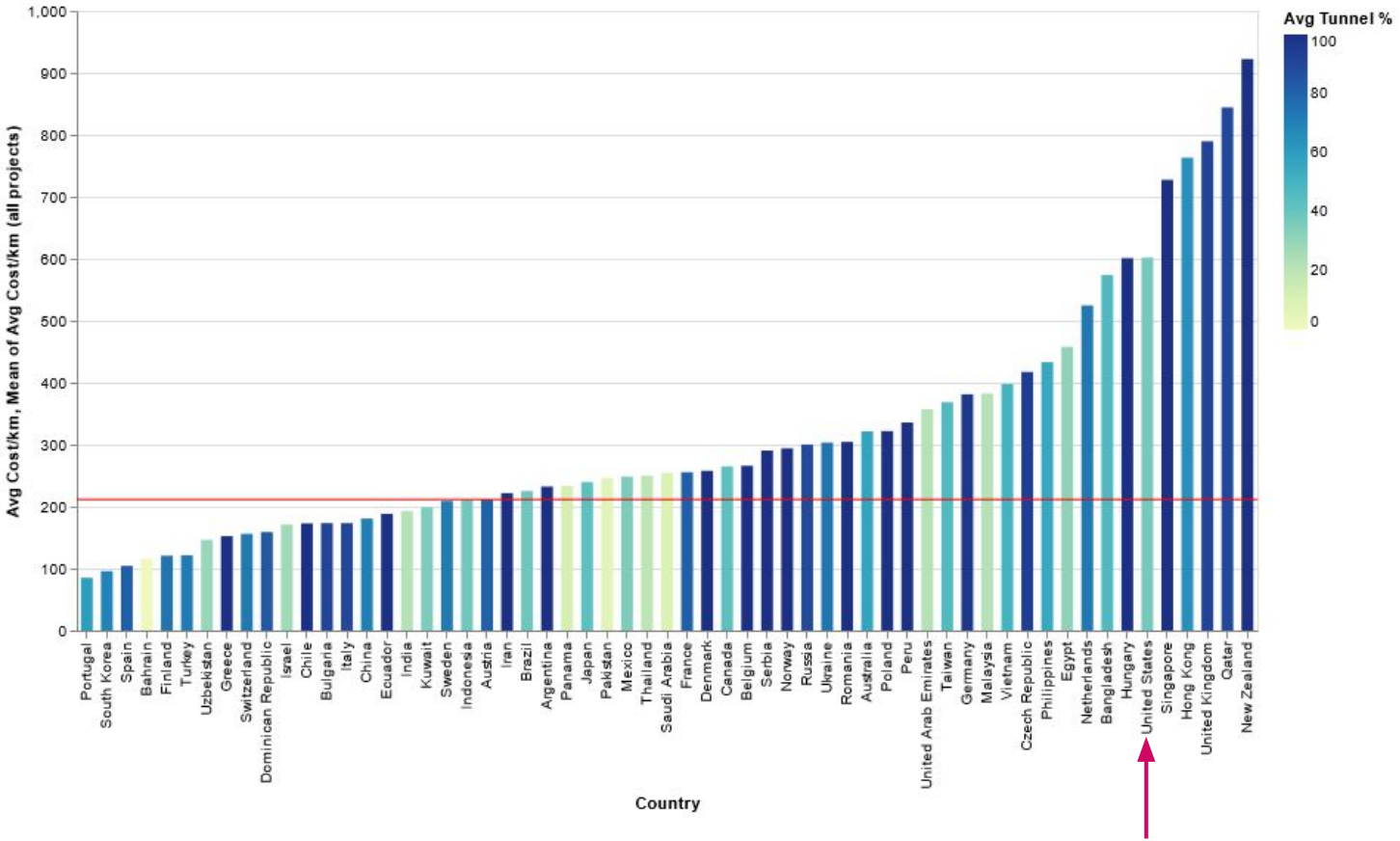
Transit Costs Project

Understanding Transit Infrastructure Costs in American Cities

Eric Goldwyn, Alon Levy, Elif Ensari and Marco Chitti

NYU Marron Institute of Urban Management


Avg Cost/km, Mean of Avg Cost/km (all projects)
1,000
900
800
700
600
500
400
300
200
100
0
Portugal
South Korea
Spain
Bahrain
Finland
Turkey
Uzbekistan
Greece
Switzerland
Dominican Republic
Israel
Chile
Bulgaria
Italy
China
Ecuador
India
Kuwait
Sweden
Indonesia
Austria
Iran
Brazil
Argentina
Panama
Japan
Pakistan
Mexico
Thailand
Saudi Arabia
France
Denmark
Canada
Belgium
Serbia
Norway
Russia
Ukraine
Romania
Australia
Poland
Peru
United Arab Emirates
Taiwan
Germany
Malaysia
Vietnam
Czech Republic
Philippines
Egypt
Netherlands
Bangladesh
Hungary
United States
Singapore
Hong Kong
United Kingdom
Qatar
New Zealand
Country
Avg Tunnel %
100
80
60
40
20
0

