On the Right Track:

Rail Transit Project Delivery Around the World

Eno Center for Transportation

September 2022

Acknowledgments

The Eno Center for Transportation would like to express gratitude to Brianne Eby, Romic Aevaz, and Katie Donahue for their research and writing contributions to this paper and to Philip Plotch, Robert Puentes, and Ethan McLeod for their help with reviewing and editing. Karen Price, Jonathan Hammond, and Michaela Boneva also provided invaluable assistance in preparing the report and accompanying digital materials for publication.

Eno would also like to thank members of our Project Delivery Advisory Panel for their expertise, constructive feedback, and support of this work, including Alison Black, David Carol, Aileen Carrigan, Richard Clarke, Eric Goldwyn, Beth Osborne, Thomas Prendergast, Edwina Smallwood, and Margaretta Veltri.

The Eno Center for Transportation would like to acknowledge and thank the Federal Transit Administration for providing financial support for this and future work related to improving transit project delivery in the United States.

About the Eno Center for Transportation

The Eno Center for Transportation (Eno) was founded in 1921 by William Phelps Eno (1859-1945), who pioneered the field of traffic management in the United States and Europe. Mr. Eno sought to promote safe mobility by ensuring that traffic control became an accepted role of government and traffic engineering became a recognized professional discipline. As a non-profit 501(c)(3) organization, Eno can look back on a long and proud history as a thought leader in national transportation policy with a strong training and leadership program.

The leader in its field for nearly a century, Eno provides government and industry leaders with timely research and an independent voice on policy issues. Eno publishes rigorous, objective analyses on the problems facing transportation and provides ideas for, and a clear path toward possible solutions. In addition, for nearly two decades, Eno Transportation Weekly (ETW) has been the premier federal transportation policy publication for transportation leaders across the country.

Through its professional development programs, Eno cultivates creative and visionary leadership by giving public and private transportation leaders the tools and training they need to succeed together. Since its inception, Eno has instructed over 3,500 transportation professionals.

Eno enjoys a truly unique position as the hub of a network of transportation industry leaders with a smart and dedicated staff and a solid reputation for credible, independent, and impactful work.

Table of Contents

Author: Paul Lewis, Chief Finance Officer and Policy Director

1.0 – Introduction

When the Infrastructure Investment and Jobs Act (IIJA) was signed into law at the end of 2021, it promised to usher in a new era in transportation, energy, water, and telecommunications projects. This major increase in investment provides public transportation programs with $90 billion in guaranteed funding over five years, a 65 percent increase over previous funding levels.[1] In early April 2022, the first tranche of money started going out to agencies across the country.[2]

Today, there is a particular emphasis on making sure that money for new public transit projects is spent more effectively, and that projects are delivered on time and on budget. Unfortunately, recent Eno research found that urban rail transit projects in the United States suffer from disproportionately high costs and long timelines compared to international peers. The United States pays more than a 50 percent premium to build at-grade and tunneled rail projects despite its projects being relatively simpler in terms of engineering aspects. For instance, projects here often run along the surface and through existing rights-of-way, and with greater distances between stations compared to international projects.[3]

Assessing how other countries govern, plan, build, and finance their rail transit projects will lead to a better understanding of how to improve delivery in the United States. Trade missions, capacity building, and technology transfer initiatives with agencies abroad are critical to learn what works, what does not, and how lessons can be tailored for other cities and metropolitan areas. Such information exchanges would help U.S. planners, engineers, leaders, and designers better understand the best practices and innovations in governance, planning, standards, and processes of transit project delivery around the world.

This study builds on Eno's 2021 Report *Saving Time and Making Cents,* and the ongoing initiative to improve transit rail project delivery in the United States. Eno selected 10 countries in which to conduct detailed reviews, summarized below and in more detail in accompanying case studies. For each country, we collected comprehensive data on recent rail projects (excluding land acquisition, support facilities, and rolling stock when possible) and added them to our construction cost database. This enabled us to make quantifiable comparisons on metrics such as number of stations, cost per mile, length, and percent tunneled. The full database can be accessed at https://projectdelivery.enotrans.org/#data-analysis.

This analysis found there are clear lessons the United States can learn from its peer nations with respect to transit project delivery. More important than the precise

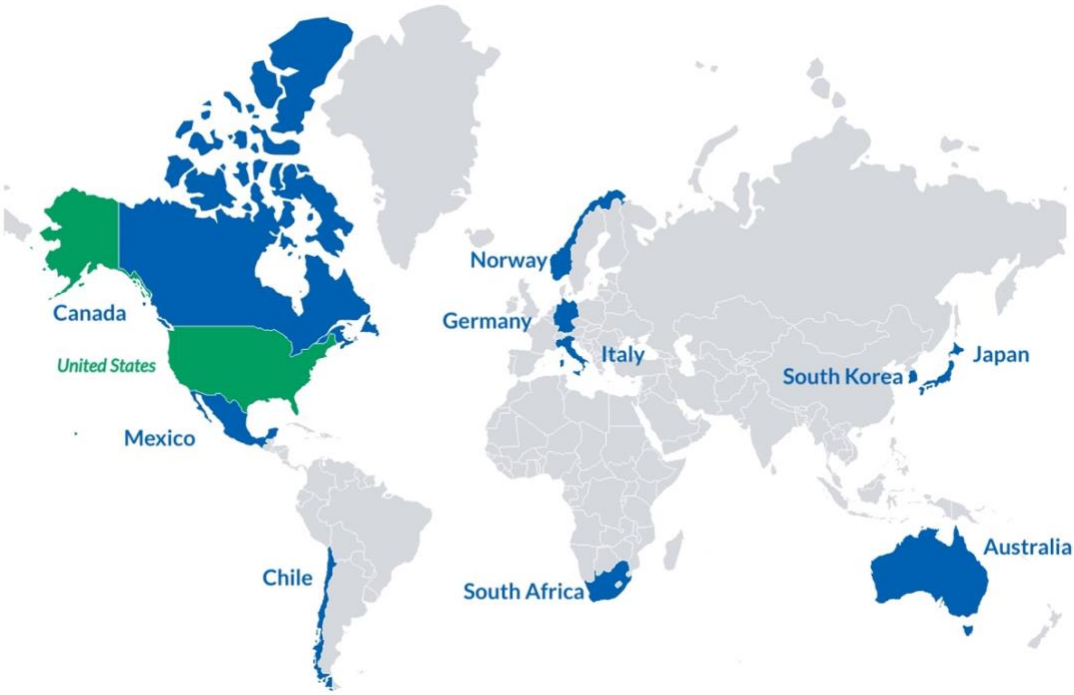
governance structure, delivery method, or process employed is the shared commitment at all levels of government to delivering high-quality transit. There needs to be strong public-sector staff capacity and management skills, close collaboration between stakeholders, and the ability for project sponsors to make prompt, firm decisions about projects. No country is inherently predisposed to having higher or lower construction costs, but those that do it best are those places where strong project governance, straightforward processes, and modern standards are aligned. Uncertainty, ambiguity, and lack of coordination are the enemies of efficient transit project delivery.

