Identifying Drivers of Construction Project Cost Increases and Schedule Increases: NYC DDC Data Case Study

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TOWN +GOWN: NYC

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Introduction

Project Overview

This project focuses on analyzing construction contract data from the NYC Department of Design and Construction (DDC) to aid in creating a risk management tool for front-end planning. The primary objectives are to preprocess the data, perform descriptive statistics, and visualize key trends and patterns.

Key Research Variables

Our analysis centers on two dependent variables: **% Change in Project Cost** and **% Change in Project Duration (Delay)**

Objectives

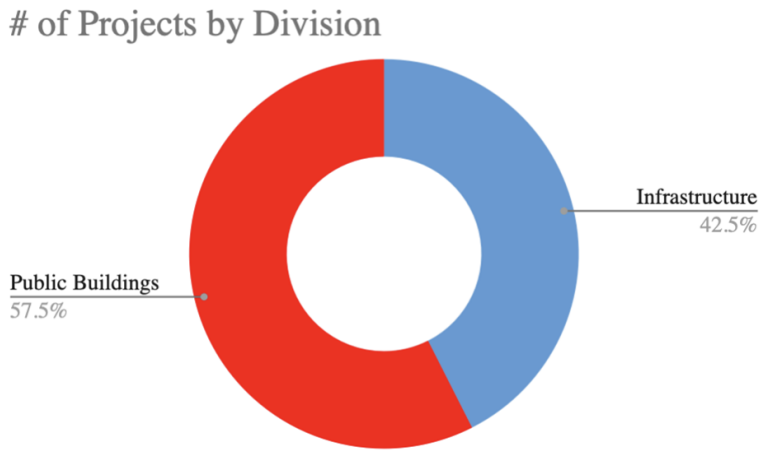
We aim to explore the relationships between these dependent variables and both internal and external factors. By identifying the specific factors that influence construction cost and schedule, we can better understand the risks and challenges involved in these projects.

Methodology

1. **Data Preprocessing:** Cleaning and organizing the raw data to ensure accuracy and consistency.
2. **Descriptive Statistics:** Summarizing the main features of the data to identify general trends.
3. **Data Visualization:** Creating graphical representations of the data to highlight key insights.

Overview

Source Data



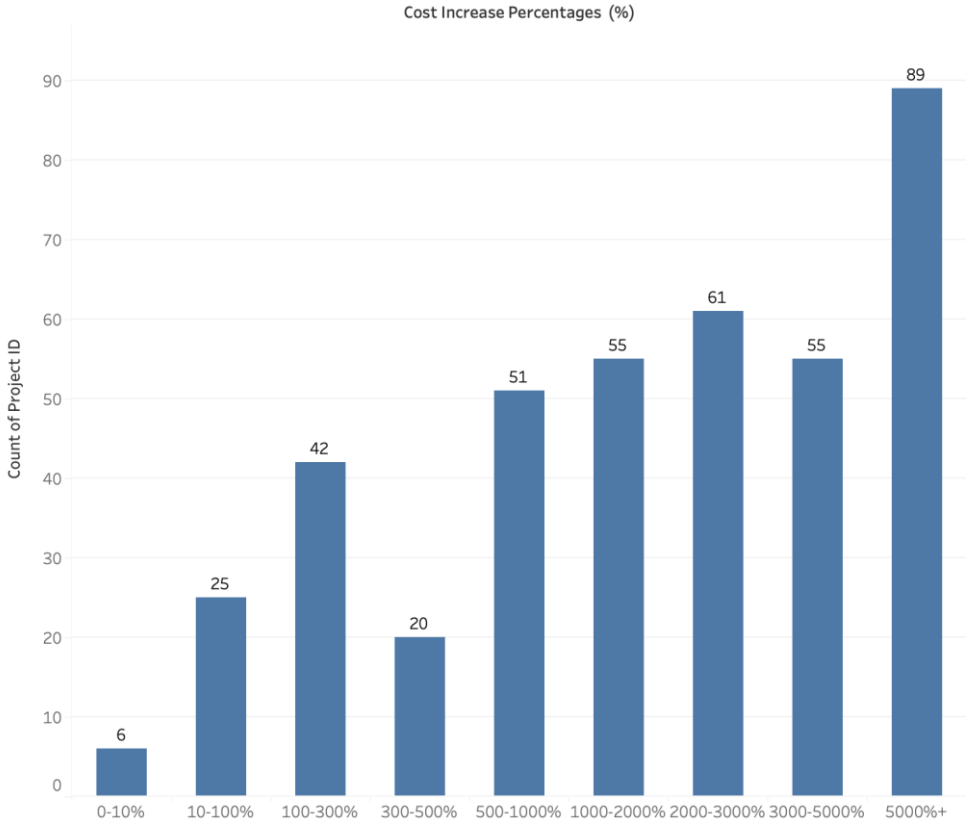
Division	Count of Projects
Infrastructure	305
Public Buildings	412
Grand Total	**717**

Variables

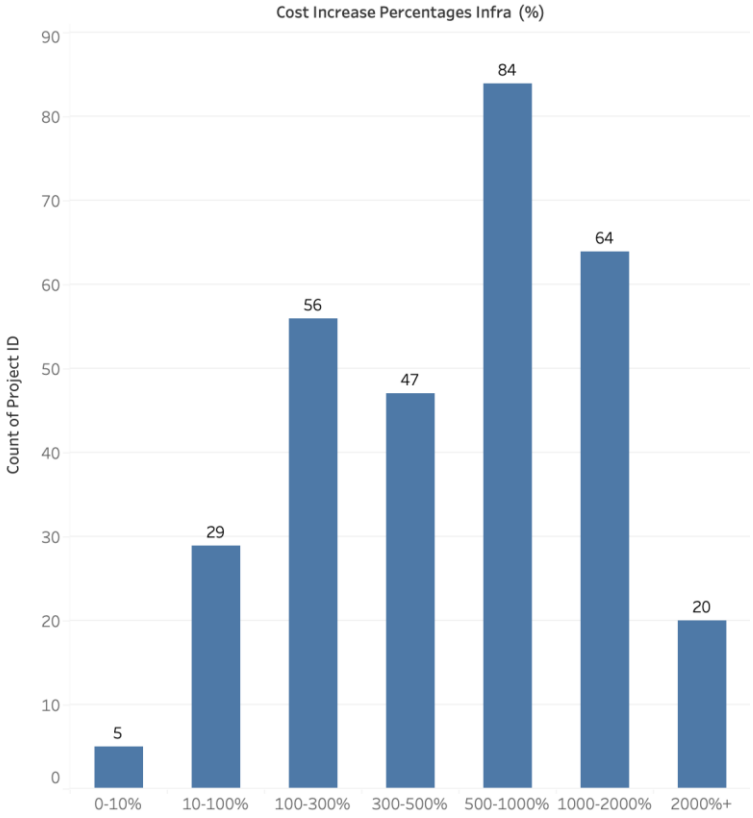
- Independent Variables Used:
  - Borough Location
  - Sponsor Agency (as proxy for project type)
  - Construction Start Year

- Dependent Variables Created:
  - % Change in Cost
    - (Current Contract Total - Original Contract Total)/Original Contract Total
  - % Change in Duration
    - (Amended Contract Duration - Original Contract Duration)/Original Contract Duration

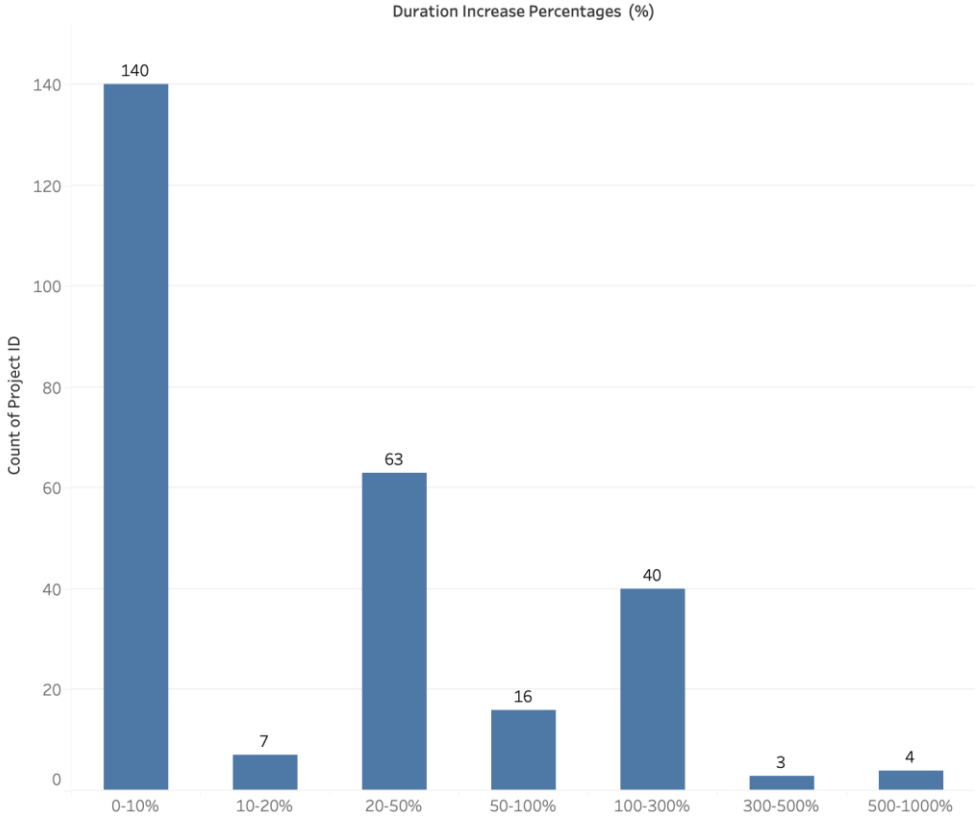
Public Buildings % Change in Cost Breakdown



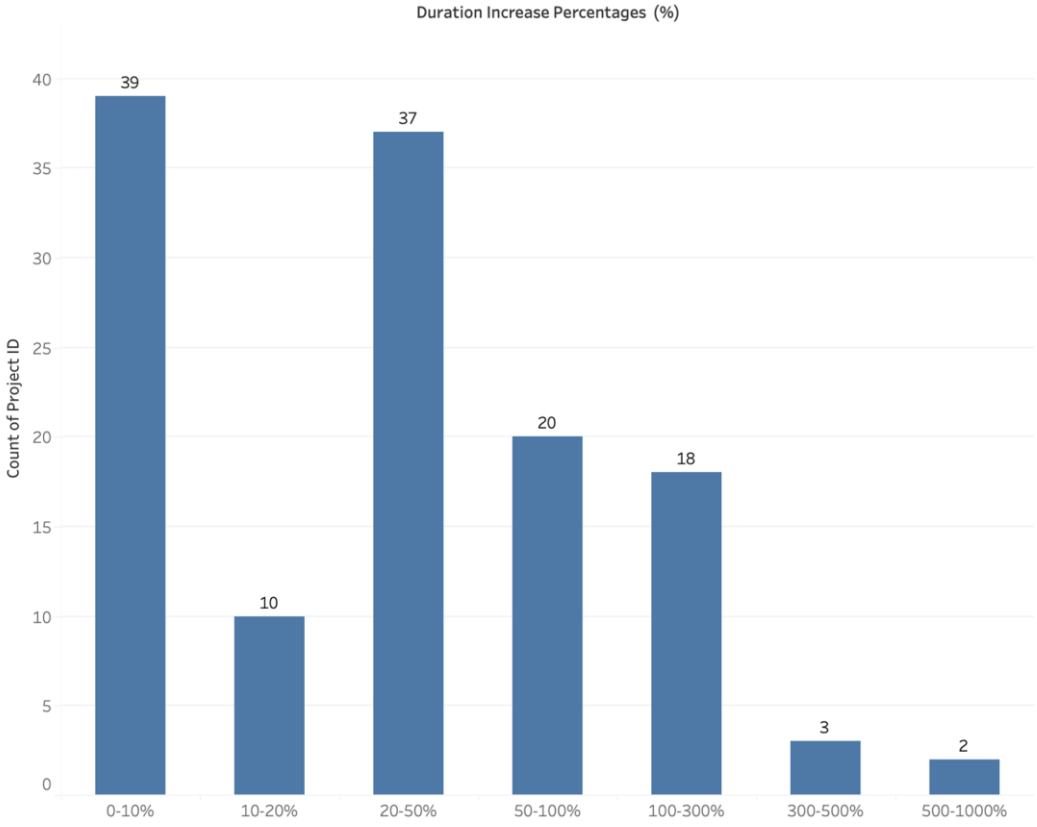
Infrastructure % Change in Cost Breakdown



