may receive fewer such budgets because of its relative geographic isolation from other neighborhoods, which makes it less likely to receive a shared budget. 2. Charlestown has a relatively long coastline and huge projects related to bridges/harbors are found in the data. These infrastructure projects are usually huge in cost and they may be the causes of these exceptionally huge budgets allocated to Charlestown.



Key Question #3: Budget Allocation for Expense Categories

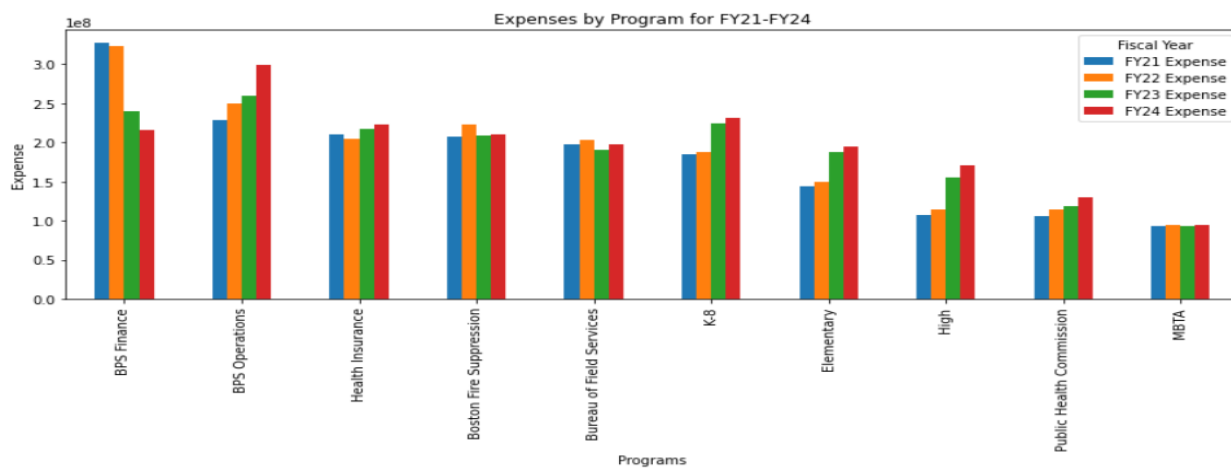
Thus far, we have determined that the Boston Public School, Police Department, and Fire Department allocate the majority of their budget to **Personnel Services**. This implies that the highest funding is directed toward the salaries, overtime, and benefits of teachers, police officers, and firefighters.

Furthermore, our bar charts illustrate that spending on Contractual Services ranks as the second-highest expense category. **Contractual Services** represent services procured to support departmental operations, such as telecommunications, utilities, and other operational services.



Key Question #4: Expenses by Program.

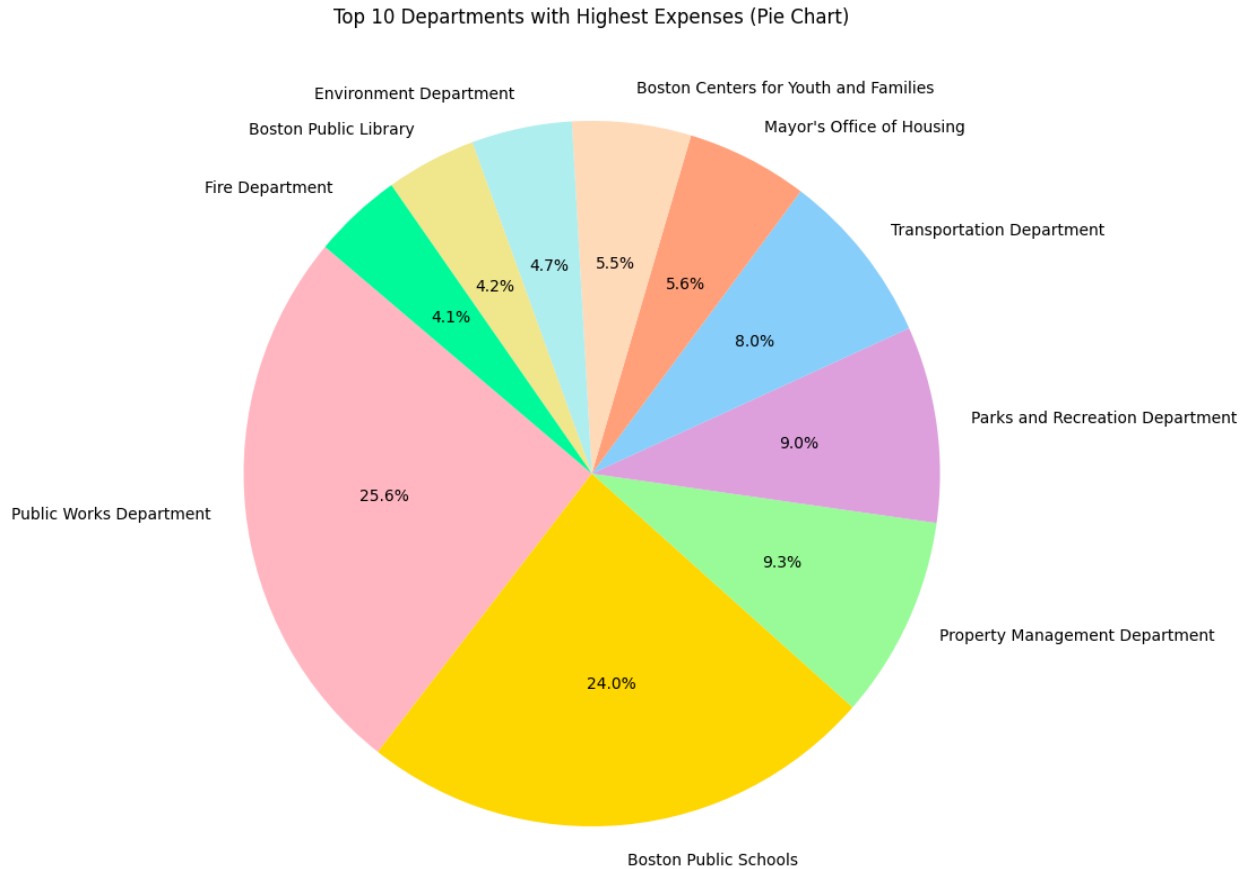
To provide a comprehensive overview of our financial allocations, we will delve into the breakdown of expenses by department and program. This detailed analysis will illuminate the distribution of funds, shedding light on how resources are allocated across various facets of our organization.