2.0 – Background and methods

To gain a better understanding of government, governance, funding structures, and other policies that support project delivery internationally, Eno selected 10 case studies from other democratically governed countries (Figure 1). While countries with one-party political systems or autocratic governments, such as China or Russia, can have success building passenger rail systems, the decision-making structure and regulatory requirements of this type of government are too dissimilar from that of democratic systems, making for many nontransferable lessons for the U.S.[4]

In selecting case study countries, we strove for geographic diversity and included only those that have built at least one major urban rail project since 2000.[5] We conducted dozens of interviews with stakeholders and experts familiar with rail transit project delivery in each place. Interviewees represented national and local government agencies, research institutions, trade associations, and other experts. We reviewed government budgets, project planning documents, environmental assessment reports, research publications, industry reports, and popular media articles.

Figure 1: Case study countries



Blue are countries reviewed in this study, compared with the United States (green)

The goal was to review how the responsibilities of different levels of government (federal/national, state/provincial, regional, local, agency) in other countries vary in terms of government, project governance, funding, regulation, planning, and project execution. We evaluated four critical areas for each country—governance, regulation, finance, and construction—to establish a common baseline of understanding and comparison.

Eno collected data on 132 rail transit projects completed in the case study countries since 2000. This information includes data on grade alignment, construction timelines, stations, and construction costs. All construction costs were converted into 2021 U.S. dollars using the OECD's purchasing power parity rates and adjusted for inflation using the Engineering News-Record Construction Cost Index (CCI). These data were added to Eno's transit construction cost dataset.

Comparing as-built construction costs can offer some clues as to whether other countries are building public transit systems more cost-effectively. However, there are several caveats and challenges when attempting to make a true "apples to apples" comparison between domestic and international construction costs, and between different projects within the same country. The final output of the database is a comparable "unit cost," in inflation- and currency-adjusted dollars per mile of rail line.

But not all projects and agencies are transparent in their cost reporting, and when they are the data tend to be reported inconsistently. For example, some projects include costs not associated with the actual unit cost of mile of rail line. Elements like maintenance facilities or rolling stock are included in some projects, but not others. Some projects deal with unstable soils, and costs can vary based on the number and length of stations. Detailed cost breakdowns are typically not reported for most projects, and if they are, there may be vast differences in the categories used.

For federally funded projects in the United States, regulations require agencies to report cost breakdowns using nine Standard Cost Categories (SCCs).[6] However, as the Eno team discovered when reviewing select cost breakdowns received through Freedom of Information Act (FOIA) requests, some agencies in the United States also use their own internal methodology to track costs, especially for projects that are locally funded. Rather than reporting project costs for items like stations, sitework, and stations, costs in some cases are broken down by project phase (i.e. preliminary engineering or final design). Cost breakdown methodologies between countries can also vary.

When comparing construction costs, it is important to avoid drawing sweeping conclusions or over-interpreting trends, though such comparisons will become richer with more data.

2.1 Government, governance, and legal structure

In general, democracies are governing systems where citizens are sovereign and control the government. Citizens vote to elect legislative representatives who have constitutional power to make policy decisions. The cases in this report are all considered to be parliamentary or presidential democracies. In a parliamentary democracy, the executive branch of government is a cabinet headed by a prime minister. In a presidential democracy, the executive branch of government is led by a president who heads an executive branch of government that is separate from the legislative branch of government (Table 1).

Such attributes matter for project delivery because the executive branch of the national government distributes funds to transit projects and creates regulations that govern their construction. Consistent policies matter for delivering megaprojects with long timelines. The case study countries range from highly centralized to federated power structures. Centralized countries make most or all of the funding and planning authorizations at the national level, while federated countries delegate much of this power to lower-level units of government.