Public Buildings % Change in Duration Breakdown

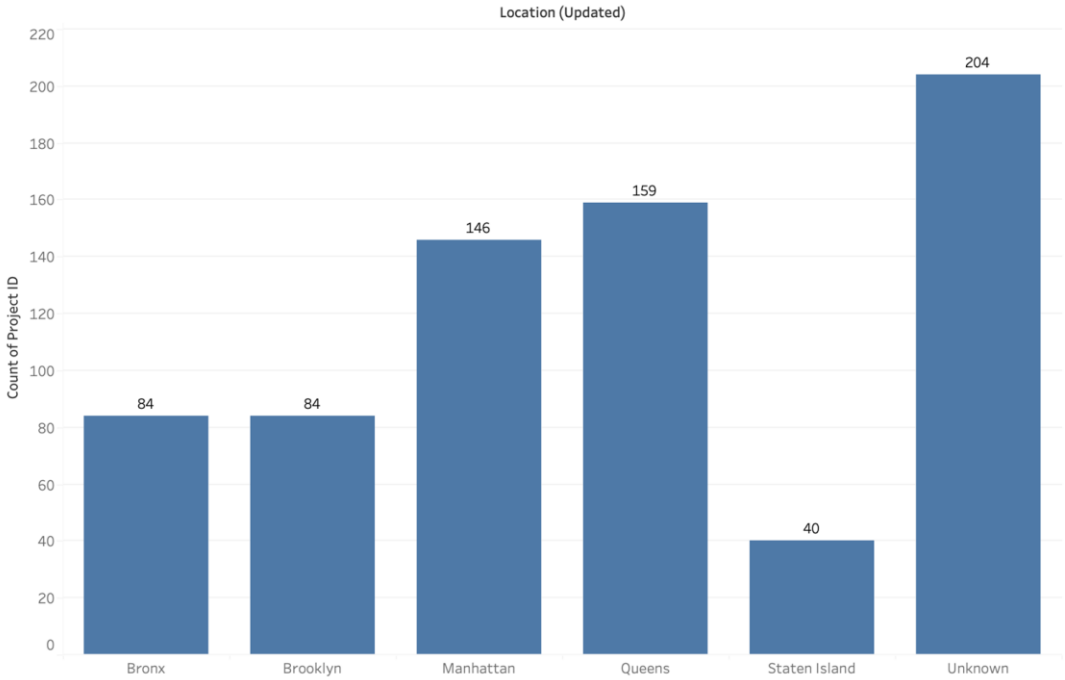


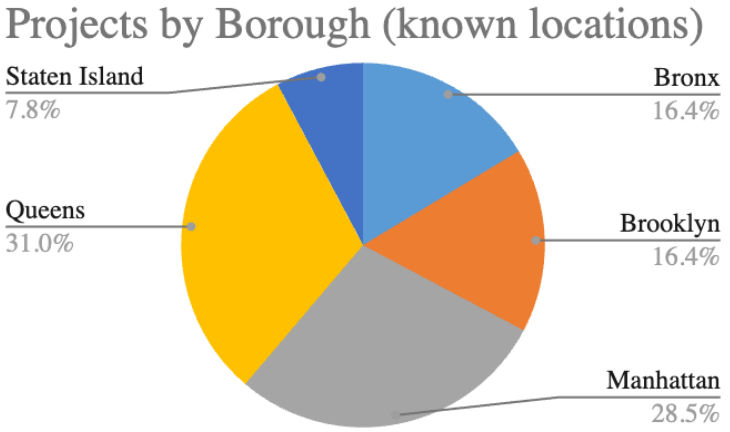
Infrastructure % Change in Duration Breakdown



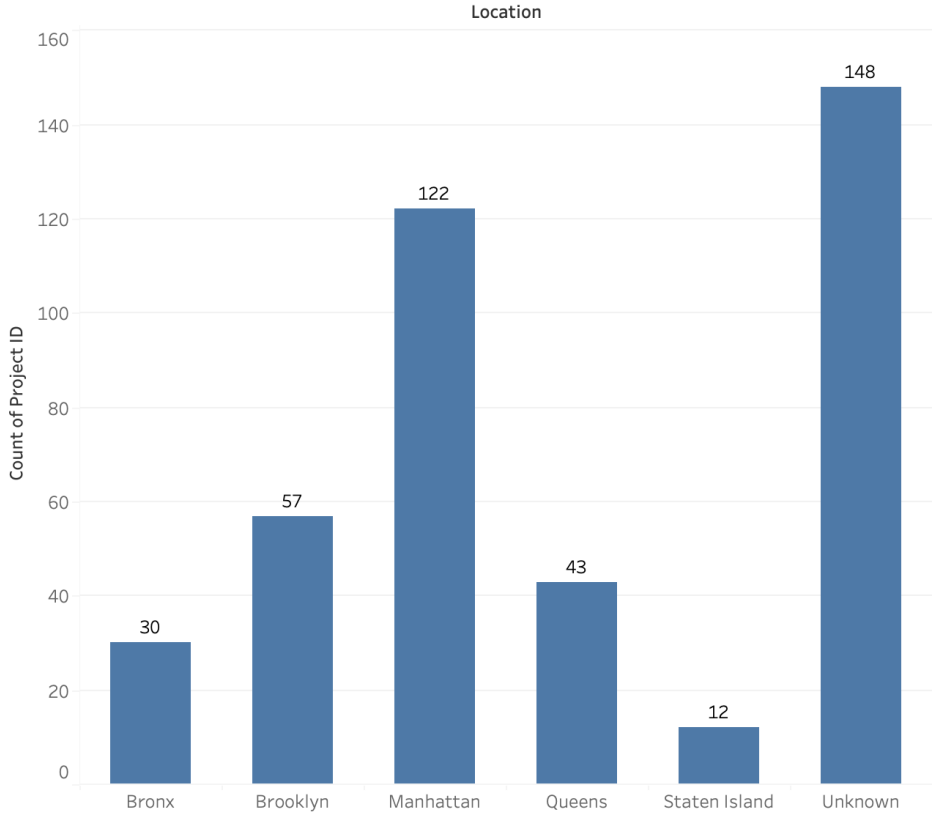
Borough Location

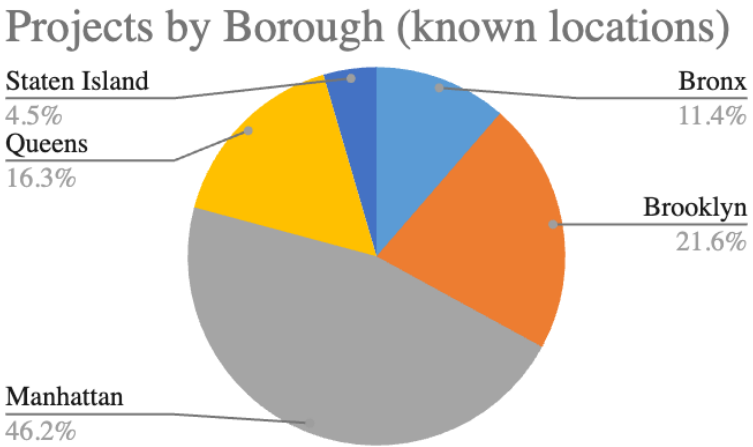
Overall Count of Projects by Borough



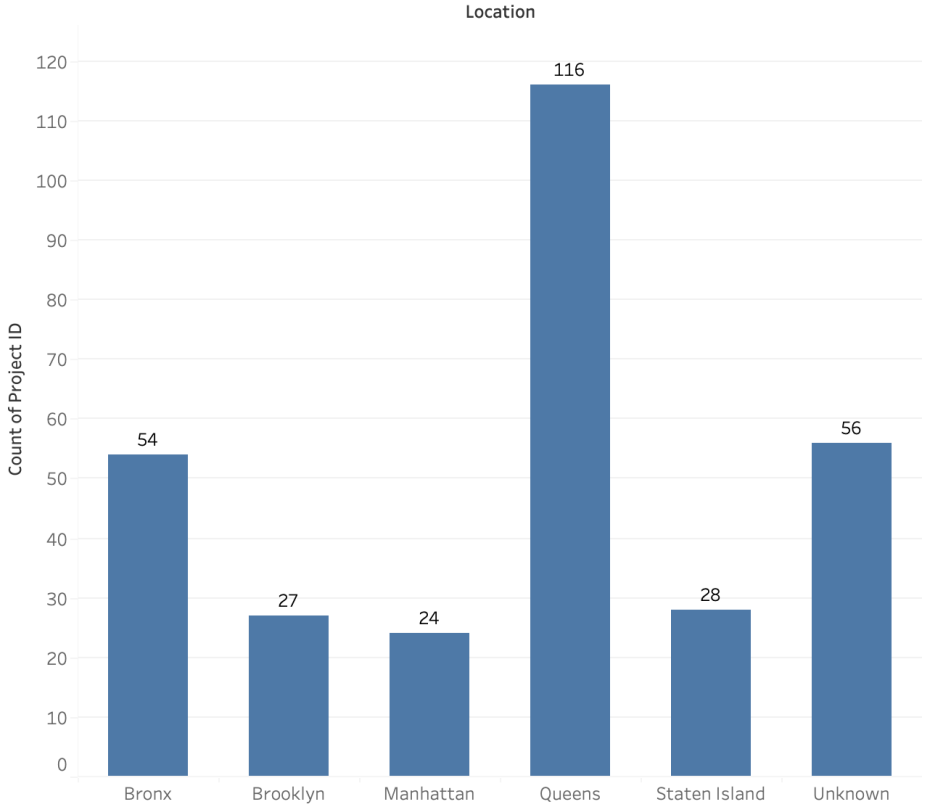


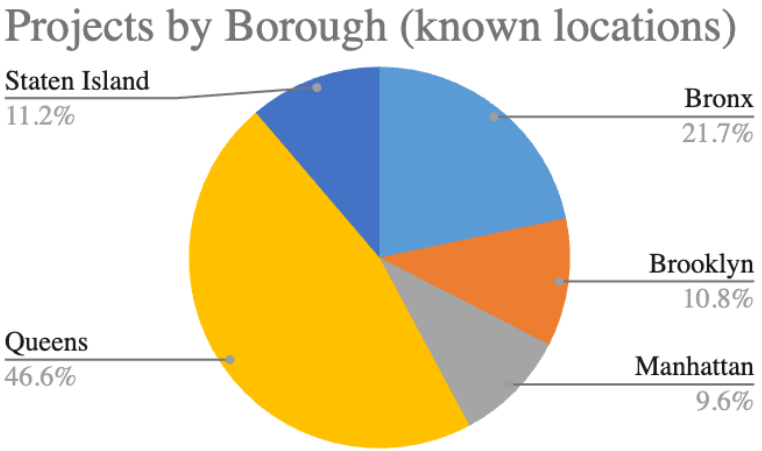
Public Buildings Count of Projects by Borough





Infrastructure Count of Projects by Borough





Public Buildings Dependent Variables Summary - % Change in Cost and Duration by Borough

Location	AVERAGE of Percentage Cost Increase
Bronx	2586.03%
Brooklyn	1422.87%
Manhattan	1703.53%
Queens	4106.20%
Staten Island	2188.05%
Unknown	6155.66%
Grand Total	**3593.15%**

Location	AVERAGE of Percentage Delay
Bronx	5.50%
Brooklyn	26.83%
Manhattan	31.31%
Queens	55.58%
Staten Island	56.64%
Unknown	29.37%
Grand Total	**31.38%**

Infrastructure Dependent Variables Summary - % Change in Cost and Duration by Borough