BPS Finance and BPS Operations represent the most generously funded programs in the City of Budget. It's noticeable that while BPS Finance experiences a declining trend in its operating budget, BPS Operations consistently receives increased investment every year.

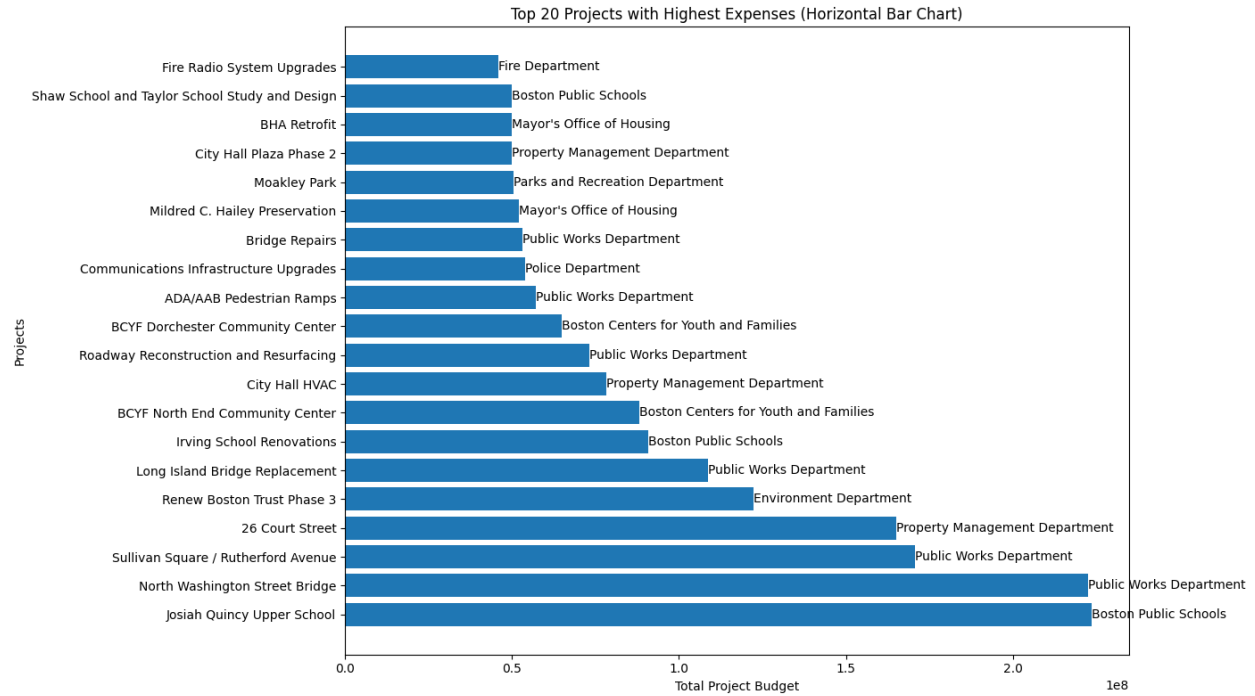
2. Data: fy24-capital-budget-plan-recommended.csv