Countries also differ in the type of legal system they use. Roughly 150 countries around the world use civil law systems, and 80 use common law systems.[7] In countries that practice common law, published judicial opinions often set precedent for succeeding cases. In civil law systems, codified statutes determine judicial outcomes. Table 1 shows the classification of each legal system for the 10 case study countries, which can affect agencies' ability to manage utility relocation, environmental reviews, and multijurisdictional issues related to delivering a large transit project.[8]

Table 1: Select governmental attributes of case study countries

Country	Government	National power structure	Legal System
United States	Presidential republic	Federated	Common law
Australia	Constitutional monarchy	Federated	Common law
Canada	Constitutional monarchy	Federated	Common law
Chile	Presidential republic	Centralized	Civil law
Germany	Parliamentary republic	Federated	Civil law
Italy	Parliamentary republic	Centralized	Civil law
Japan	Constitutional monarchy	Centralized	Mixed
Mexico	Presidential republic	Federated	Civil law
Norway	Constitutional monarchy	Centralized	Civil law
South Africa	Republic	Centralized	Mixed
South Korea	Presidential republic	Centralized	Civil law

We also examined varying roles of government, including transit-related responsibilities of the national government (e.g. transportation cabinet officials, ministers of other relevant agencies, and, in some cases, research institutions); sub-national governments (i.e. provincial, regional, or local governments); transit agencies (i.e. the primary capital project delivery and/or operating bodies of public transit); and other stakeholders, such as special purpose delivery vehicles and private operators, if applicable.

2.2 Project regulation and planning

Transit projects usually need a range of authorizations and permits to proceed. Those usually require mandated planning processes, environmental review, and safety standards such as fire protection and preparation for seismic events. Such approvals to proceed are often necessary to receive funding and can be set at all different levels of government, depending on the country and its structure.

Project planning consists of all processes that occur prior to construction. It begins when cities or metropolitan areas submit project funding proposals from state, provincial, or national governments. Throughout this process, there is interaction between officials at all levels of government. Similarly, the countries included in this study require some form of an environmental review process to allow project sponsors

(i.e. the public institutions charged with leading project delivery) to measure the environmental externalities associated with the project and its construction. At this point, the project sponsor either evaluates one discrete project or a series of alternatives, comparing it with a "no-build" option, and assesses its potential impacts on the environment.

Laws and regulations at all levels of government dictate the processes by which projects are planned and what is possible for project delivery. Throughout both the preliminary planning and environmental review phases, varying degrees of public input are sought to inform the final documentation produced and, ultimately, the nature of the project. The public is typically given a defined period of time to offer comments on the proposed project, and government officials are generally required to respond to those comments or incorporate them into project plans.

2.3 Project funding

Rail transit capital projects are expensive, and funding is derived from a combination of sources.

Most national governments provide grants to project sponsors as part or all their funding package. These grants involve competitive applications, legislative earmarks, infrastructure banks, or other programs and are typically distributed from a national-level transportation agency. Local, state, or provincial governments also provide grants or dedicated taxes for transit projects, especially in federated systems that devolve significant planning authority to local governments. Typically, local contributions comprise a smaller portion of capital funding than national government grants, but in some cases the national government provides little or no financial support for urban transit.

In some systems, passenger fare revenue exceeds operating expenses and provides some of the funding resources needed for capital expansion. Project sponsors can bond against future passenger fares to complete a funding package. This is uncommon but has been used to fund some of the system expansions in Chile, South Korea, and South Africa. Also relatively rare is private funding, either through a public-private financing partnership (P3) or other arrangement where a for-profit consortium builds and operates transit under an agreement with a government or agency. In this case, private investors are repaid through passenger fares or promises of government funding if they meet construction or operational requirements.

2.4 Project construction

The work of building a transit project is typically contracted out to private companies that specialize in various aspects of construction. The transit agency (or project sponsor) manages and oversees the project, and also oversees private firms that provide services such as engineering, planning, project management, and design. Construction contractors build the physical infrastructure and project managers who are either public sector employees or hired private consultants are also overseen by the project sponsor.

In some cases, public special purpose delivery vehicles (SPDVs) are created for specific projects to oversee planning and construction. These temporary, self-governed entities are more common outside of the U.S. and are usually public corporations empowered to make decisions about project delivery.

There are several contract types available for organizing the project delivery process, including:[9]

- Design-bid-build (DBB), in which the project sponsor hires an engineering and planning firm to design the project and awards separate contracts to construction companies based on the designer's plans. The project sponsor owns design details and assumes much of the project's financial risk.
- Design-build (DB) allows the project sponsor to procure design and construction together in a single contract. The DB entity is typically a consortium of multiple firms that is liable for delivering the planned asset, usually according to a fixed price.
- Construction manager-at-risk (CMR) contracts shift some control and risk to the private sector, though the project sponsor controls and owns project designs. The construction manager is selected prior to the completion of the design, and thus can participate in the design process.

Project construction also involves procurement rules, workforce compensation and unionization, project management structures, and approaches to address community disruption. These factors can vary from project-to-project and country-to-country. For example, many projects cover workforce healthcare and other benefit costs directly either through employer-based plans or government payroll taxes, and other countries do not. Those that are noteworthy or consistent within a country are highlighted in this report.

3.0 Analysis

This analysis found large variation in construction costs across the 10 case study countries. Construction costs for primarily tunneled projects range from under $300 million per mile in South Korea, Chile, Norway, and Italy to over $500 million in Germany and Japan. The United States averages over $1.3 billion per mile if including two short, tunneled projects in New York City, or $582 million per mile on average if they are excluded.

Table 2: Average cost per mile for primarily tunneled projects ($USD million)

1. United States*	$1,347
2. Japan	569
3. Germany	509
4. Canada	483
5. Mexico	468
6. South Korea	292
7. Italy	271
8. Chile	135
9. Norway	120

**U.S. average is $582 million per mile excluding New York City.*
Note: Tunneled projects are those that are 80 percent or more underground. There are no lines that are more than 80 percent tunneled in Australia or South Africa, so those countries were omitted from this part of the analysis.