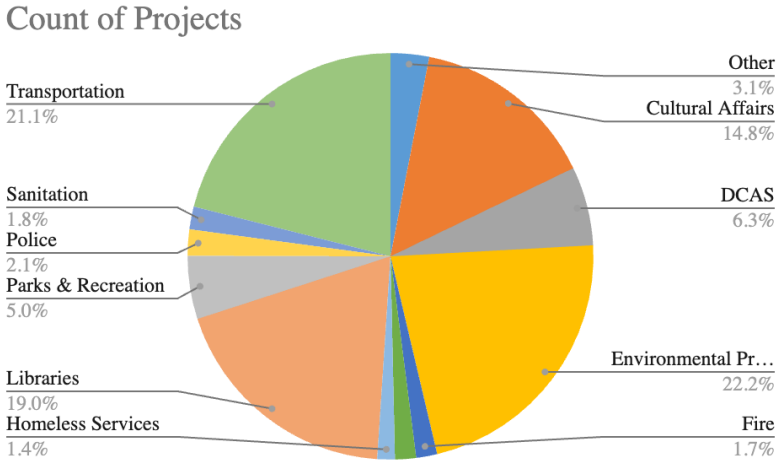
Location	AVERAGE of Percentage Cost Increase
Bronx	797.18%
Brooklyn	945.05%
Manhattan	790.48%
Queens	697.02%
Staten Island	746.66%
Unknown	728.49%
Grand Total	**754.40%**

Location	AVERAGE of Percentage Delay
Bronx	48.25%
Brooklyn	15.49%
Manhattan	8.89%
Queens	31.25%
Staten Island	13.42%
Unknown	15.05%
Grand Total	**26.50%**

Sponsor Agency

As proxy for project type

Overall Projects by Sponsor (as proxy for project type)



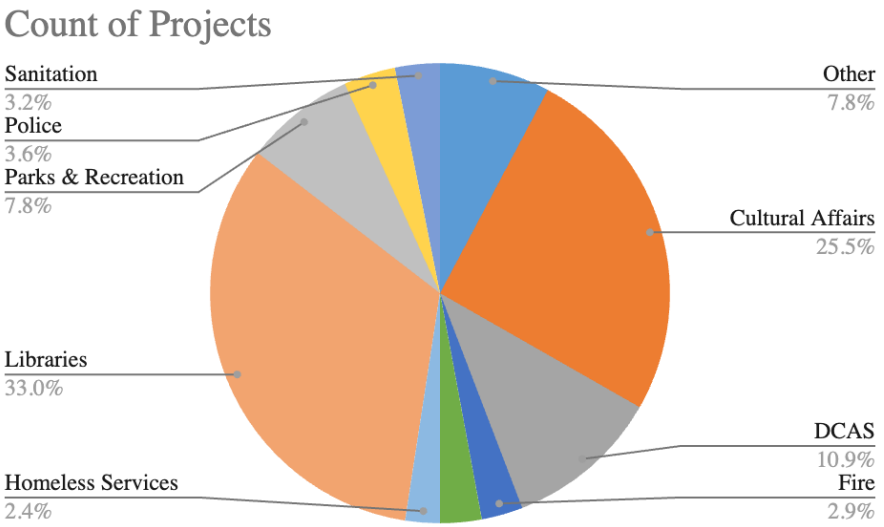
Sponsor	COUNTA of ProjectID
	3
Aging	1
Children Services	1
Consumer Affairs	1
Corrections	4
Cultural Affairs	106
DCAS	45
Environmental Protection	159
Fire	12
Health	12
Health & Hospitals Corporati	1
Homeless Services	10
HPD	1
Libraries-BPL	30
Libraries-NYPL	67
Libraries-QBPL	39
Mayors Office Operations	8
Parks & Recreation	36
Police	15
Sanitation	13
SocialServices-HRA	1
Trans. & Env. Protection	1
Transportation	151

Sponsor (Updated)	# Projects
Other	3
Other	1
Other	1
Other	1
Other	4
Cultural Affairs	106
DCAS	45
Environmental Protection	159
Fire	12
Health	12
Other	1
Homeless Services	10
Other	1
Libraries	30
Libraries	67
Libraries	39
Other	8
Parks & Recreation	36
Police	15
Sanitation	13
Other	1
Other	1
Transportation	151

- Projects are coded to ‘Other’ if project count is less than 10 (see table)
- ‘Libraries’ project comprises all 3 library projects (BPL, NYPL, QPL)

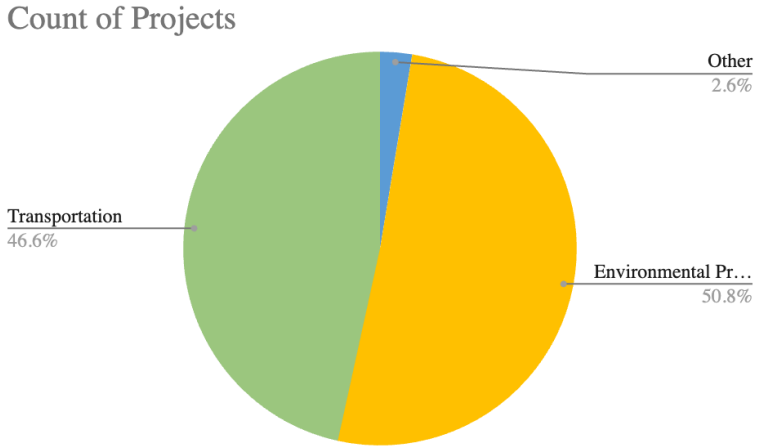
Public Buildings Projects by Sponsor (as proxy for project type)

Sponsor	COUNTA of ProjectID
Aging	1
Children Services	1
Consumer Affairs	1
Corrections	4
Cultural Affairs	105
DCAS	45
Environmental Protection	4
Fire	12
Health	12
Health & Hospitals Corporation (HHC)	1
Homeless Services	10
HPD	1
Libraries-BPL	30
Libraries-NYPL	67
Libraries-QBPL	39
Mayors Office Operations	8
Parks & Recreation	32
Police	15
Sanitation	13
SocialServices-HRA	1
Transportation	9
Grand Total	**411**

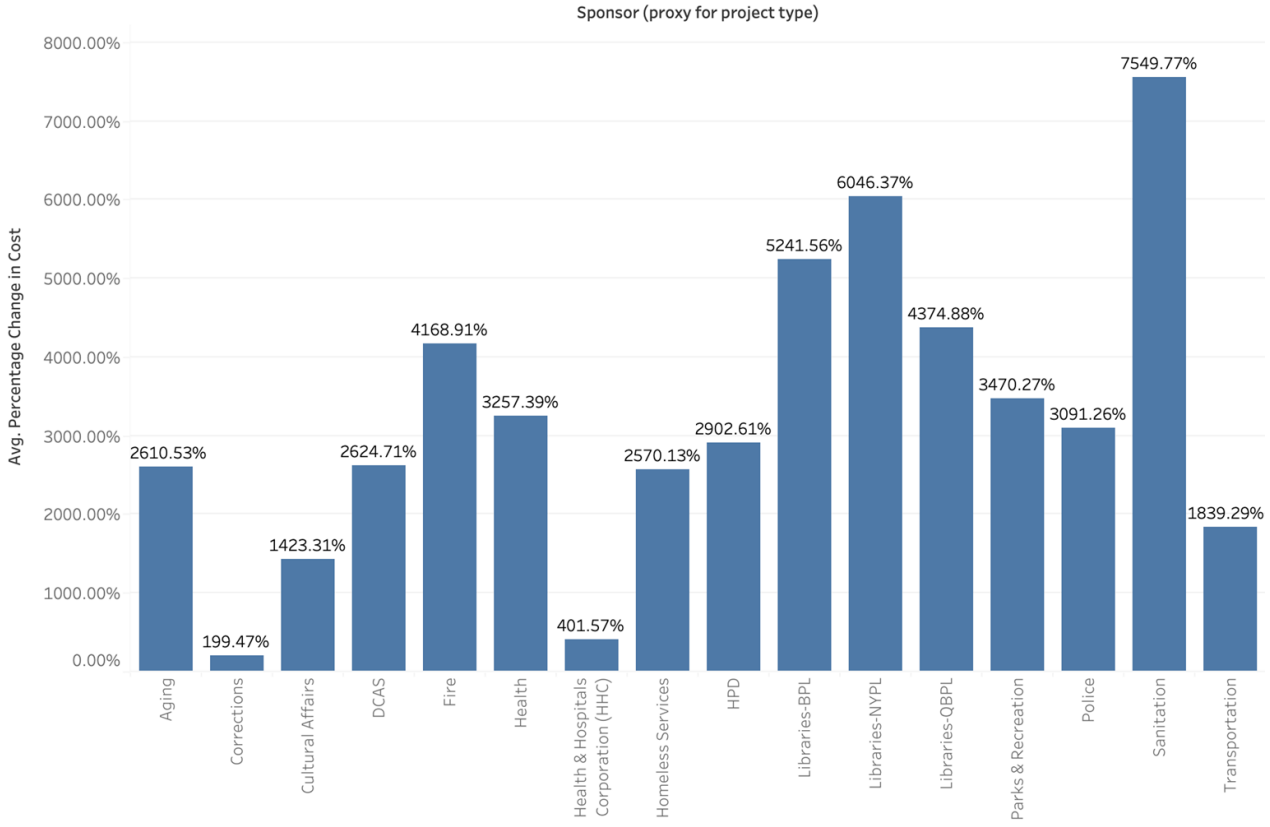


Infrastructure Projects by Sponsor (as proxy for project type)

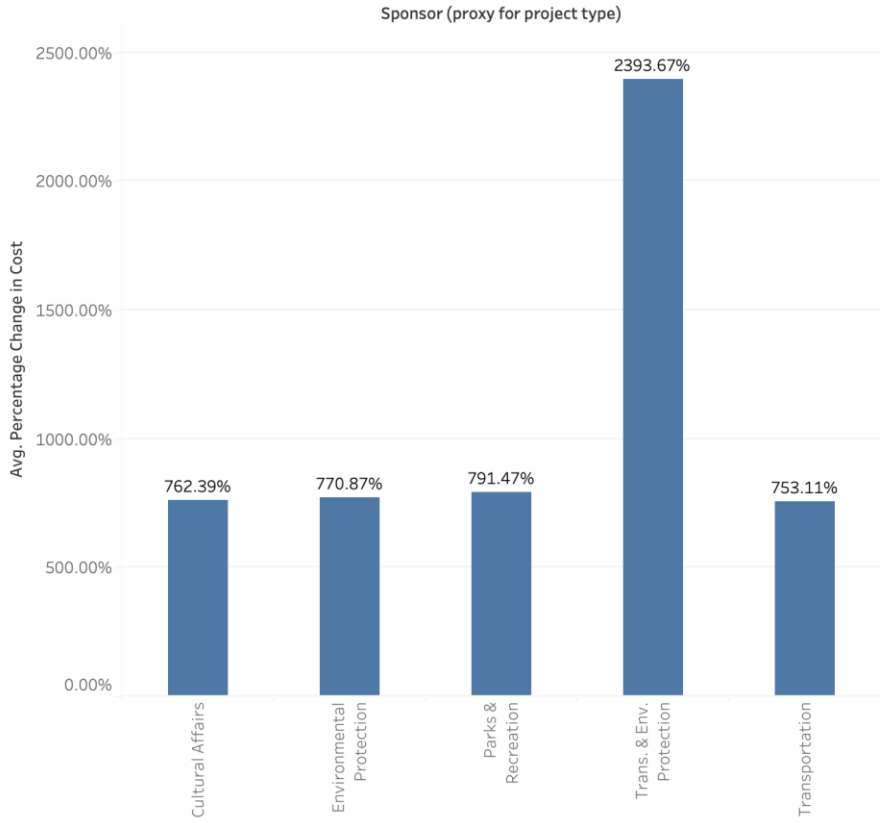
Sponsor	COUNTA of ProjectID
Cultural Affairs	1
Environmental Protection	155
Parks & Recreation	4
Trans. & Env. Protection	1
Transportation	142
Grand Total	**303**