For this dataset, we present an analysis of the Capital Budget data, focusing on key metrics, top programs, projects, and scopes of work. The dataset encompasses **17 departments**, **433 programs**, and **413 scopes of work**. Notably, two departments received the highest funding shares: the **Public Works Department** and **Boston Public Schools**, occupying **23.46%** and **22.02%** respectively. Following closely, the **Property Management Department and Parks and Recreation Departments** stand as the third and fourth in the rank, each occupying nearly identical percentages of the total capital budget, with **8.52%** and **8.25%**. Subsequently, the Transportation Department, Mayor's Office of Housing, Boston Centers for Youth and Families, Environment Department, Boston Public Library, and Fire Department round out the list of departments receiving substantial funding.

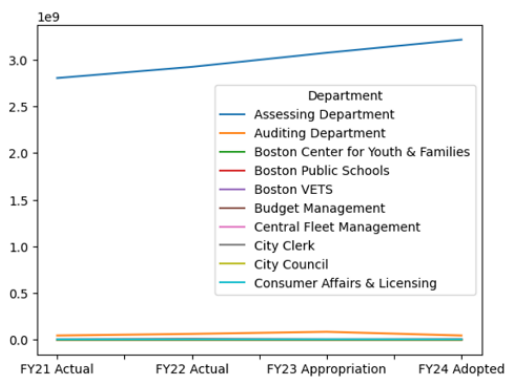
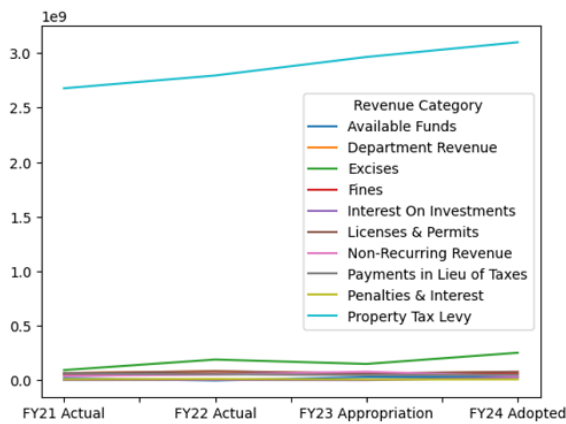


The bar charts representing projects and scopes of work exhibit a parallel correlation. The project garnering the highest funding is the **Josiah Quincy Upper School**, affiliated with the Boston Public Schools. Its scope of work involves the design and construction of a new facility for the school. Following closely is the **North Washington Street Bridge project**, securing approximately **\$200 million**, dedicated to the design and construction of a replacement bridge. This project falls under the purview of the Public Works Department.

The third-ranking project is **Sullivan Square/Rutherford Avenue**, also under the Public Works Department, with an estimated value of around **\$170 million**. The fourth project, **26 Court Street**, pertains to the Property Management Department. Lastly, in the fifth position, the **Renew Boston Trust Phase 3** project, affiliated with the Environment Department, secures a noteworthy allocation.



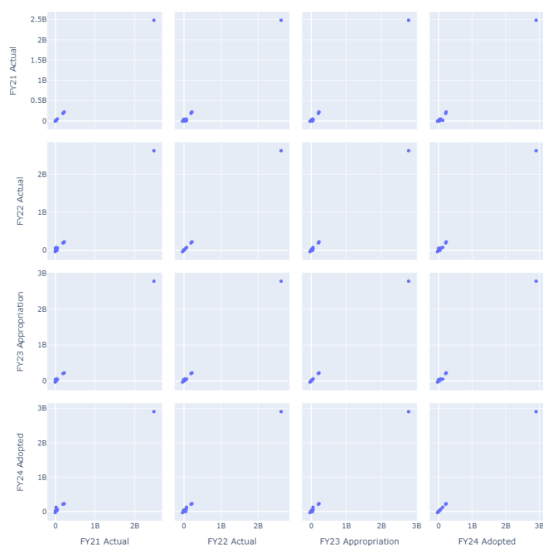
3. Data: fy24-adopted-revenue-budget.csv



Spending by Department: The chart lists different departments, like the Assessing Department, Auditing Department, and Boston Public Schools, among others. We see spending amounts for FY21 Actual, FY22 Actual, FY23 Appropriation, and FY24 Adopted.

Spending by Budget Category: This chart breaks down the budget into categories such as Revenue Category, Available Funds, Department Revenue, etc. Similar to department spending, you can track changes over time. Comparing the categories will show where the city prioritizes its spending. For example, a large proportion of funds in the 'Property Tax Levy' might indicate heavy reliance on property taxes for revenue.