Similarly stark variations in at-grade construction costs were also observed in our 10-country sample. Some countries, like Japan, witnessed higher-than-average construction costs for both at-grade and tunneled projects, while countries like Italy and Norway are characterized by lower-than-average costs across varying grade alignments. One notable exception is Germany, which has the third highest tunneling costs but the lowest at-grade construction costs. This is due in part to German tram projects, which often run through mixed traffic and are relatively simpler to design, permit, and construct.

Table 3: Average cost per mile for primarily at-grade lines ($USD million)

1.	Japan	$202
2.	Mexico	175
3.	United States	132
4.	Australia	117
5.	Canada	96
6.	Norway*	64
7.	Italy	56
8.	Chile	39
9.	Germany	35

**Norwegian lines are 74%+ at grade.*

Note: There are no lines that are more than 80 percent at-grade in South Korea or South Africa, so those countries were omitted from this part of the analysis.

Despite the wide cost variation for both tunneled and at-grade projects, we found no discernable relationship between a country's transit construction costs and its system of government, level of centralization in planning and financing, or use of common versus civil law.

For example, in Australia transit planning and decision-making is concentrated at the state level, with far fewer cross-jurisdictional issues than the United States. Yet despite this structure, Australia's at-grade construction costs were among the highest in our database. This is largely due to the recent extension of Sydney's heavy rail system, which experienced several cost overruns and was the costliest at-grade project among the case study projects at $325 million per mile. Our case study found that high costs on this project were due to underbidding by contractors, inaccurate risk assessment, and complex interfaces between the line and several brownfield sites.

Similarly, transit planning, governance, and decision-making in both Chile and Japan is highly centralized, yet those countries fall on opposite ends of the cost spectrum. While decision-making is strong and centralized at the national level, Chile's extraordinarily low construction costs are mostly due to favorable soil conditions, strong staff capacity and expertise, and minimal pushback against projects.

Conversely, Japan is home to four of the five most expensive tunneled projects we examined (outside of the U.S.) despite similar expertise and concentration of decision-making and planning at the national level. At nearly $1.3 billion per mile, the 2.5-mile Minatomirai Line in Yokohama is the most expensive tunneled project outside of the United States in our database. This high cost may partially result from complex site conditions along the route, including building through reclaimed land in the city center.[10] Other tunneled projects in Japan have involved complex capacity expansion

projects along existing transit routes, in addition to new lines. The country's focus on high operational standards may necessitate more costly design.

These variations suggest that certain governmental structures or legal requirements do not inherently predispose a place to have higher or lower costs. Rather, countries can achieve success in project delivery by implementing best practices. Norway, for example, does not have a strong pipeline of tunneling projects like Chile and has less in-house expertise. However, it benefits from a tradition of strong public sector management and uses cost-efficient designs.

Also unclear is what explains the United States' significant and growing cost and timeline premium. Like previous Eno research and analysis of transit construction costs, our comparison of construction costs within this 10-country sample found the United States pays more on a per-mile basis to build transit than most peer countries abroad, and much higher than in places like Norway, Chile, and Italy.

When comparing U.S. construction costs with all projects in our database, the United States pays 48 percent more on a per-mile basis to build primarily at-grade transit projects, and 57 percent more for below-ground lines. This cost premium holds for both tunneled and at-grade projects. When including the disproportionately expensive tunneled projects recently completed in New York City, the U.S. tunneling premium rises to 263 percent. Additionally, at-grade projects in the United States take, on average, three months longer to construct, while below-ground projects take more than nine months longer than similar projects abroad.

Table 4: Comparison of average rail transit construction costs ($USD million)

	Type	Per mile U.S.	Per mile Non-U.S.	U.S. Cost Premium
All projects in Eno database	At-Grade	$132	$89	48%
	Tunneled	$582*	$371	57%

**Does not include New York City projects*

One caveat in comparing tunneling costs is that there have been relatively few tunneled lines completed in the United States since 2000. The tunneled lines in Table 5 are currently under construction and are therefore not included in our database, but all are expected to cost more than most peer projects abroad. Including these projects would further increase the U.S. tunneling premium.

Table 5: Select U.S. projects currently under construction, estimated costs ($USD million)

Location	Project	Length (miles)	Percent Tunneled	Est. Cost per Mile
Seattle	Light Rail Northgate Extension	4.3	81%	$464
Los Angeles	Purple Line Extension Phase 1	3.9	100%	$871
Los Angeles	Purple Line Extension Phase 2	2.6	100%	$958
Los Angeles	Purple Line Extension Phase 3	2.6	100%	$1,400
Los Angeles	Regional Connector	2.0	100%	$915
San Francisco	Central Subway	1.7	100%	$941