Case Studies

- Boston: Green Line Extension
- Istanbul: M4, Marmaray and M9
- Italy: Milan, Rome, Turin and Naples
- Sweden: Citybanan and Nya Tunnelbanan
- New York: Second Avenue Subway, Phase 1

Second Avenue Subway Case

Second Avenue Subway Timeline

Map by Andrew Lynch: https://www.vanshnookenraggen.com/_index/2021/01/ind-second-system-track-map/

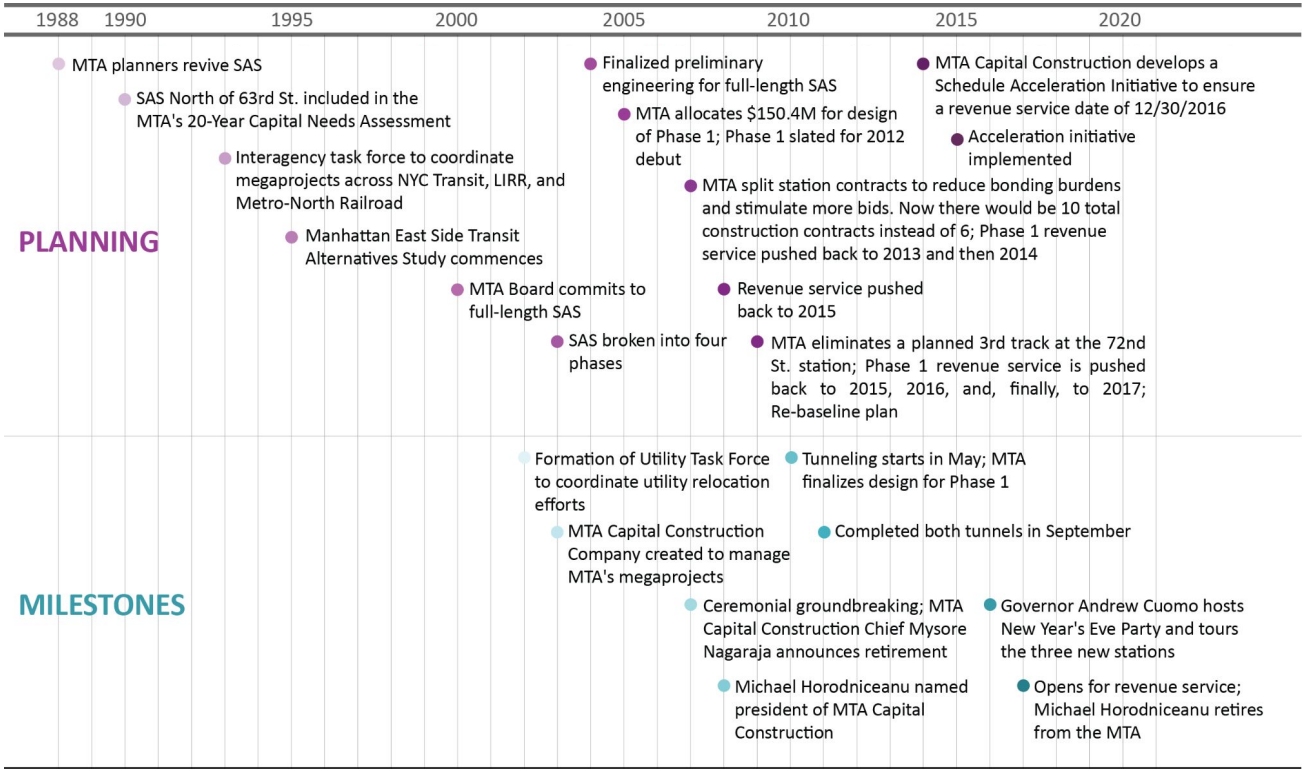
Second Avenue Subway Timeline: IND Costs

- In the late 1920s-30s, the city built the publicly-owned Independent Subway (IND), roughly the modern A-G lines, to compete with older privately-operated lines
- The IND as built was unusually expensive for the time: $180m/km in 2022 dollars (1930s London, Paris: $40m/km)
- “The city did not get what it paid for, but it certainly paid for what it got” - Robert Caro
- Full-length mezzanines, underground flying junctions, gentle curves cutting across street corners, Sixth Avenue construction = $$$
- High costs = in the Depression and WW2 the city had no money for Second Avenue Subway