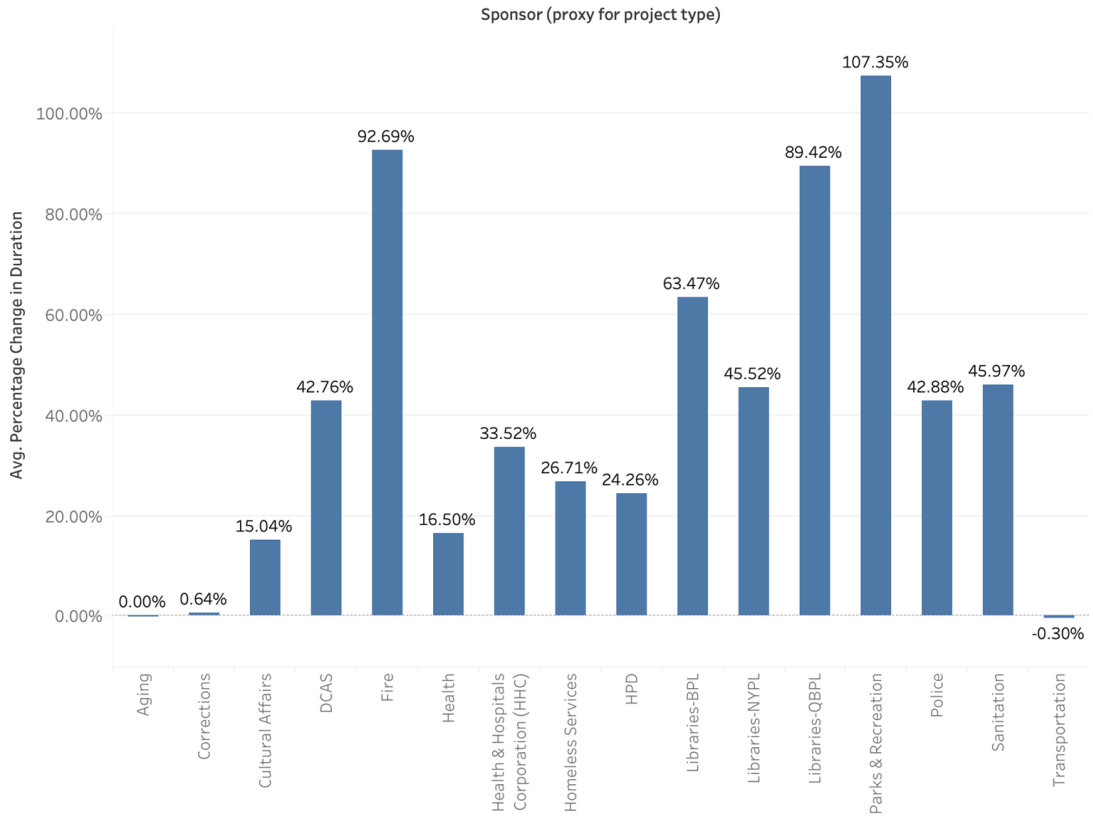
Public Buildings % Change in Cost by Sponsor as Proxy for Project Type



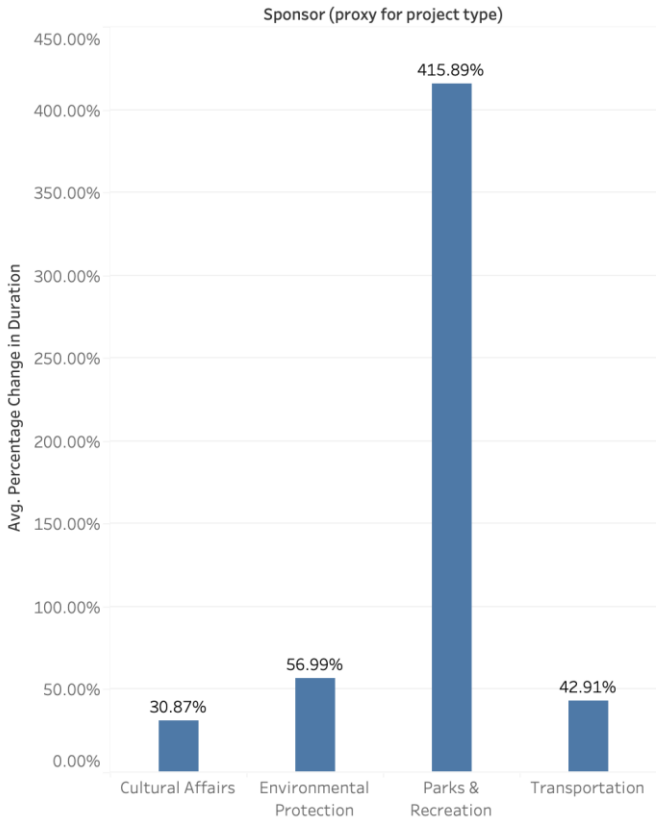
Infrastructure % Change in Cost by Sponsor as Proxy for Project Type



Public Buildings % Change in Duration by Sponsor as Proxy for Project Type

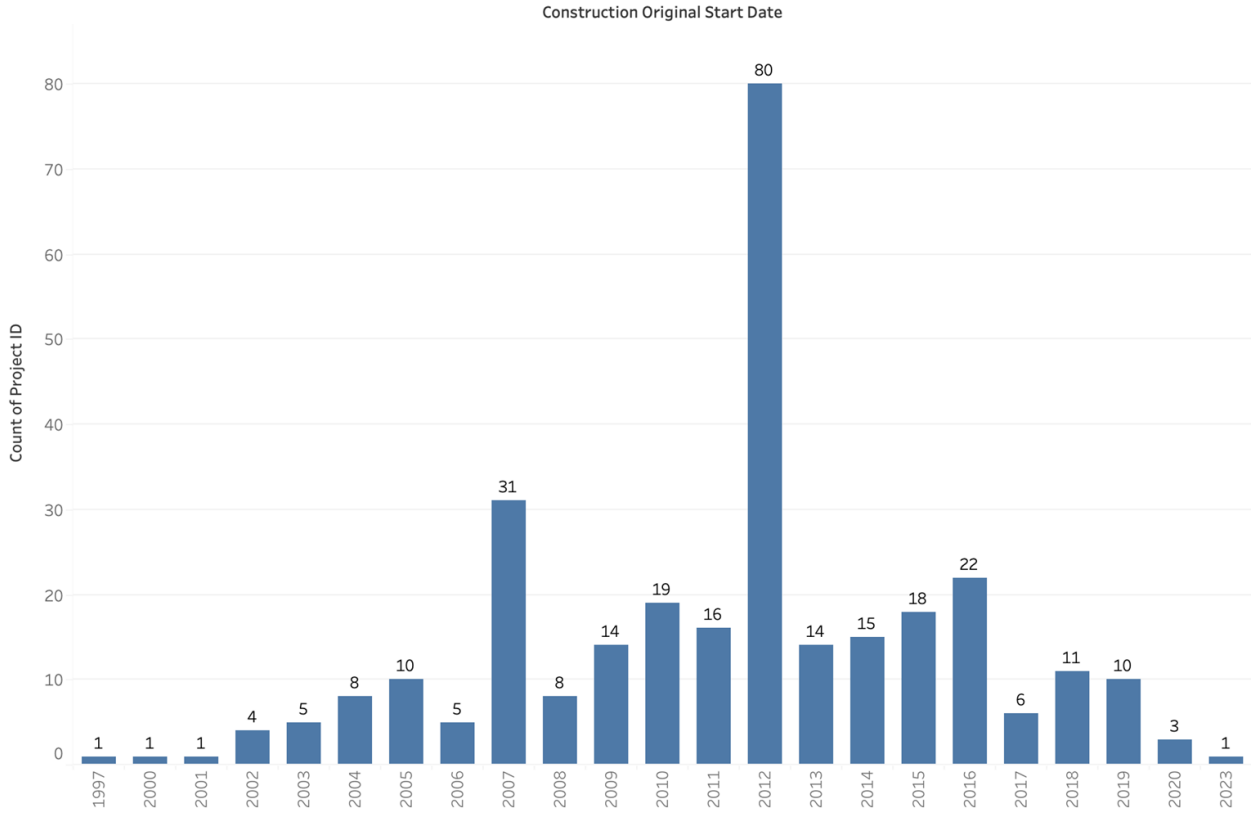


Infrastructure % Change in Duration by Sponsor as Proxy for Project Type

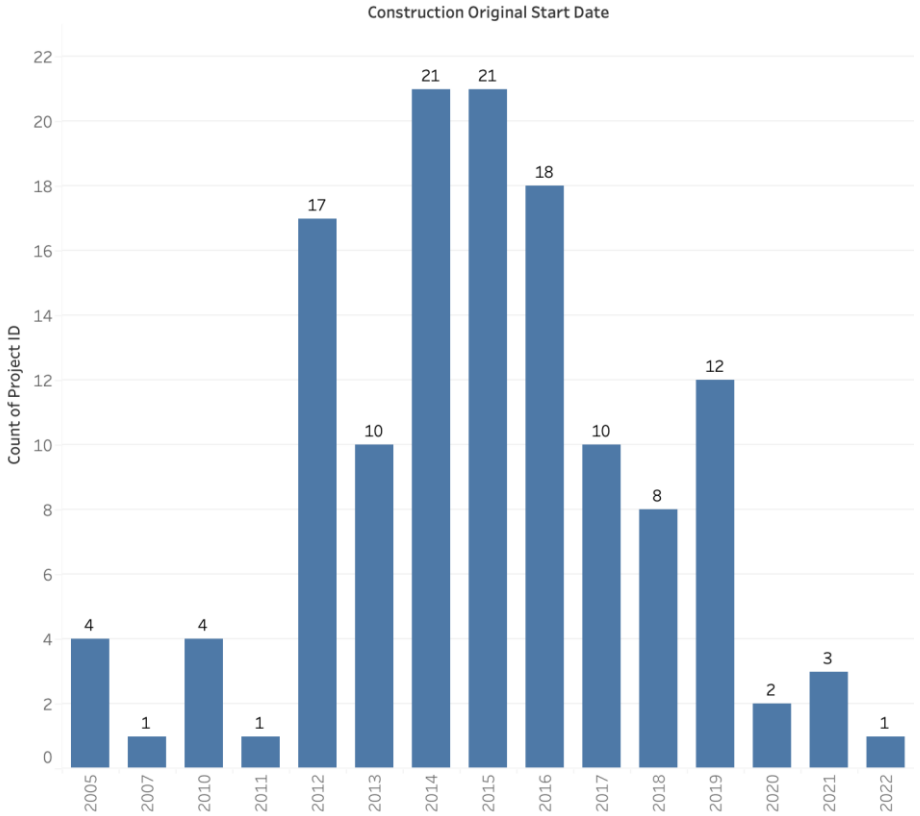


Construction Start Date

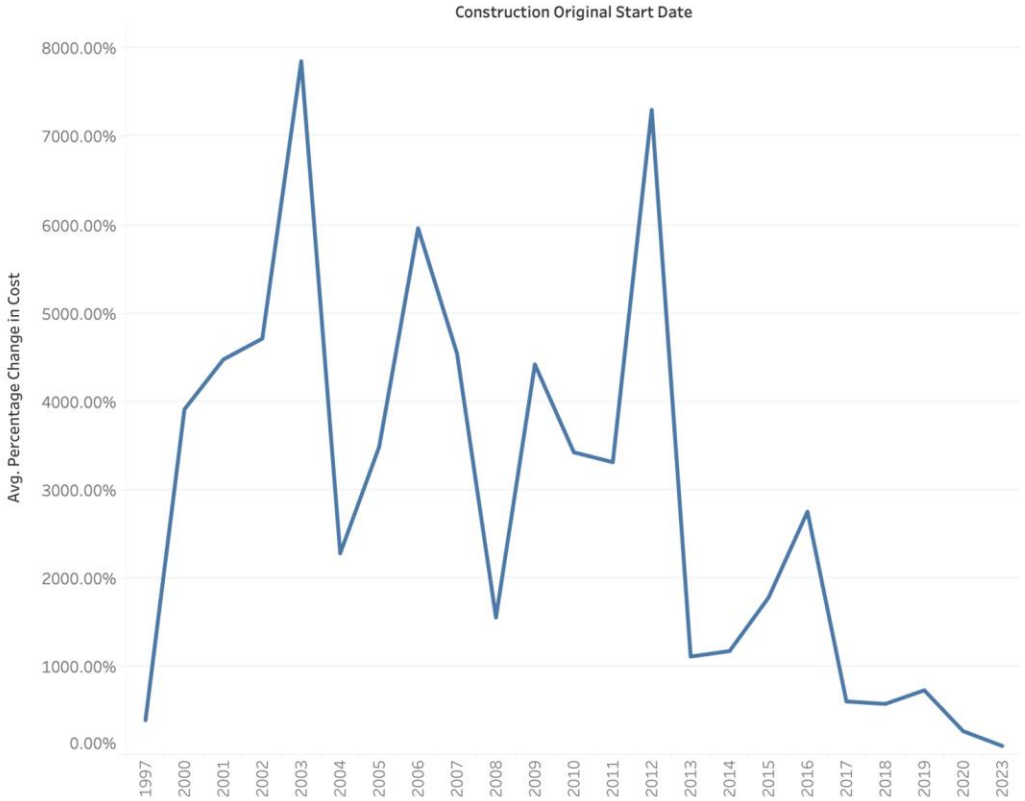
Public Buildings Projects by Start Date (Year)