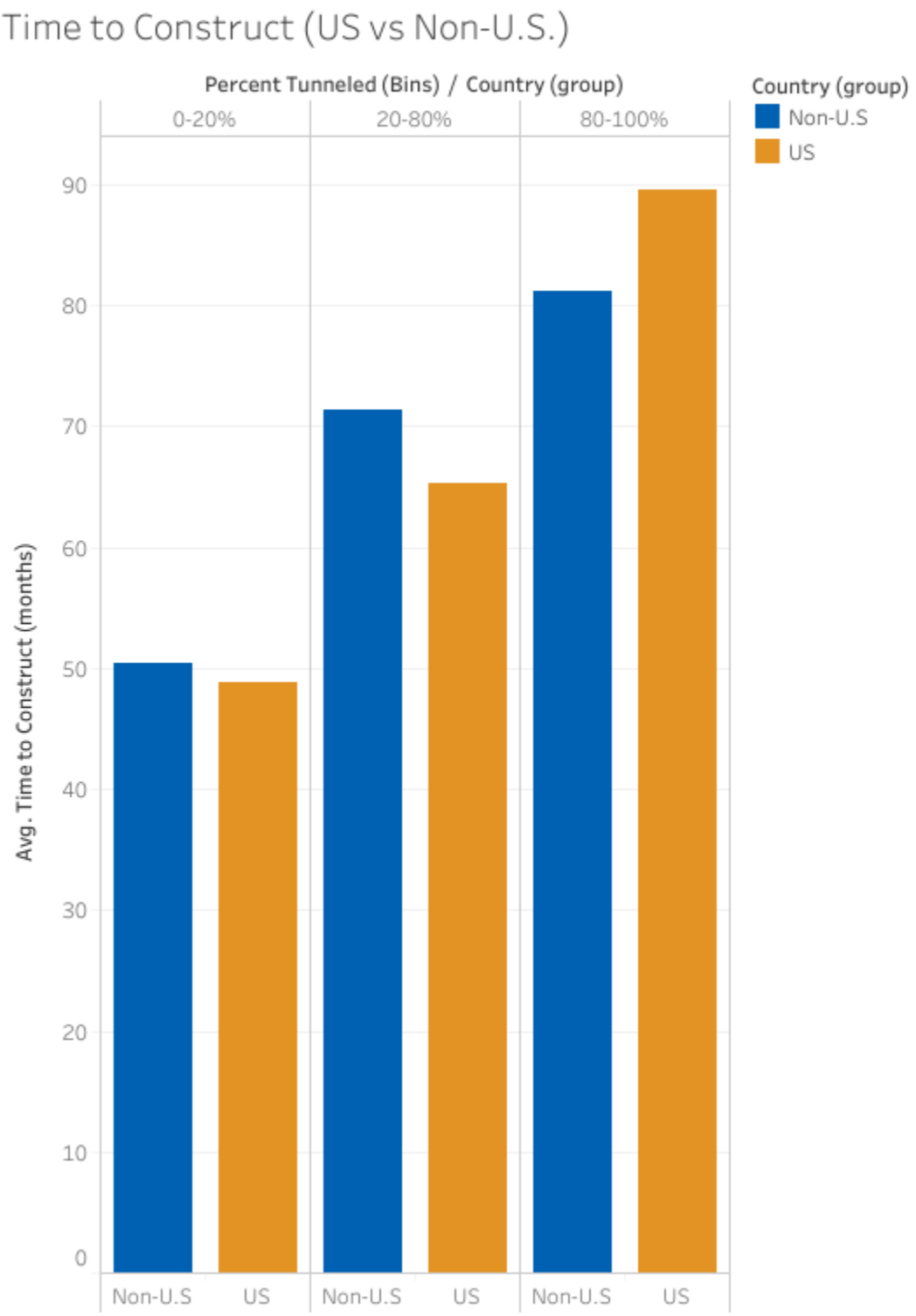
Note: cost per mile for these projects might include vehicles, maintenance facilities, contingency, and financing. They also are not the final cost, which are subject to change.

In addition to project costs, Eno's database includes information on project construction timelines, measured as months between groundbreaking and opening of the project. This metric only covers the time to construct a line, and not the other pre-construction aspects that this and previous Eno research has identified as important cost and timeline drivers. For example, preparatory sitework, the environmental review process, land acquisition, stakeholder engagement, and lengthy planning periods, are not captured in these timelines. Projects may be proposed in one form or another, but not formally become reality until years or decades later. It is thus difficult to pinpoint a precise and consistent "start" date for transit lines. While the construction timeline metric does not capture the full timeline of a project, this and previous Eno research shows there is a direct relationship between the time it takes to construct a transit line and its final construction cost across both U.S. and internat
ional projects.[11]

For projects in the ten case study countries, the United States constructs projects in an average of 54.3 months, while the average construction time for the other countries is 68.4 months. But as shown in previous Eno research, this can be attributed to the United States building mostly at-grade projects, while peer countries build many more tunneled lines, which take longer on average.

When it comes to building tunneled lines, the United States takes on average 89.6 months, compared to 81.1 months in the ten-country sample, as shown in Figure 2. This table shows the construction period (in number of months) for three types of projects: those with 20 percent or less tunneling, projects with between 20 percent and 80 percent tunneling, and those with 80 percent or more tunneling.

Figure 2: Time to Complete (In Months), U.S. vs. Case Study Country Projects



Note: This graphic excludes projects that took more than 150 months to construct. Additionally, only four U.S. projects are tunneled between 20 and 80 percent, which limits the takeaways of that portion of the data. Several projects from Mexico were excluded due to an inability to find precise groundbreaking data.

Construction timelines in the United States average slightly better than the international for projects with less than 20 percent tunneled. However, compared to some of the lowest cost countries the United States still takes longer. For example, at grade projects in Australia, Germany, and Chile average 25.1, 26.7 and 42 months, respectively.

4.0 Recommendations

This scan of quantitative and qualitative information about rail transit construction costs around the world reveals important considerations for policy makers in the United States. These recommendations can be grouped into three broad categories:

Governance: the authorities and institutions tasked with carrying out various phases of project development; includes determining those entities' composition, their basic functions, how they make decisions, and how they interact with other public and private entities.

Processes: the procedures and practices undertaken by the various entities that deliver a project; includes determining the steps that must be followed and timelines for completing those tasks.

Standards: the specifications, rules, and regulations that determine the physical structure of a project as well as adherence to policy goals; includes determining guidance on designs and any other policy frameworks.

Within each of those categories, specific recommendations follow.

4.1 Government structure is not an indicator of project costs or timelines, but leaders and project sponsors must recognize that *governance* is important.

Leaders in the United States need to increase the public and political appeal of building rail transit.