Second Avenue Subway Timeline: Postwar

- Second Avenue Subway was treated as the most important subway extension, followed by Nostrand and Utica
- 1951: the city raises $559m (2022: $6.3b, $350m/km), but due to diversion to other priorities and Korean War inflation, little is built
- 1972: a priority segment, 34th-126th, begins construction, but by 1973 the cost estimate is $1.3b (2022: $8.6b, $630m/km)
- 1975: due to the city's financial crisis, construction is halted; only three discontinuous segments are built, two to be used for Phase 2 this decade

Second Avenue Subway Timeline: Current Project



Second Avenue Subway Contracts

	CONTRACT		PROPOSED	ACTUAL	INCREASE
	Date Contractor Work	Bids	Duration Cost	Completion Duration Cost	Duration Cost
TUNNELS	3/20/2007 **S3 Tunnel Constructors JV** TBM Tunneling	2	40 months $ 337 million	3/30/2012 60 months $ 378 million	50% 12%
96th STREET STATION	5/28/2009 **E.E. Cruz/Tully Construction** Heavy Civil/Structural, and Utility Relocation	4	43 months $ 325 million	11/5/2013 53 months $ 372 million	23% 15%
	6/22/2012 **E.E. Cruz/Tully Construction** Station Finishes, MEP Systems, Ancillary Buildings, and Entrances	7	42 months $ 324 million	8/7/2017 61.5 months $ 411 million	46% 27%
86th STREET STATION	7/8/2009 **J.D'Annunzio & Sons, Inc.** Excavation, Utility Relocation, and Road Decking	5	19 months $ 34 million	11/16/2011 28 months $ 41 million	47% 19%
	8/4/2011 **Skanska/Traylor JV** Heavy Civil/Structural	5	37 months $ 302 million	12/16/2014 52 months $ 326 million	41% 8%
	6/12/2013 **86th Street Constructors** Station Finishes, MEP Systems, Ancillary Buildings, and Entrances	5	35.5 months $ 208 million	9/29/2017 51.5 months $ 266 million	45% 27%

S

	CONTRACT		PROPOSED	ACTUAL	INCREASE
	Date Contractor Work	Bids	Duration Cost	Completion Duration Cost	Duration Cost
72nd STREET STATION	10/1/2010 **Schiavone/Shea/Kiewit** Cavern Mining, G3/G4 Tunnels, and Heavy Civil/Structural	3	39 months $ 447 million	1/14/2014 39.5 months $ 448 million	1% 0%
	2/14/2013 **Judlau Contracting** Station Finishes, MEP Systems, Ancillary Buildings, and Entrances	5	33 months $ 258 million	8/3/2017 56.5 months $ 347 million	71% 34%
63rd St. Stn.	1/13/2011 **Judlau Contracting** Reconstruction	6	40 months $ 176 million	12/29/2017 83 months $ 229 million	108% 30%
SYSTEMS	1/18/2012 **Comstock Skanska JV** Track, Power, Signals, and Communications	4	55 months $ 262 million	7/12/2018 78 months $ 336 million	42% 28%
DESIGN & CM	5/31/2007 **PB Americas** Consultant Construction Management		91 months $ 81 million	8/31/2021 173.5 months $ 204 million	91% 152%
	12/20/2001 **Aecom-Arup JV** Design and Engineering Services		183 months $ 187 million	3/31/2021 210 months $ 451 million	15% 142%

Second Avenue Subway: Some Extra Costs

Even before beginning the final analysis, we noticed some peculiarities.

- Marx Brothers Playground: $15 million (2022: $20m) to NYC Parks to use its territory to stage construction; the Other People's Money issue
- Work hour constraints while the tunnel-boring machine (TBM) worked 24/7 required additional muck storage at 96th Street, costing $20-30m for the storage chamber plus higher trucking costs

Why Is Second Avenue Subway So Expensive?