Change Over Time: By comparing the 'Actual' spending from FY21 and FY22 to the 'Appropriation' for FY23 and the 'Adopted' budget for FY24, you can assess how the city's spending priorities are shifting. There are areas where the 'Adopted' budget is significantly different from the past 'Actual' spending? This could indicate a new policy or a change in focus.



The scatter matrix displays the relationships between budget allocations across four fiscal years for the city of Boston: FY21 Actual, FY22 Actual, FY23 Appropriation, and FY24 Adopted. The matrix format allows for pairwise comparison of each fiscal year against the others, offering a visual correlation assessment between the respective budgets. From the graph, a pattern of positive correlation emerges, where increases or decreases in budget figures from one year appear to be mirrored in the subsequent years. This trend suggests a level of consistency in budgetary

allocations, indicating that departments or categories with higher budgets in one year often continue to receive higher budgets in the following years.

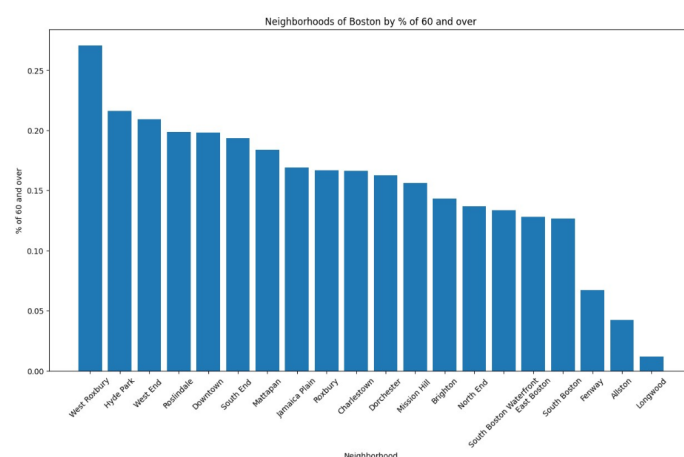
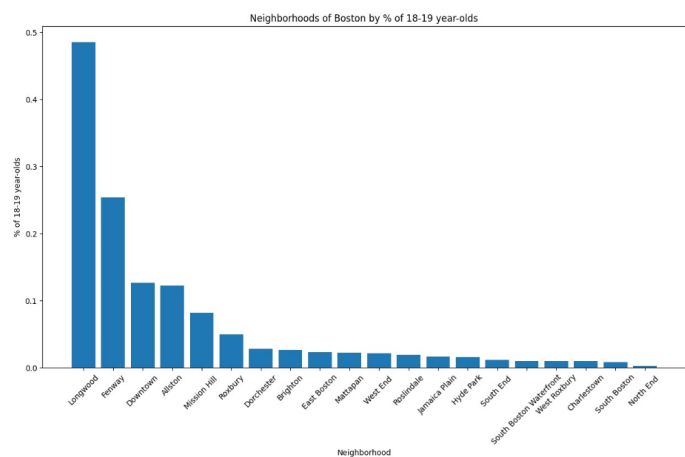
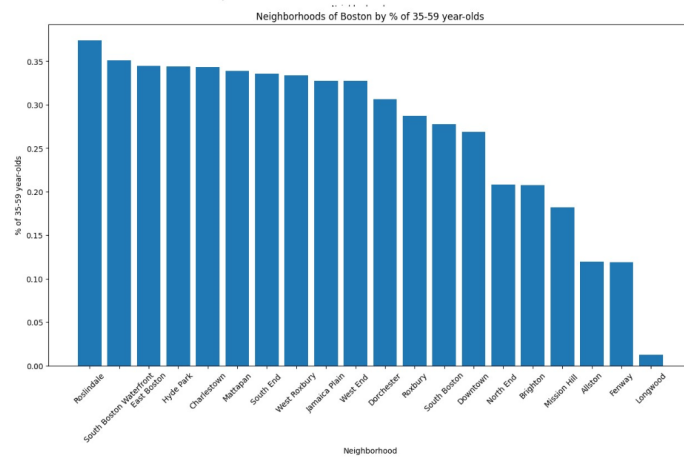
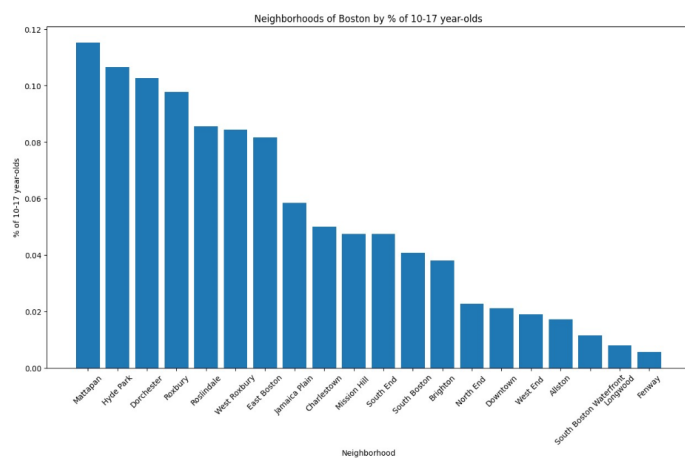
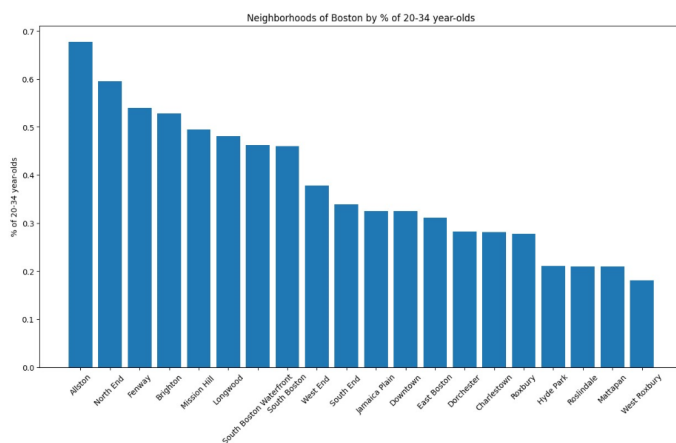
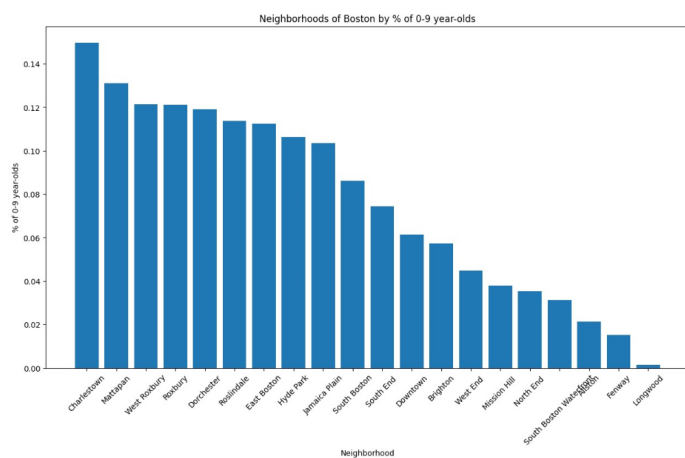
Extension analysis