The presence of cultural and political demand for transit projects reduces project resistance. In countries or regions that have successfully built numerous new rail lines at relatively low cost, one helpful precursor for initiating project delivery is robust public acceptance and demand for new rail lines.

In land-constrained countries like South Korea and Japan, the spatial advantages of rail infrastructure over automobile infrastructure create broad support for building rail. In addition, in places like Chile, the public views rail as a contributor to economic competitiveness with other leading international urban economies. In Australia, residents view rail transit as a means to prepare for population growth.

One aspect of building consistent support for transit is developing stable public institutions involved in various aspects of project delivery to offset changes in the broader political climate. Some countries use public sector research groups to assess project feasibility, such as Infrastructure Australia (and comparable state-based infrastructure organizations) and South Korea's various state-sponsored infrastructure think tanks. Such stability helped in Chile, which has a consistent capital program housed at Santiago Metro. Chilean presidential administrations are constitutionally limited to only four years, so the consistency of public sector expertise is beneficial to project delivery.

When political interference does occur, it tends to drive up costs. The ad-hoc and politicized nature of transit decision-making in Canada undermines the planning process by injecting uncertainty over project plans. Some projects in Toronto have been proposed and cancelled (and re-proposed again) based on changes in political leadership, even for projects that were already planned or under construction, resulting in hundreds of millions of dollars in sunk costs and significant delays.[12] Even in the Toronto region, political disagreements over transit have revolved around whether proposed light rail lines should be tunneled, rather than the value of transit as a mode.

Project sponsors need to focus on making sure their institution has the right governance, authorities, and staff to lead a transit megaproject.

Internationally, a focus on the right size and skills of staff, as well as appropriate institutional jurisdiction and authorities, helps to complete projects. Agencies can either develop in-house capacity at existing institutions or through SPDVs. Regardless, what matters is whether an organization has the ability to move complicated projects forward.

Chile, Italy, and parts of Germany deliver projects using existing public agencies, and they are among the least costly and fastest completed. In Chile, planning and project management is conducted in-house by the capital project division of Santiago Metro. In each case, they develop the right authorities to permit projects and relocate utilities, and invest in top-level staffing to ensure projects can proceed. Germany and Norway employ SPDVs, government-sponsored bodies that manage construction before handing ownership and operations back to the public operating agency, in the construction of rail lines. In those cases, the SPDV also has the appropriate authorities and the ability to attract top talent to manage projects.

The most successful projects use traditional methods, but agencies should consider procuring projects using public-private partnerships when warranted.

P3s can be an opportunity to leverage private sector expertise and borrowing capacity. Projects that have relied on P3s have, historically and irrespective of geography, produced varied outcomes. Few transit P3s exist in the United States, including the Hudson-Bergen Light Rail in New Jersey, the Eagle P3 commuter rail lines in Denver and the Purple Line in Maryland, which is still under construction. In other countries, project success for P3s is closely tied to effective public sector oversight of private partners.

In Australia, the use of P3s to deliver rail projects has grown since 2013, in part to compensate for a small domestic market of project delivery expertise. In 2015, the national government developed a policy framework to guide consistent processes and oversight across the country with respect to procuring a P3.[13] While P3s remain a common delivery method for rail transit projects, public expertise — of both how to manage the private sector and how to deliver a major rail project in-house — has grown within the past five years. However, project costs remain relatively high in Australia. For example, the at-grade Sydney light rail L2 and L3 extensions were built at a cost of $325 million per mile.

In South Korea, the use of P3s was primarily a response to the Asian financial crisis of the late 1990s. The national government relied on this model to deliver select rail projects to meet growing travel demand despite limited public ability to issue debt. For example, the South Korean U-Line (fully automated, grade-separated light rail) was built at a cost of $97 million per mile under a P3 model. Despite this success, P3s are less commonly used today and are broadly perceived as more expensive due to private sector profit margins.

South Africa's Gautrain was delivered via a P3 due to insufficient public sector expertise. In that country, P3s must be registered and authorized by the National Treasury and undergo additional study on their feasibility. This process allows the national government to have close oversight of P3 procurement. Still, the project was built at a cost of $241 million per mile, a quarter of which was tunneled.

Most other projects in this study were DBB or DB projects with no private sector involvement in financing or operations.

Project sponsors should keep construction contracts relatively small, even if it means breaking up lines into segments.

Rarely do international civil construction contracts exceed $150 million for transit lines. This was cited as a critical part of the success of the low-cost tunneling projects in Chile, Spain, France, Norway, and elsewhere. In Chile, for example, project managers in Santiago found that few construction firms have the capacity or experience to handle a $1 billion project, so such procurements would end up with few bidders. On the other hand, many companies can handle a contract of $150 million or less. For similar reasons, construction contracts in Norway are also divided into smaller packages to ensure more competition given the limited number of firms with expertise in railway technology.

Breaking up civil works into smaller contracts can also protect projects from disruption. Large megaprojects frequently encounter unanticipated problems. A contractor could have underbid and found itself unable to cover its costs. Labor strife or poor work quality can halt construction. Disagreements over contractual terms can create work stoppages. But when transit lines are broken into segments, disputes stop construction only on a portion of the project while other segments can proceed.

To give the agency more leverage, Santiago Metro has a policy where no two contractors are allowed to work on adjacent segments of a tunneled line, and no contractor can be awarded two segments of any given line. When a contractor underperforms, project managers simply cancel the agreements and award the work to the contractors working on adjacent segments. While this might result in a delay on that segment, when dealing with a single contractor, an agency is beholden to it unless it wants the entire project stopped and to have costs escalate.