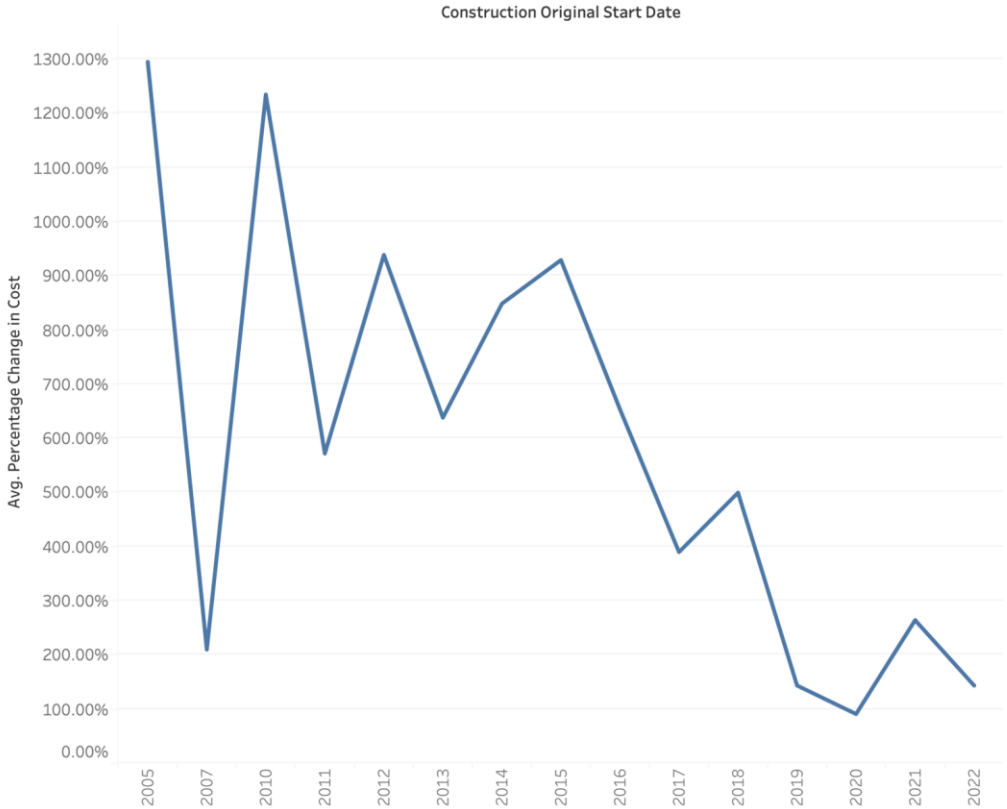
Infrastructure Projects by Start Date (Year)



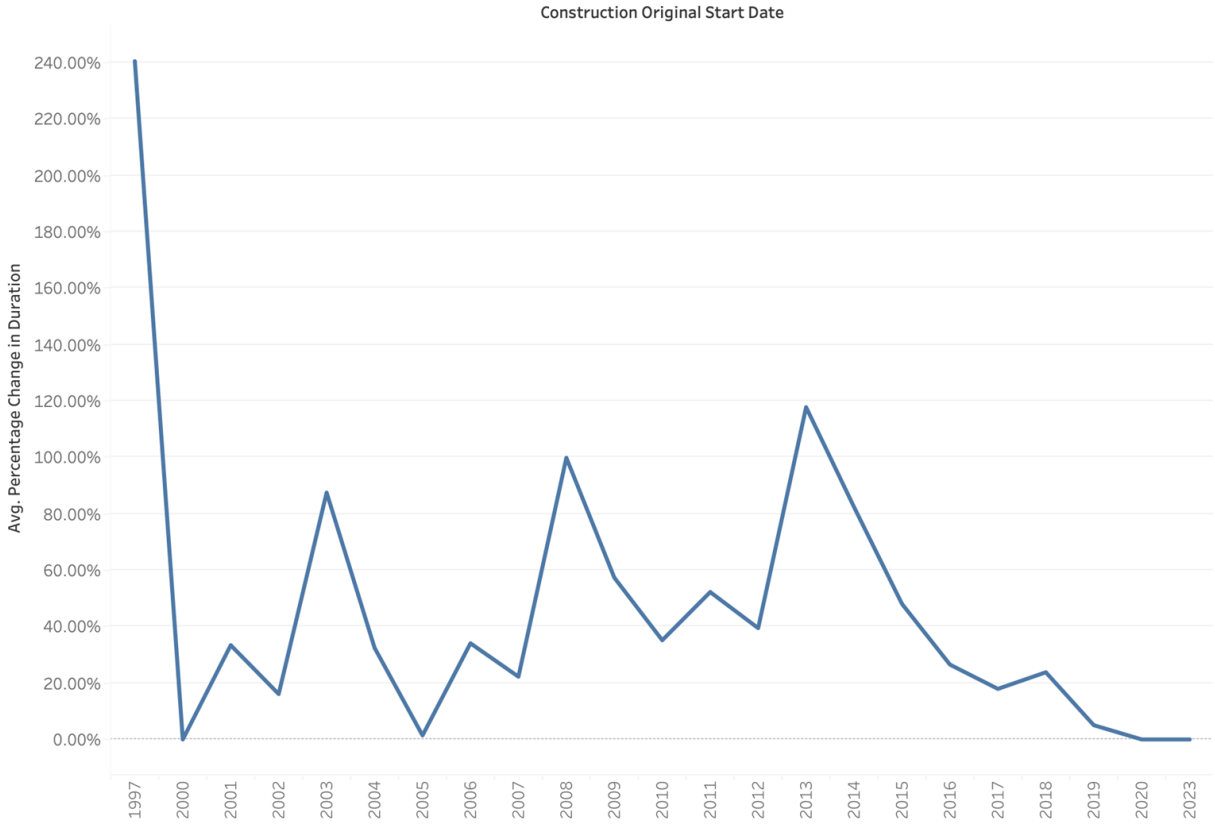
Public Buildings % Change in Cost Over Time



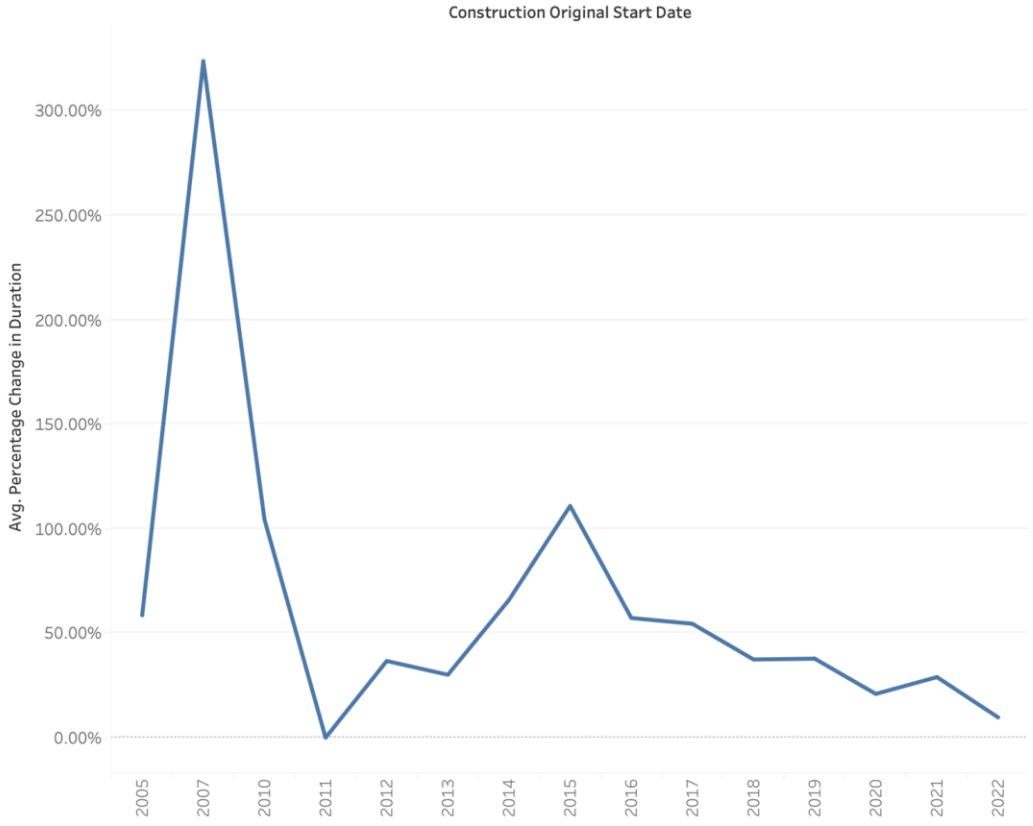
Infrastructure % Change in Cost Over Time



Public Buildings % Change in Duration Over Time



Infrastructure % Change in Duration Over Time



External Data

External Variables

Source: FRED

Variable definitions:

- **Unemployment rate, construction**
  - Unemployment rate of hourly workers in the construction industry
- **Total spend, nonresidential construction**
  - Total in millions of dollars ($) spent on nonresidential construction projects
- **Producer Price Index (PPI), construction materials**
  - PPI: average selling price received by domestic producers for their products
  - Used to assess inflation at wholesale level prior to reaching customer
  - Construction materials include all raw materials obtained to begin projects
- **Construction materials - new orders**
  - Measures order transaction volume in millions of dollars ($) of raw materials and supplies
- **LIBOR**
  - Interest rate used in lending between banks on the London interbank market used as a reference for setting the interest rate on other loans

Timing Differences

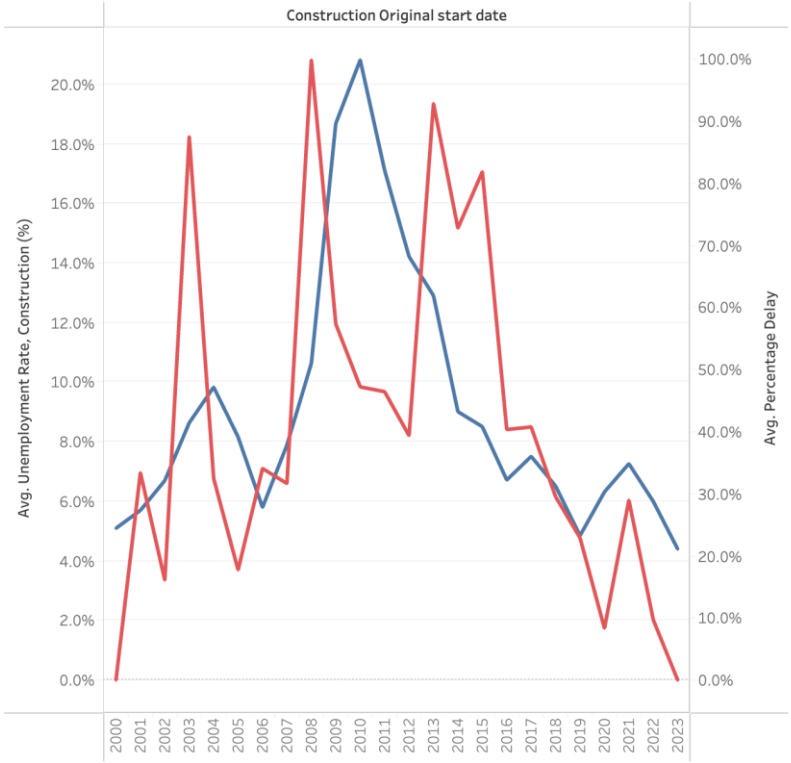
The data is represented based on the first day of each month:

DATE	LNU04032231
2000-01-01	9.7
2000-02-01	10.6
2000-03-01	8.7
2000-04-01	5.8
2000-05-01	5
2000-06-01	4.6

To account for the time between a project bid and its commencement, the data from 6 months prior to the project's start date was used