Our comparison cases help illuminate how New York spends $2b/km where $200m/km is more normal

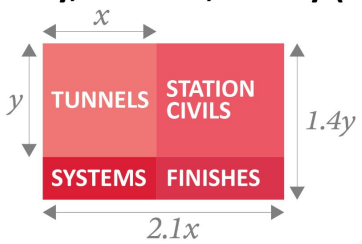
Primary Factors

- Physical Structures
- Labor
- Procurement
- Soft Costs

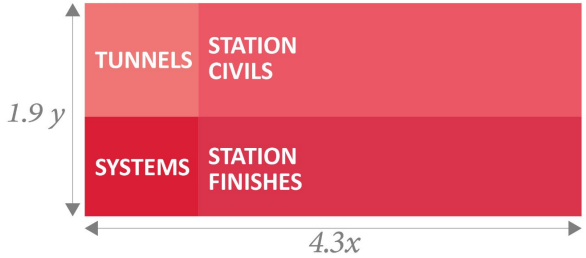
Physical Structures:

Stations and Tunneling

Italy, Sweden, Turkey (Baseline) Rail Construction Costs

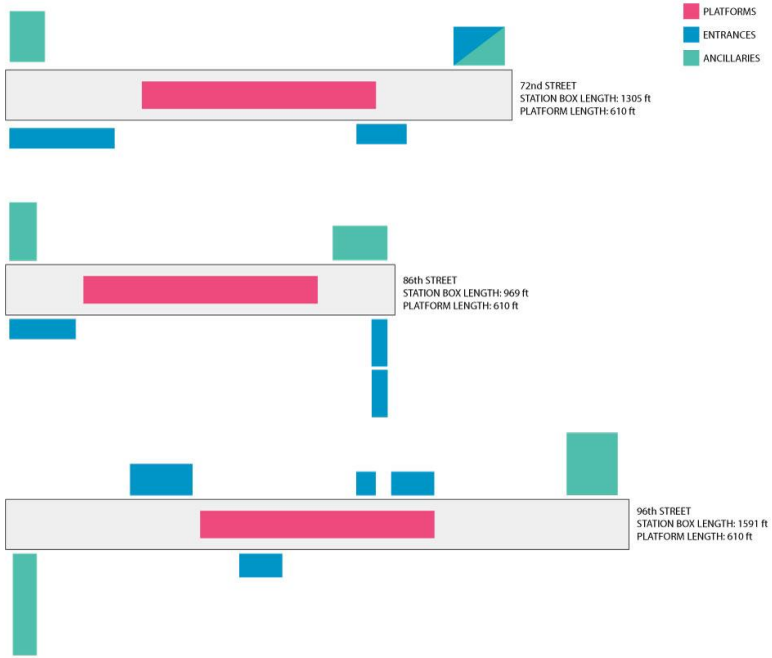


Second Avenue Subway Construction Costs



Physical Structures:

Stations and Tunneling



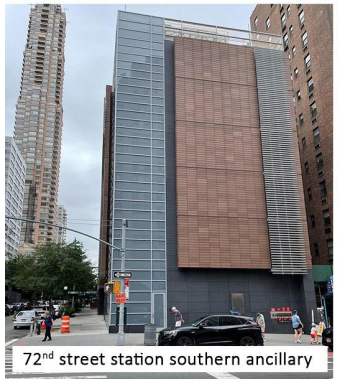
Physical Structures:

Stations and Tunneling

72nd street station northern ancillary

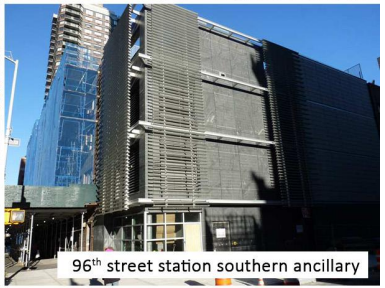
86th street station northern ancillary

96th street station northern ancillary



72nd street station southern ancillary

86th street station southern ancillary

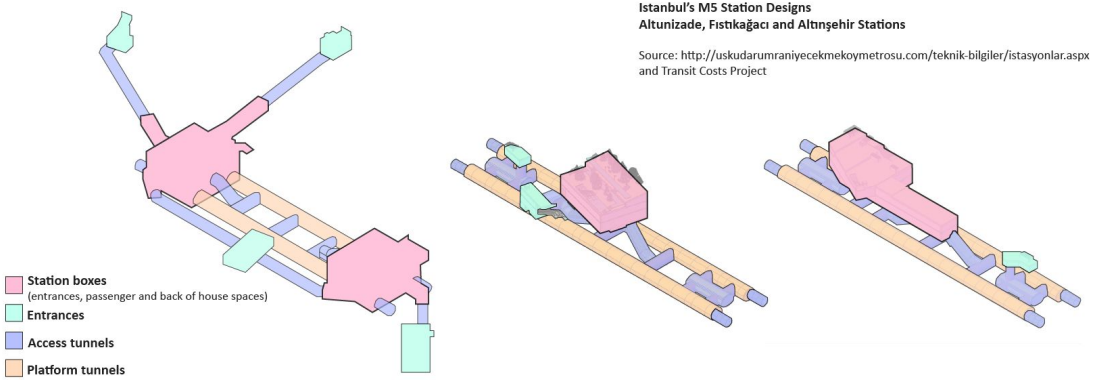


96th street station southern ancillary

72nd st. North: Laverick, K., https://www.vanshnookenraggen.com; 72nd st. South: Goldwyn, E.; 86th st. North: Henderson, J., https://www.wikiwand.com; 86th st. South and 96th st. South: Walsh, K., Forgotten New York.; 96th st. North: Google Street View.