There are some benefits to combining project elements into larger contracts, including the potential to reduce the need for public project managers to coordinate various construction projects. In the United States, many projects are bundled into very large contracts, primarily to capture the benefits of project integration and risk assignment to the contractor. Dividing construction into several small contracts can also make P3s and DB difficult when an agency is interested in using those methods, or an expensive tunnel boring machine is necessary.

However, a large, single contract often results in high bids from contractors to reflect the risk in these large, complex projects. International peers with lower project costs consistently cite the use of smaller contracts as a way to bring additional competition and project control.

Project management and oversight need to be led by public sector staff.

Developing expertise within public agencies reduces the need to hire expensive consultants to conduct some of the early phases of project planning and implementation. In all countries that we reviewed, project management staff are in-house, ranging from 20 to 40 public sector staff per project. Consultants are helpful in the larger projects but are used for discrete tasks.

South Korea invested in its internal workforce capacity following the first phase of subway construction in Seoul in the 1970s. At that time, the city obtained technical assistance from Japan, and subsequent construction was performed using in-house staff that had learned from this expertise. Today, the bulk of the preliminary project planning work is completed in-house, with external contractors hired to build projects. Regions that are building new in-house capacity should reach out to other countries with successful track records in project delivery to leverage their expertise.

In Italy, national reforms in the mid-1990s encouraged the cultivation of more in-house staff to manage public works projects. As a result, Italian transit projects have relied less on external private consultants.

4.2 Other countries face similar challenges with processes needed to build high-quality projects, and the United States should learn from their experiences managing them.

Frequent, early stakeholder coordination needs to be a priority.

When a mix of public, private, and civic stakeholders are involved in project delivery, strategic coordination is imperative for avoiding bumps in processes. In Norway, there is strong, regular coordination between national and local stakeholders as political officials negotiate annual funding allocations for transportation as part of the country's national funding model. The country also relies heavily on public-sector technical staff to guide these planning and funding decisions.

Utility relocation also involves a complex web of stakeholders, and delays with this process have been identified as a significant risk for projects across the world, including in the United States. While voluntary coordination councils serve to foster agreement between stakeholders and some states establish memoranda of understanding with utilities, early coordination during the planning phase is still needed to mitigate relocation challenges.[14]

It is important to gather public input on project details, but project managers should be empowered to make decisions without subjecting every detail to lengthy community consultation.

Community engagement offers an important means for project delivery teams to hear concerns and desires for a project and its construction. It is an important way to make sure that projects best serve community needs, though historically in the United States it can also result in lengthy and expensive litigation. While project managers should hear and aim to address major community concerns, they should also be entrusted as experts on project delivery to make tough decisions.

Some countries, such as Chile, Mexico, South Africa, and South Korea, conduct few consultations with the public. Importantly, these places have a baseline level of public support for transit not experienced in the United States. While less intense public engagement is a factor for reducing project timelines and costs, it is not suited for the United States where there are high expectations for community engagement.

A better approach is to plan for and invest in community engagement during the planning phase of project delivery – early enough that project plans are far along but not so early that plans are likely to change drastically – and use the input gathered to build projects that will likely garner broad community support. Project managers should then be empowered to build projects suited to meet community needs, and stay engaged with the community throughout the remaining planning and construction stages of the project.

The United States should learn from other countries' efforts to further streamline reviews for environmentally beneficial transit projects.

Other countries experience many of the same frustrations as the United Stated with environmental reviews delaying climate-friendly projects like large new rail transit lines or extensions. In response, many have taken steps to streamline their processes.

In 2020, the Australian government announced that select major projects could be eligible for a streamlined environmental review in which joint assessment teams, comprised of national and state or territory officials, would work together to expedite approvals.[15] That same year, the German government passed the Planning Acceleration Act III to trim elements from the planning approval process for public transit projects.[16]

To acknowledge the positive environmental effects of transit, in 2008 the Canadian province of Ontario established the Transit Project Assessment Process (TPAP). This streamlined, self-directed process allows project sponsors to analyze potential impacts

and solicit public input within specified time windows in order to minimize conflicts and expedite approvals during project development.[17] Subsequent reforms in Ontario established a separate environmental review process for pre-construction activities to allow project sponsors to proceed with utility relocation and other preparation activities while awaiting full environmental clearance.

4.3 The standards to which projects are held affect project delivery and final outcomes. Project sponsors in the United States should seek to develop high-quality projects informed by best international practices.

The public sector should refine and improve formalized assessment models to better evaluate projects and bidders.

Most countries, including the United States, require cost, schedule, and risk reviews prior to projects moving forward with construction. For example, Norway's Quality Assessment model allows all major projects to be assessed by independent experts to minimize cost and timeline overrun risks and develop a project delivery plan. Consultants review preliminary project documents and conduct benefit-cost analyses to ensure enough alternatives have been considered, to determine if the underlying cost and timeline estimates are accurate, and to assess whether the proposed management plan is of high quality. While there are some issues with the specifics of the assessment and whether it is powerful enough to change project scopes, the general approach is a useful model for determining feasibility early in the planning process.

In South Korea, the central government took over early project feasibility analyses in the late 1990s after observing that local governments had overestimated demand and economic viability of new rail lines. This transition allowed for a more objective analysis and better alignment with the central government's financial support. Aside from this assessment and the ultimate approval of construction, the central government is limited in its involvement in early project planning, which allows local governments to take the lead on project plans that are best suited to their conditions.

Formal assessments are also beneficial during procurement. Contractors in Italy are chosen based on the MEAT (Most Economically Advantageous Tender) criterion, which focuses on best value for money rather than lowest price. MEAT considers quality of work and past technical merit, and analyzes projects' lifecycle costs, environmental outcomes, and social effects.