- Example: Project has Start Date of **8/12/16** - use data as of **2/1/16**

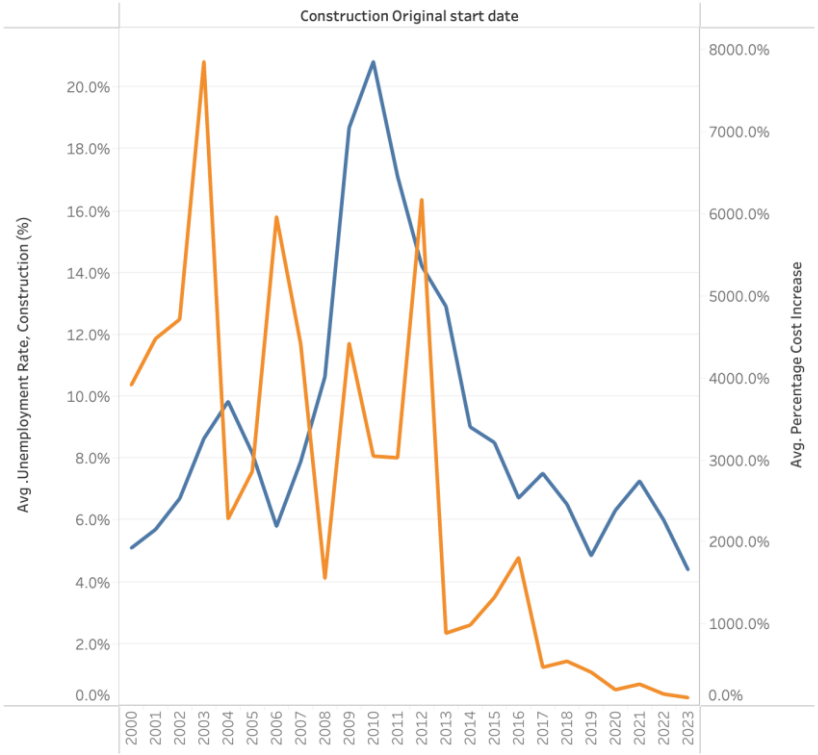
Unemployment Rate & % Cost Increase



Legend:

- UE Rate, Construction
- % Cost Increase

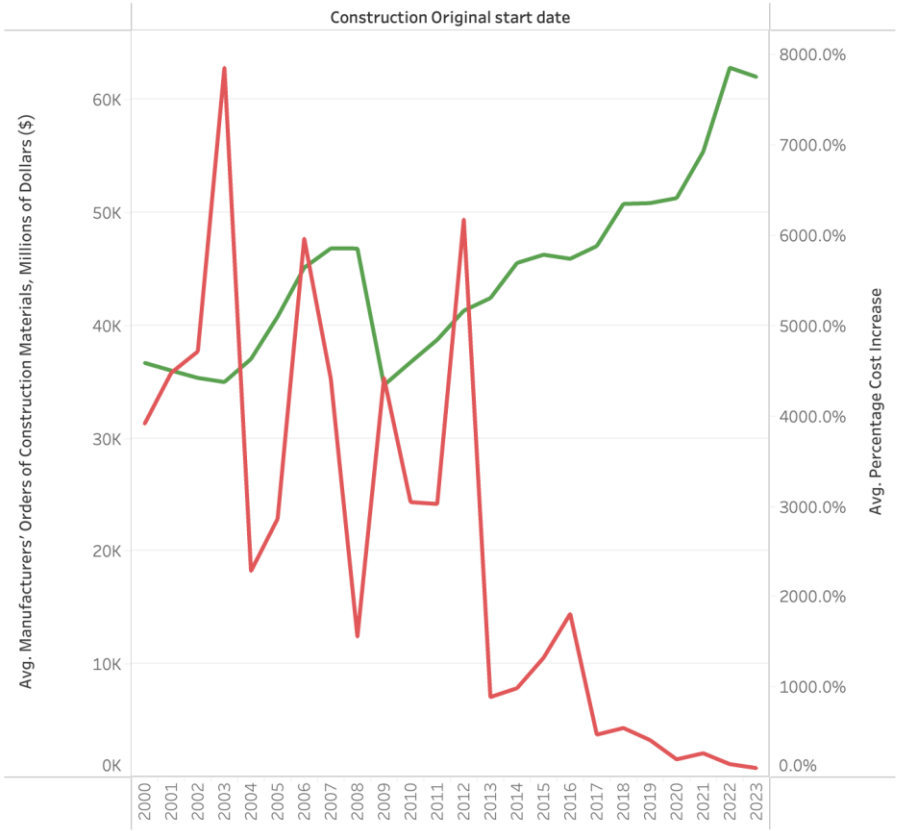
Unemployment Rate & % Change in Duration



Legend:

- UE Rate, Construction
- % Change in Duration

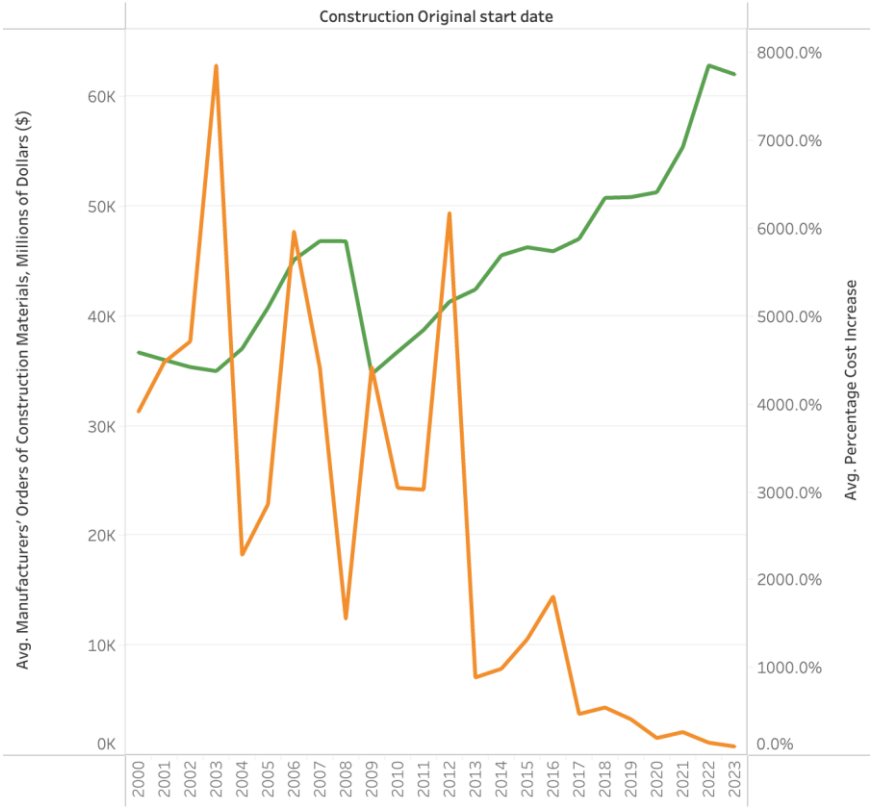
Manufacturers’ Orders vs % Cost Increase



Legend:

- Manufacturers’ New Orders
- % Cost Increase

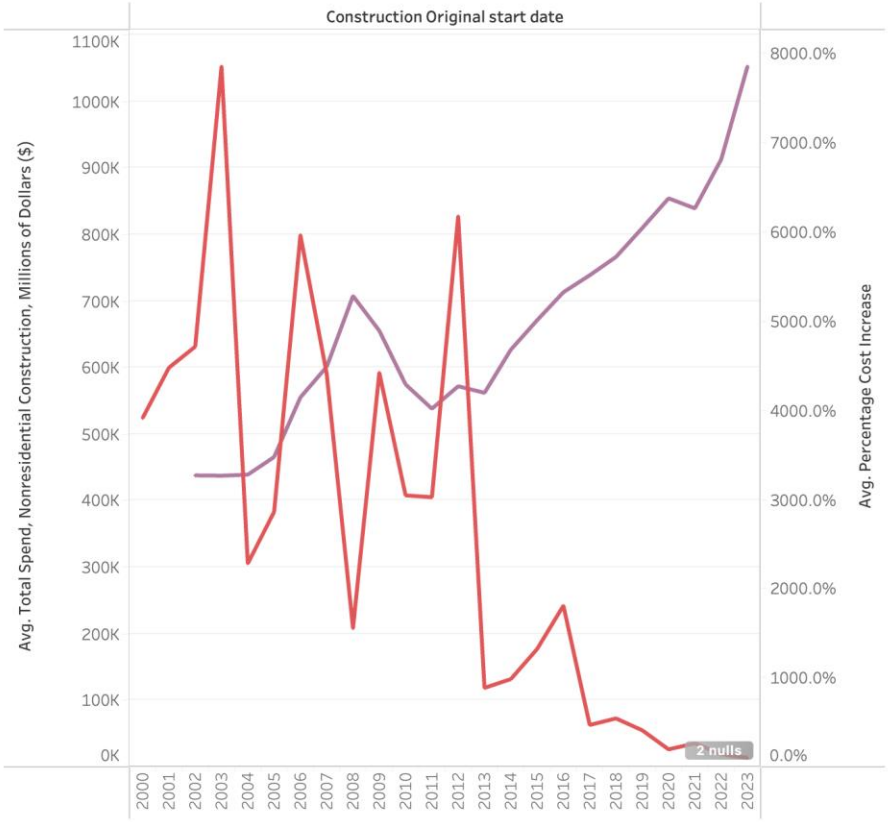
Manufacturers’ Orders vs % Change in Duration



Legend:

- Manufacturers’ New Orders
- % Change in Duration

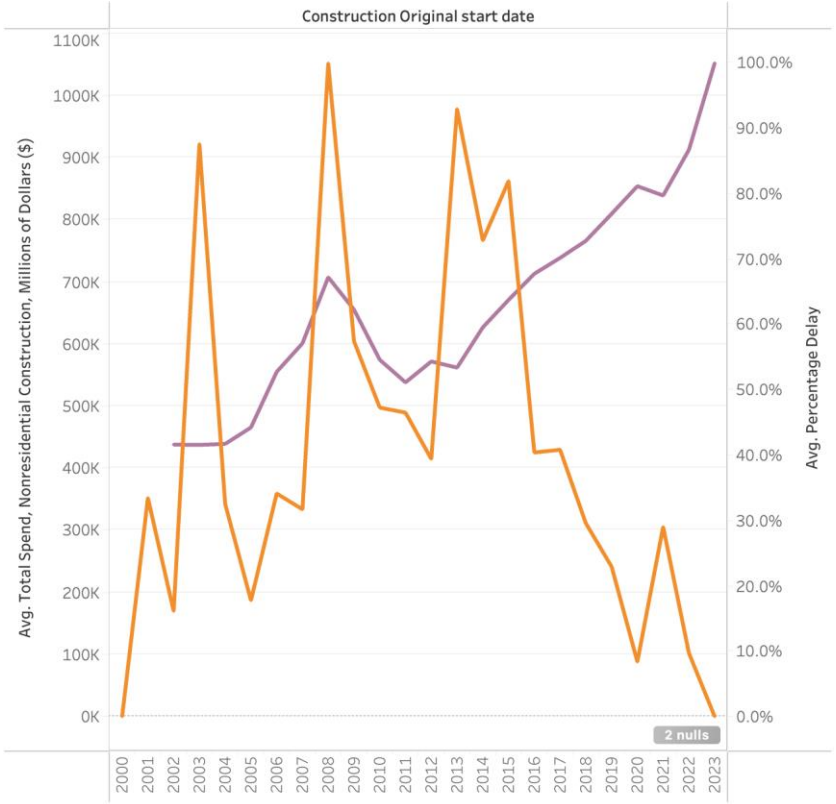
Nonresidential Construction Spending vs % Cost Increase



Legend:

- Nonresidential Spending
- % Cost Increase

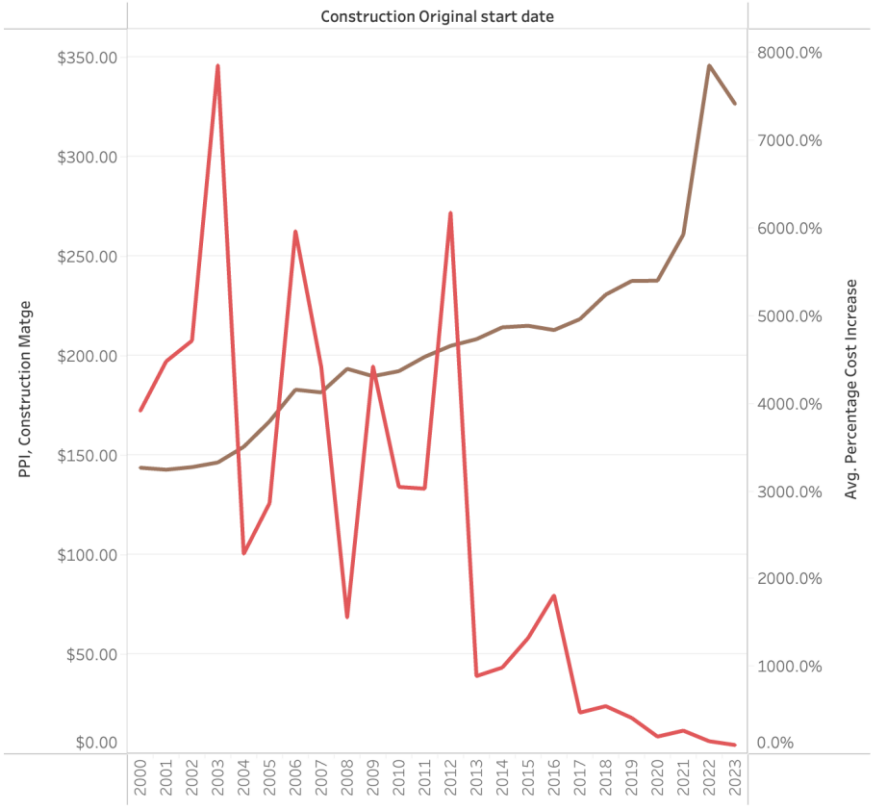
Nonresidential Construction Spending vs % Change in Duration



Legend:

- Nonresidential Spending
- % Change in Duration

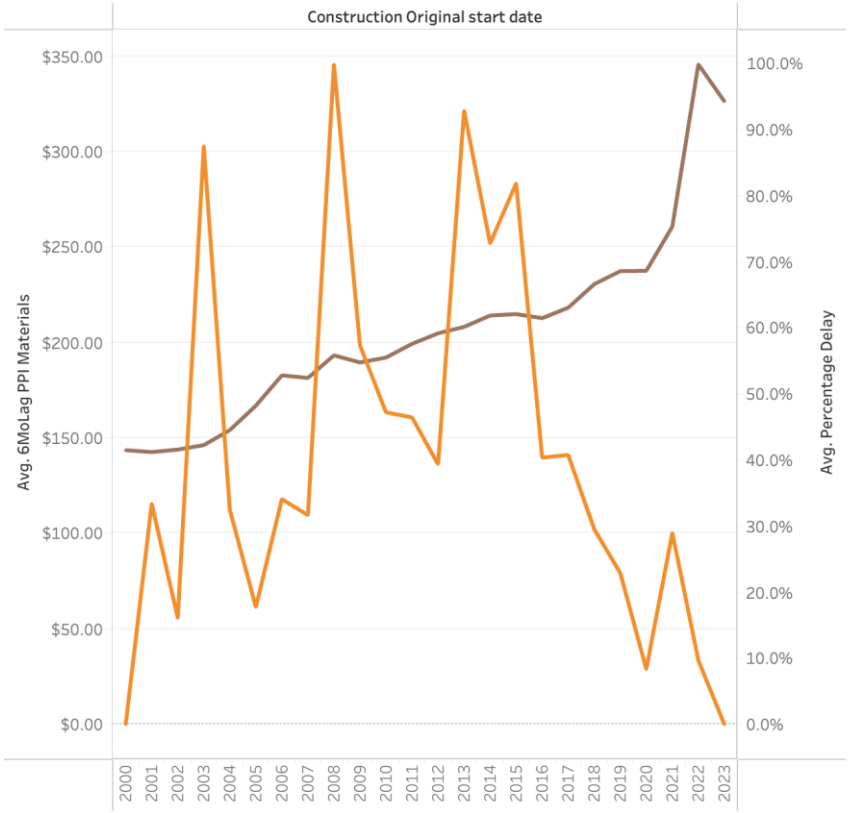
PPI, Construction Materials vs % Cost Increase



Legend:

- PPI, Construction
- % Cost Increase

PPI, Construction Materials vs % Change in Duration



Legend:

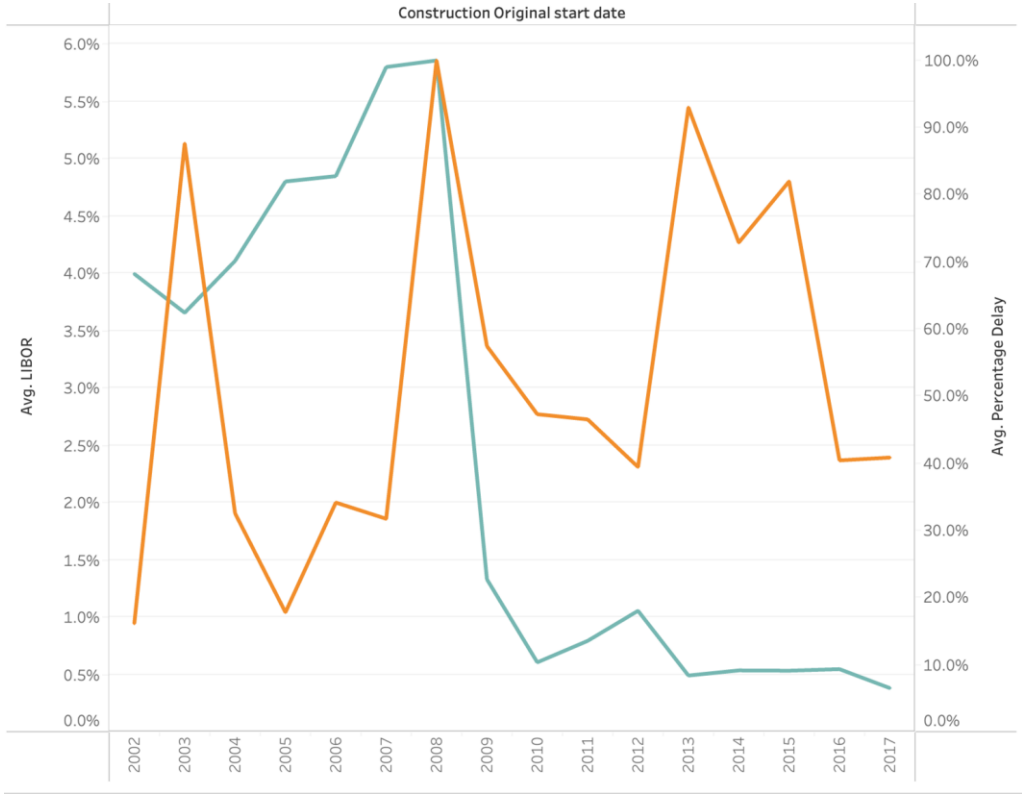
- PPI, Construction
- % Change in Duration

LIBOR vs % Cost Increase

Legend:

- LIBOR
- % Cost Increase

LIBOR vs % Change in Duration



Legend:

- LIBOR
- % Change in Duration

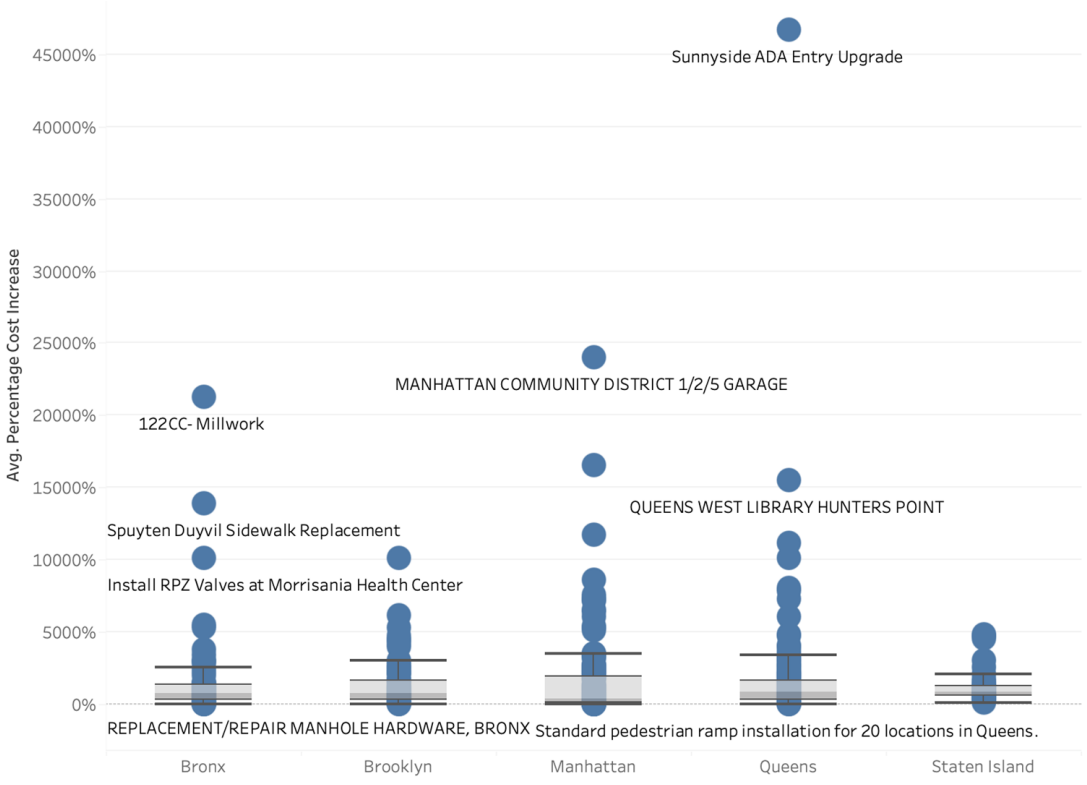
Appendix

Zip Code Analysis

Project Description
DCLA MMA - Air Handler Replacements: WHVAC-2, 3,
METS REPLACEMENT OF 7 AIR HANDLING UNITS
AMNH – ACE Central Plant Upgrade
DSNY - LIGHTING DEBUNDLING PROJECTS
DSNY Betts Ave. Incinerator Boilers Replacement
1125 CARROLL ST BKLN LSP FACILITY
LEONARD COVELLO
GI CONS OF ROW BIOSWALES & STORMWATER PHASE 1
GI CONS OF ROW BIOSWALES & STORMWATER PHASE 2

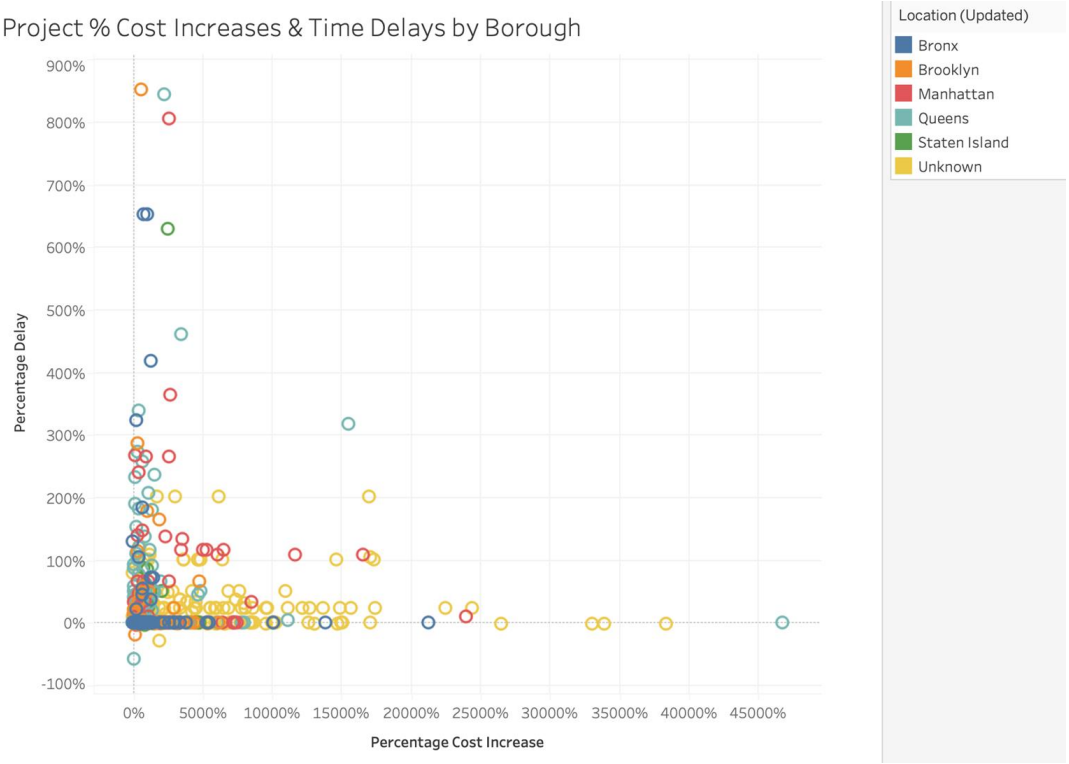
- Many projects have vague descriptions or need to be Googled to define the address
  - Many also have the borough but do not indicate exactly where
- Team manually found boroughs for most projects (left remainder as ‘Unknown’)
- **Zip code analysis can be done in future when additional data is provided**

Which Projects Had Highest % Change in Cost?