Physical Structures:

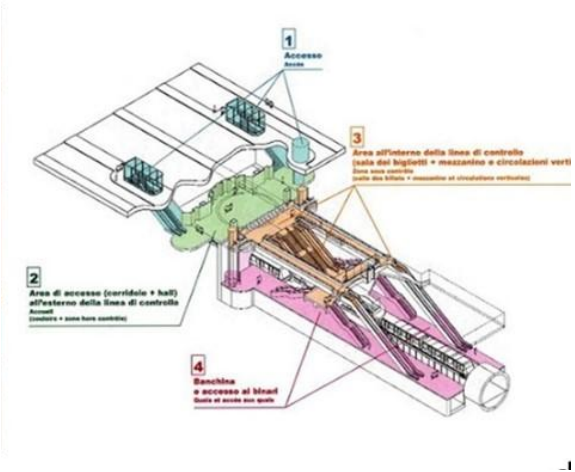
Stations and Tunneling



Istanbul's M5 Station Designs
Altunizade, Fıstıkağacı and Altınşehir Stations

Source: http://uskudarumraniyecekmekoymetrosu.com/teknik-bilgiler/istasyonlar.aspx and Transit Costs Project

Istanbul's M5 stations



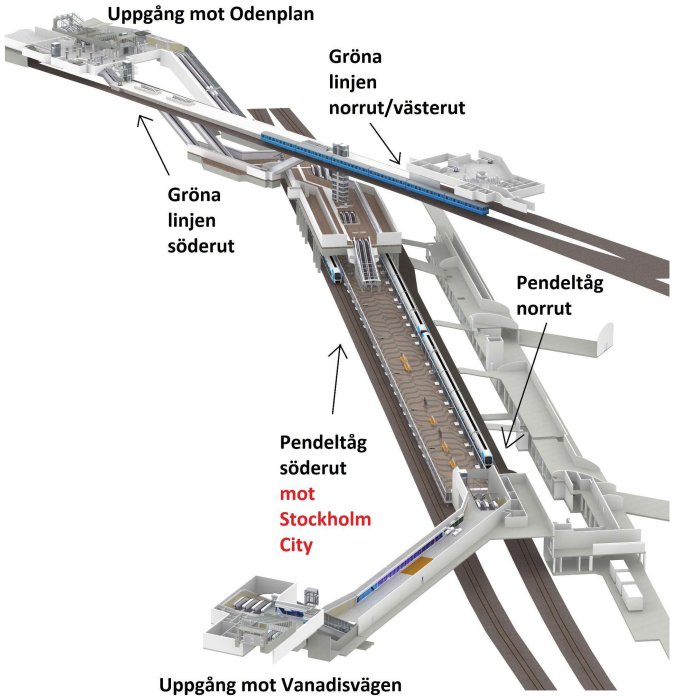
Turin Station

Physical Structures:

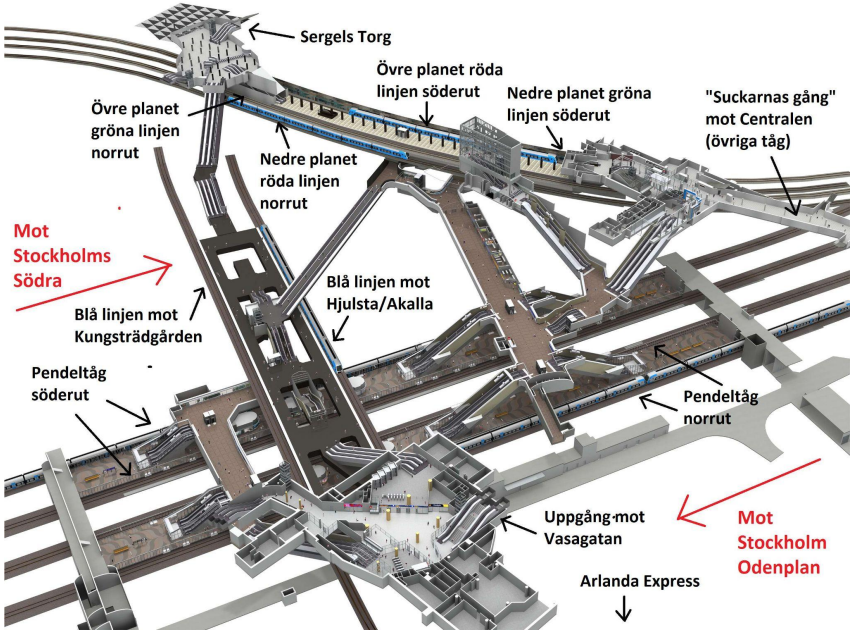
Systems and Standardization

GLX Station Proposal

Physical Structures: Station Sizing



Odenplan Stations



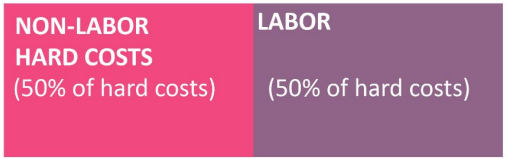
Stockholm City Station

Labor

In the Northeastern US, labor is 50% of hard costs (Sweden, Italy, Turkey: 20-30%).

Italy, Sweden, Turkey (baseline) rail construction costs

SAS construction costs



This means there's a 3x premium on labor costs, and a 1.5x premium on overall costs coming from just labor excess. Why?

Labor: White-Collar Issues

There is severe **overstaffing** in Northeastern infrastructure projects. But it's not purely about union problems:

- White-collar supervisor efficiency is particularly low: the Green Line Extension employed a supervisor per 1.8 trades worker (New England private-sector norm: 1 per 2.5-3).
- Utility conflict means that New York utilities demand that their own supervisors be in the tunnel at MTA expense, adding more supernumeraries

Labor: Blue-Collar Issues

We caution that in the US, managers readily blame labor and overrate its importance; in particular, wages and benefits in New York are the same as in Stockholm. However, three real problems exist:

- Rigid overtime rules (2x in New York, inc. weekends; Sweden: no overtime; France: 1.25-1.5x), combined with a seniority system in which workers deliberately seek out shifts with overtime; this also reduces safety
- Mostly local labor force, low intra-national and no international mobility
- Unions are perceived as a veto point even on changes that are pure tradition, not contractual