When analyzing a city's budget, it is important to consider where resources are being committed and what ends those resources are serving. We can see now how spending is allocated by department or by neighborhood, but we don't yet have a full picture of certain broader questions, such as whether certain groups are disproportionately benefitting from the current budget allocation over others. Digging deeper into demographic information can point toward potential inequities or gaps in resources for certain groups.

This extension project was inspired in part by an article in the Boston Globe: <https://www.bostonglobe.com/2023/10/01/opinion/affordable-housing-suburbs-senior-housing-zoning/> about affordable housing being disproportionately allocated towards seniors rather than younger adults or families. This, while ostensibly increasing the amount of affordable housing, does not allow younger families to thrive. Therefore, we wanted to see if we could find if Boston's budget could potentially be distributed in a similar manner, with a disproportionate amount of funds being allocated towards older communities (communities which may be voting at a higher rate as well), or whether Boston is able to balance the needs of children, students, and families.

Currently, we have access to Census data Census data: <https://data.boston.gov/dataset/2020-census-for-boston> and neighborhood demographics data: <https://data.boston.gov/dataset/neighborhood-demographics>. These have age demographic breakdowns by neighborhood as well as a plethora of other information for us to explore in our analysis.

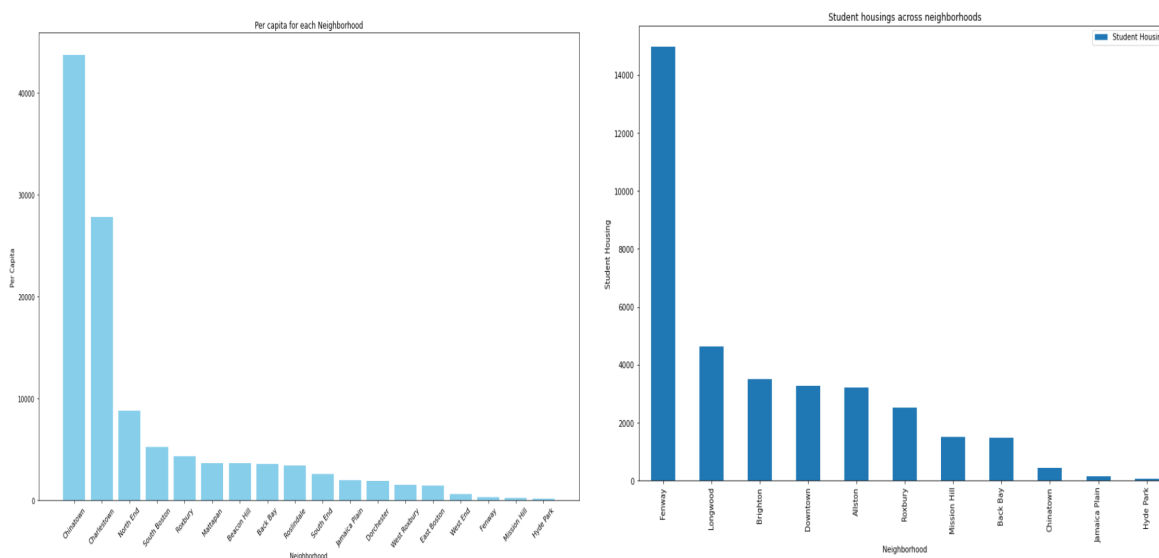
Age Demographic Proportions by Neighborhood



The above figure shows a breakdown of Boston's neighborhoods based on what percentage of their population is a particular age demographic. We see, for example, Charlestown having the highest proportion of 0-9-year-olds at slightly above 14%. One interesting observation: if you look back to the Capital Budget Plan breakdown by neighborhood, Charlestown has by far the largest funding for FY24. This could be a promising observation either way you look at it as Boston is either investing heavily in its youth or Boston's heavy investment in Charlestown is promoting young families. More data analysis is required to clarify this analysis.

The data also corroborates another unique aspect of Boston: Longwood and Allston, being so close to various Universities (and home to BU), unsurprisingly have very high proportions of young adults, with Longwood being nearly 50% 18-19 year-olds and Allston having more than 65% 20-34 year-olds.

Per Capita and Student Housing for each Neighborhood



The plot on the left is the Per capita income for each Neighborhood in Boston, and the plot on the right is the Student housing distributed across neighborhoods in Boston.

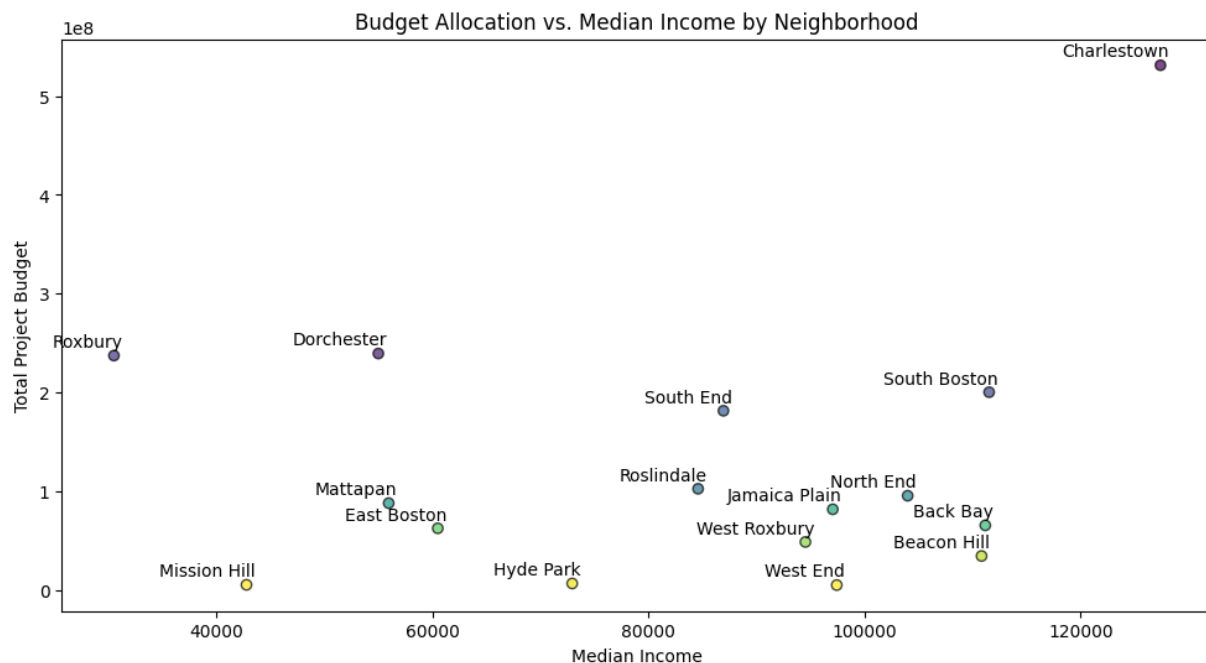
An interesting inference is that low per capita income zones like Fenway, have a very high amount of student housing, which is very intuitive. Similarly places like Chinatown, that have

high per capita income have very few student housing, forming an inverse correlation between the two plots.