Which Projects Had the Longest % Change in Duration ?

Project Cost & Delays by Borough



Project Cost & Delays by Borough (cont.)

Trend Lines Model

A linear trend model is computed for sum of Percentage Delay given sum of Percentage Cost Increase.

Model formula:	Location (Updated)*(Percentage Cost Increase + intercept)
Number of modeled observations:	695
Number of filtered observations:	0
Model degrees of freedom:	12
Residual degrees of freedom (DF):	683
SSE (sum squared error):	524.774
MSE (mean squared error):	0.768337
R-Squared:	0.0131413
Standard error:	0.876549
p-value (significance):	0.613184

Analysis of Variance:

Field	DF	SSE	MSE	F	p-value
Location (Updated)	10	6.9438311	0.694383	0.903748	0.529197

Conclusion: No significant correlation between cost increases & duration delay

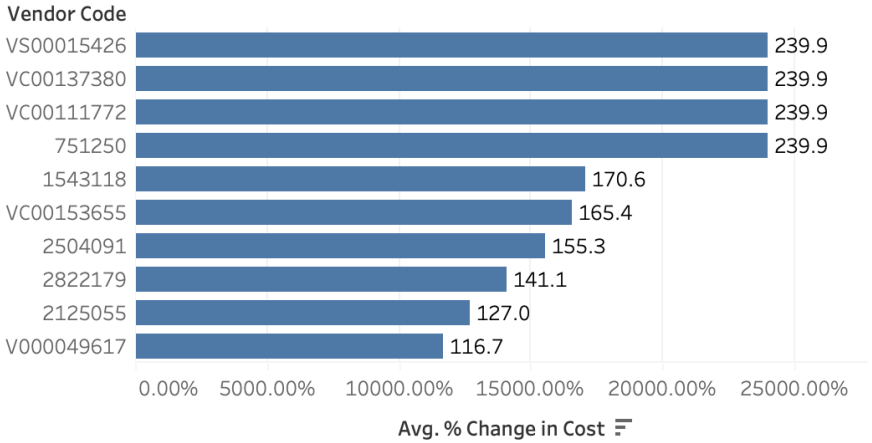
Vendor Analysis

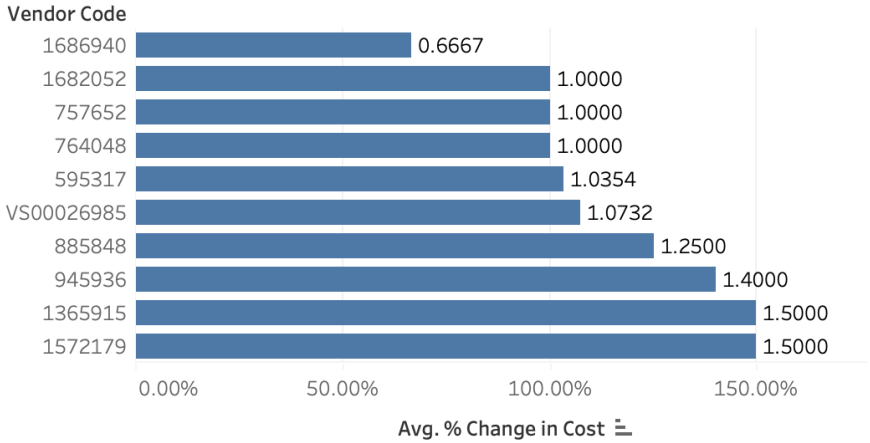
- The sheet “RegistrationDetails 850” contains all possible vendor codes a project can have. Determining the exact vendor code may not be possible due to one-to-many matching items (as shown below):

FMSID_Combined	Project Description	Sponsor	Division	% Change in Duration	% Change in Cost	Potential Vendor Codes
HWCSCH3A	SCHOOL SAFETY IMPROVEMENT, PHASE III - 4 SCHOOLS		Infrastructure	-	741.84%	3197890
HWCSCH3A	SCHOOL SAFETY IMPROVEMENT, PHASE III - 4 SCHOOLS		Infrastructure	-	741.84%	1382664
HWCSCH3A	SCHOOL SAFETY IMPROVEMENT, PHASE III - 4 SCHOOLS		Infrastructure	-	741.84%	1261230
SECBR1	RECONSTRUCTION OF CATCH BASIN - STATEN ISLAND	Environmental Protection	Infrastructure	-	400.00%	2821783
HWRC054-R	HYLAN BOULEVARD INTERSECTION IMPROVEMENT (RE-BID)	Transportation	Infrastructure	-	640.73%	539090
HWRC054-R	HYLAN BOULEVARD INTERSECTION IMPROVEMENT (RE-BID)	Transportation	Infrastructure	-	640.73%	VS00007394
HWRC054-R	HYLAN BOULEVARD INTERSECTION IMPROVEMENT (RE-BID)	Transportation	Infrastructure	-	640.73%	800259
SER200219	STORM SEWERS IN CLEVELAND PL & FINGERBOARD RD	Environmental Protection	Infrastructure	87.64%	765.34%	2821783

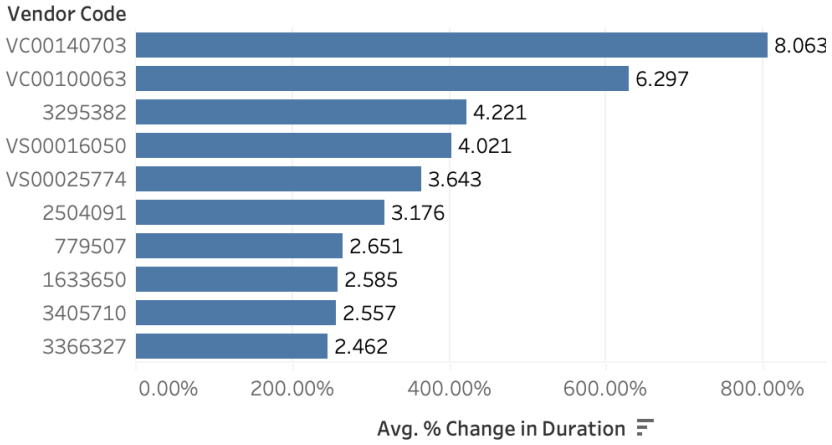
- There are only 149 matching ProjectIDs between the data from Town and Gown and the vendor information analyzed by students in 2016. Therefore, vendor analysis will be done in a future study.

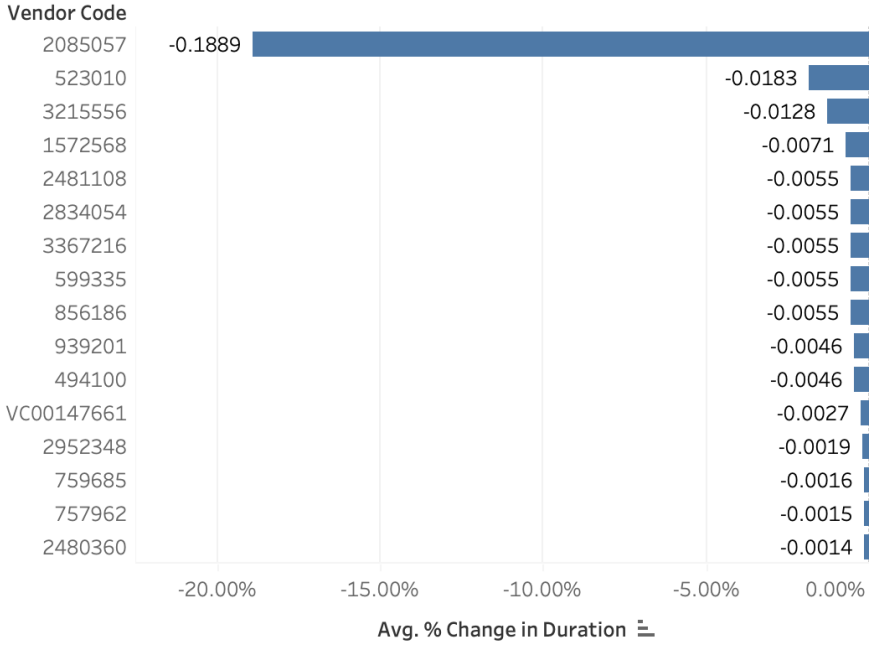
Public Buildings % Change in Cost by Vendor (Top & Bottom 10)



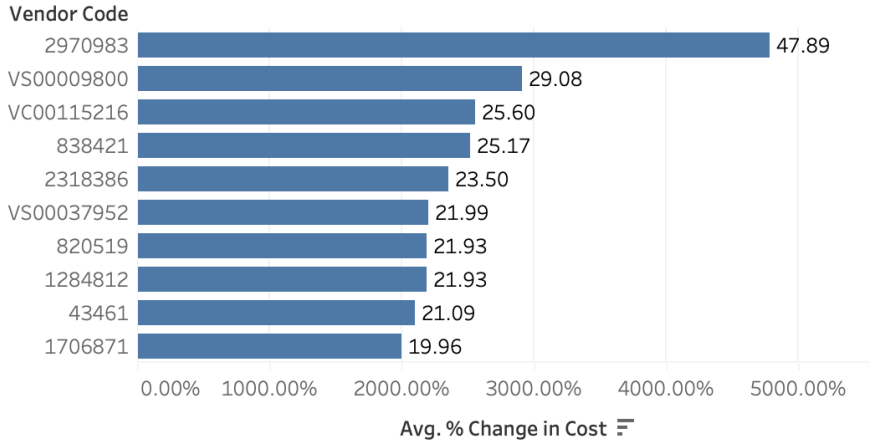


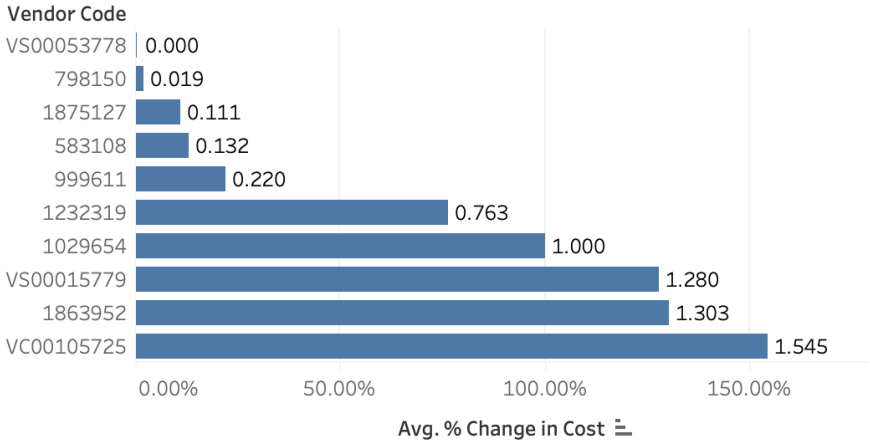
Public Buildings % Change in Duration by Vendor (Top 10 & Reductions)





Infrastructure % Change in Cost by Vendor (Top & Bottom 10)





Infrastructure % Change in Duration by Vendor (Top 10 & Reductions)