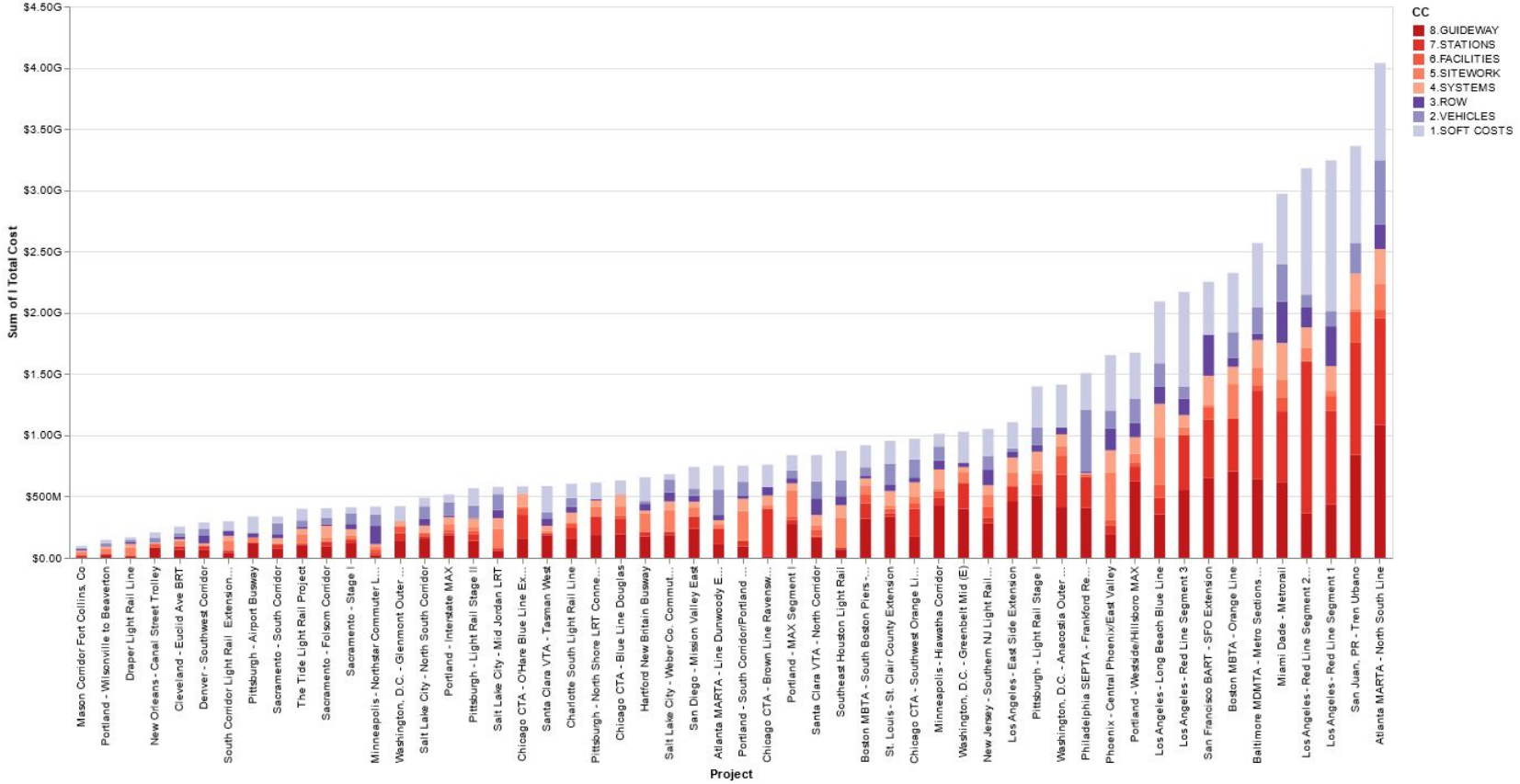
Labor: Some Numbers

SAS TBM staff numbers

Actual and Proposed Tunnel Boring Machine Staffing for Second Avenue Subway Phase 1

Team	Number of Staff/Shift	Fully-Laden Employment Cost	Proposed Number of Staff/Shift	Fully-Laden Employment Cost of Proposed Scenario
TBM Crew	20	$73,720	13	$47,457
Support gang- Shaft Service crew, Bottom, and Top crew	26	$89,964	17	$57,882
Total per Shift	**46**	**$163,684**	**30**	**$116,529**
Total	**138**	**$491,052**	**90**	**$349,586**

Procurement and Soft Costs



Procurement and Soft Costs: the Globalized System

In the 1990s, a **globalized** system of procurement developed in the UK/Hong Kong/Singapore:

Traditional system	**Globalized system**
Design-bid-build	Design-build
Itemized contracts	Fixed price contracts
Public-sector risk	Private-sector risk
In-house supervision of contractors	Greater use of consultants

The globalized system has coincided with a cost explosion everywhere it's been tried (Anglosphere premium)

Procurement and Soft Costs: Good Political Practices

The best systems employ an **apolitical civil service** with permanent in-house staff and public-sector learning. This means all of the following:

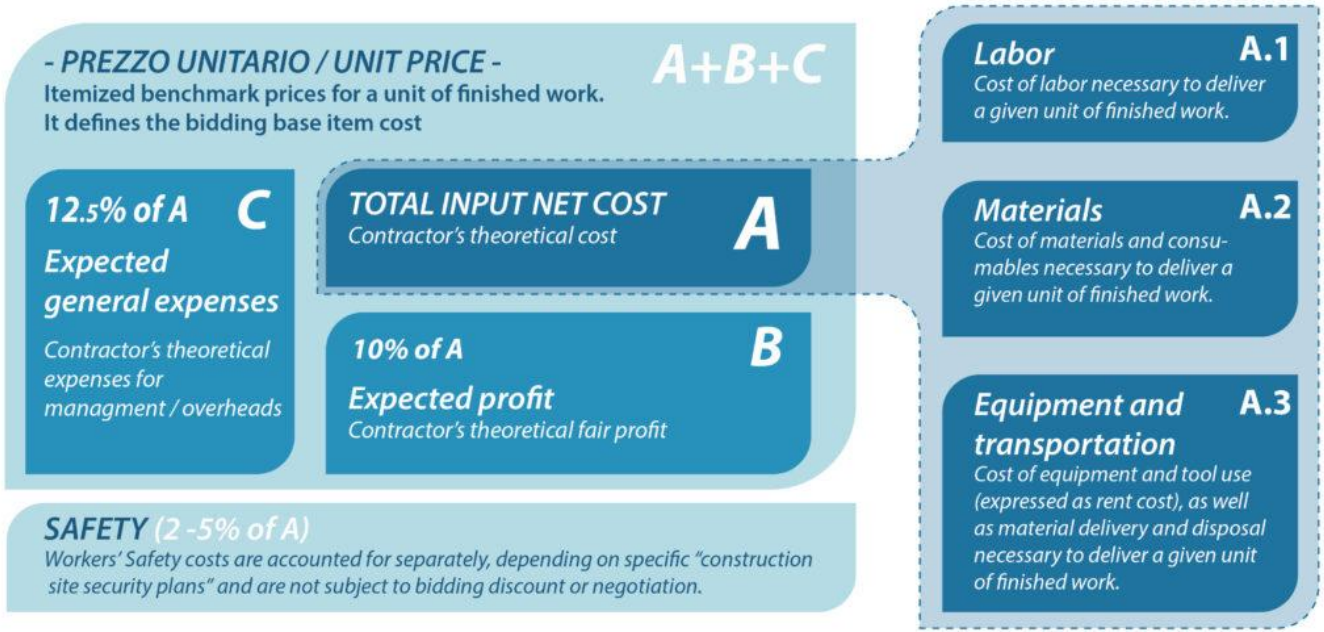
- Political *macro*- but not *micromanagement* of planning and engineering decisions, even in highly politicized, polarized systems (Italy, Turkey)
- Consultants may assist, but there must always be sufficient in-house capability to supervise them, rather than other consultants supervising consultants and contractors (“bring back the bureaucrats”)
- Consistent regulations: if something works, don’t tighten rules and don’t impose unfamiliar regulations on contractors
- Limited contingencies - projects must be rated on absolute costs, not overruns