Budget Allocation vs. Median Income by Neighborhood

We aimed to investigate the potential correlation between median income and budget allocation. Our analysis, however, has revealed that the relationship between them is not strictly proportional. Unlike what we expected, we did not observe a consistent increase in the budget allocation with a rise in median income across neighborhoods.

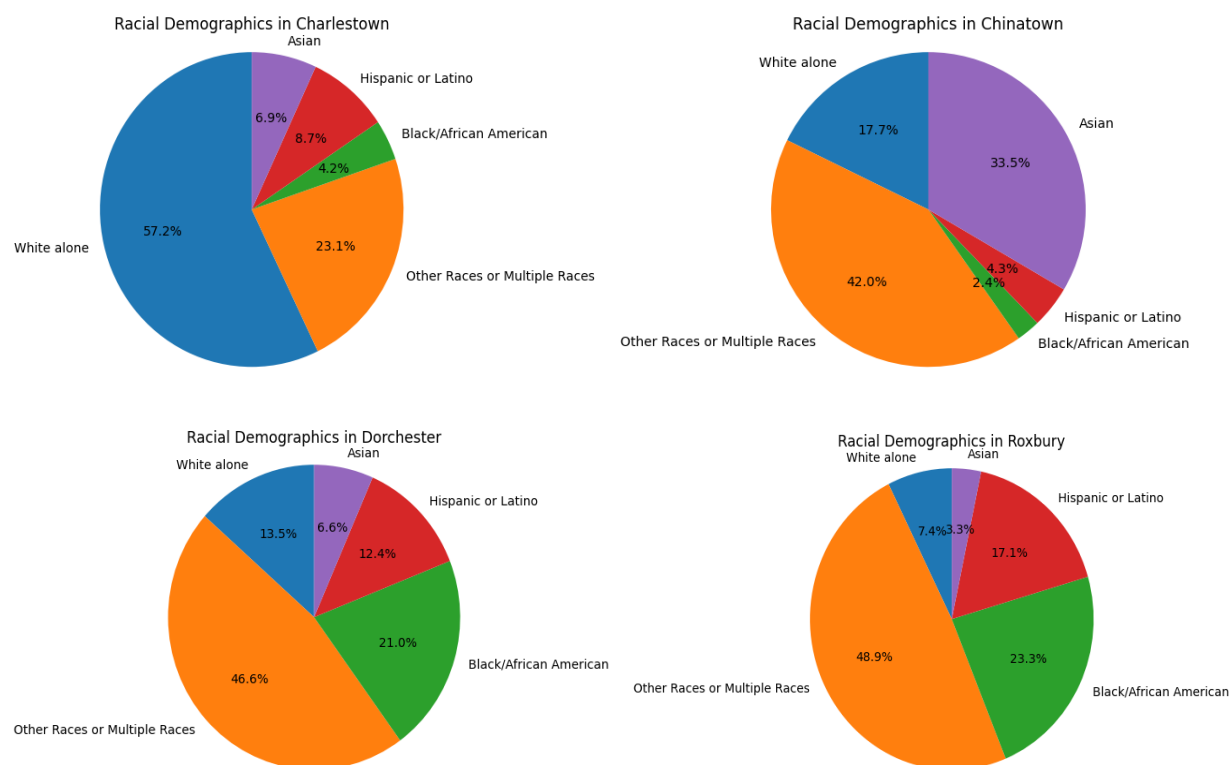
Notably, **Charlestown** emerged as the top-funded area in Boston, boasting the highest median income at approximately **\$140,000 per year**. On the other hand, **Roxbury** and **Dorchester** received significant funding shares despite having relatively low median incomes - **under \$40k** and **roughly \$58k**, respectively.