Procurement and Soft Costs: Project Delivery

The lowest-cost countries consistently use the following procurement system:

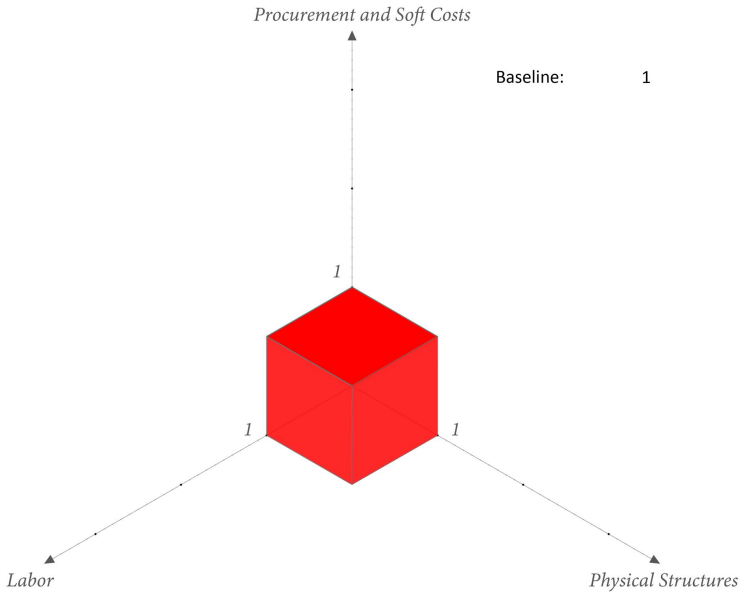
- Technical scoring: contracts are given by a technical score (50-80% of bid), rather than lowest-bid
- Itemized costs: changes are pre-priced, reducing change order friction (Bolotnyy-Vasserman, Ryan: 10-20% cost savings)
- Flexibility: builders can do substantial changes to the design (“des-bid-ign-build”)
- Fast response: in-house staff can make quick decisions if a change is needed, without needing to go through a consultant or senior manager

Procurement and Soft Costs



Procurement and Soft Costs: Consultants

Factor of 8-12



Recommendations: Politics and Management

- Find champions who will macro- and not micromanage
- Be globally curious and don’t be snobbish - smaller and poorer cities than yours often have the right answers; use global knowledge to develop in-house knowledge
- Coordinate with other agencies, including utilities and (for regional rail projects) other railroads
- Foster transparency of utilities, itemized costs, etc.
- Staff up in-house, and avoid politicization

Recommendations: Procurement

- Regardless of whether you use design-build, supervise contractors yourself and don’t be a nightmare client
- Itemize contracts and make the items publicly available, anchoring the change order process
- Do not privatize risk
- Award contracts based on technical merit, not just cost
- Standardize regulations
- Limit contingencies - all money in the budget will be spent

Recommendations: Physical Structures

- Standardize the systems, reuse designs, and avoid overspending on signature stations - stations can look nice without each one having a separate escalator design
- Build as shallowly as possible, with cut-and-cover stations and if possible also cut-and-cover tunnels
- Build right-size station boxes, little longer than the platforms of the trains they’re expected to serve

Thank you