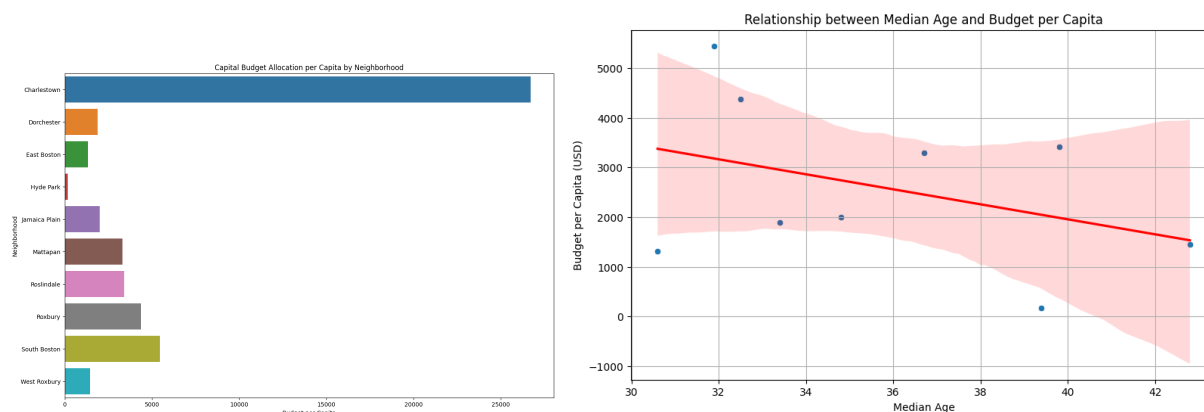
Racial Demographics in Neighborhoods

Our analysis on Racial Demographics in Neighborhoods indicated that budget distribution is not correlated with races. Charlestown, Chinatown, Dorchester, and Roxbury are the areas that received the highest funding, and it's noteworthy that these areas do not exhibit the

same racial composition. For example, in our pie charts, the percentage of white people in **Charlestown** is **57%**. In contrast, **Chinatown** has a significant percentage of Asian and Multiple Races (**75.5% in total**), with the percentage of White individuals being only **17.7%**. A similar situation is observed in **Roxbury**, where **23.3%** of the population is Black, and in **Dorchester**.



Relationship between Median Age and Budget per Capita



Here we see data that may support our previous observation that Boston seems to be highly invested in supporting its youth. While the trend is not strong, there is a slight correlation between a younger median age and greater capital budget funding for a neighborhood. This could be because part of the capital budget includes construction for buildings such as schools, and younger neighborhoods would have greater school construction and repair costs.

Challenges/Limitations

While there is a plethora of data available on the City of Boston, one challenge we faced was being able to compare or correlate different datasets. One particular challenge was that different data sources often have differing definitions of Boston neighborhoods; some lump Allston and Brighton together, some include Chinatown as a distinct neighborhood while others don't, etc. So, when putting together data based on neighborhoods we had to be conscious of this distinction, which either required finding different sources or doing lots of research and data cleaning to make sure we were comparing like sources.

Conclusion

Analyzing how a city allocates its resources is a problem that is as broad as it is opaque; it requires an informed understanding of public policy, the genuine lived-in situation on the ground, and all the interlocking moving parts that make a city able to function. These cannot all be fully encapsulated by data alone. Nonetheless, data provides an invaluable way of defining

and communicating a snapshot of these puzzle pieces, with the caveat that the data scientist in question must be as responsible and unbiased as possible in their approach.

For our report, while we do not have firm evidence to point to any particular inequities and inefficiencies, we can point out how Boston allocates its resources. Here, we can see a city that seems to invest massively into education, with the vast majority of the most recent budget being allocated to expenses such as teacher salaries, new school construction, and neighborhoods with relatively younger populations. We cannot yet compare this to other cities, but it is, in our opinion, a welcoming sign that Boston is allocating so many of its resources into supporting its youth and younger families.

Individual Contributions

Logan Neishloss: Worked on EDA throughout the project. Did research into and data analysis for the extension project. Helped coordinate team meetings and guarantee that deliverables meet project expectations.

Ruoxi Jin: Helping with finding datasets. Did data preprocessing (files: pre-processing.ipynb and the three processed csv files), data analysis based on fy24-adopted-revenue-budget.csv (files: revenue_2.ipynb and revenue_4.ipynb). Helped with report based key questions.

Priscilla Nguyen: I conducted an analysis of both the operating budget and capital budget. I addressed key questions related to these budgets. Additionally, I worked on the extension project, where I explored the potential correlation between budget allocation and median income by neighborhood. Furthermore, I investigated the relationship between racial demographics and budget distribution.

Qicheng Cao: Analyzed data (fy24-capital-budget-plan-recommended.csv), did research into the geographic distribution of budgets, and visualized the analysis related to geographic correlations in base analysis and extended analysis. Used linear regression to find the relationship between age and budgets in different neighborhoods. Wrote our base analysis findings in the report and made the framework of extended analysis. Also corrected grammatical errors in the report.

Shreyas Sudarsan: Analyzed the operating budget data (fy24-adopted-operating-budget.csv), visualizing the operating budget allocation across various departments and programs for

FY21-24. Wrote our base analysis findings in the report, which includes the EDA for operating budget. Worked on per capita budget analysis for various neighborhoods in Boston and also correlated this with student housing data. Observed that some places with high amounts of student housing have low per capita and vice versa.