Project assessments, however, can also be subject to political interference. In Canada, numerous interviewees noted that business case analyses and formal evaluations of projects carry little to no weight if there is political pressure to complete a project. Projects there may still move ahead even if technical staff find that a project scores poorly.

Transit agency staff should participate in study tours and learn about best practices in other places.

Transit project delivery stakeholders in the United States should routinely seek out best practices and identify decision-making and planning processes that contribute to successful projects. Tunneling projects in Chile, Italy, and Norway, as well as at-grade light rail projects in Germany, stand out as examples of speedy, low-cost projects. Learning from these countries and applying their lessons in the United States can help project sponsors deliver rail transit more cost effectively.

Other democracies around the world provide examples of strategies for handling challenges in project delivery, things to avoid, and successful outcomes. But this represents only a first step in gathering insights from abroad; leaders must prioritize direct peer-to-peer learning. Site visits and study tours are effective practices for learning directly from others' experiences. Agencies can take advantage of numerous resources, such as the Federal Transit Administration's Project Management Oversight Learned Program, National Transit Institute courses, UITP conferences, and American Public Transportation Association committees. To foster broader learning, the Federal Transit Administration should establish dedicated programs to exchange best practices on project delivery and design, including but not limited to regular study tours in the U.S. and abroad.

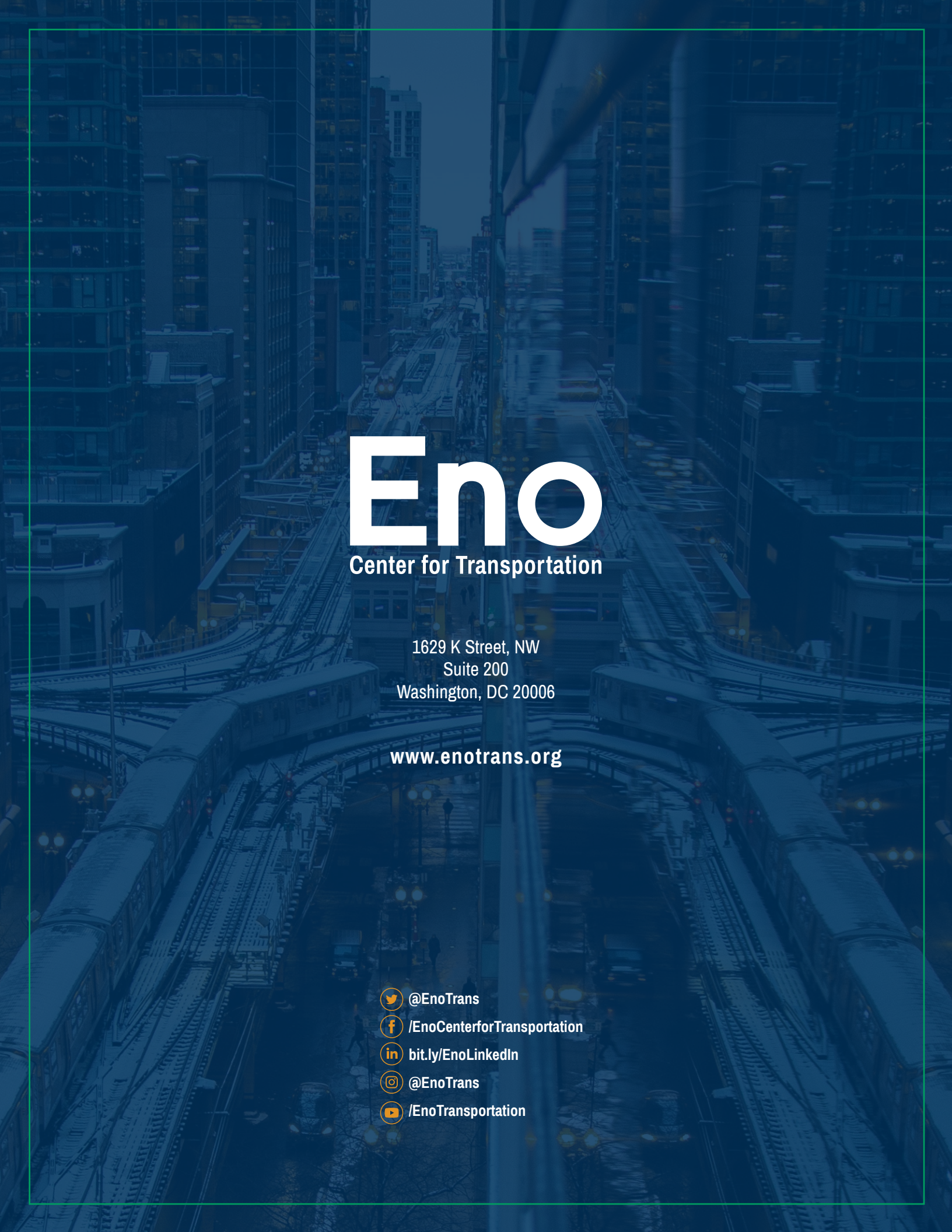
5.0 Conclusion

The United States pays more for rail transit on a per mile basis than the average of ten peer nations reviewed in this study due to many compounding factors. These include issues with inadequate project governance, inefficient processes, and lack of standardization, as detailed above.[18] Meanwhile, across the ten countries evaluated for this research, all of them share in common a democratic government structure but vary considerably in terms of the actual governance, processes, and standards to which projects are held. Likewise, rail transit projects delivered in these countries fall on a spectrum of costs and delivery times, but these outcomes are not tied to any particular factor.

Our study found successful project delivery in countries with strong public institutions with the capacity to manage megaprojects, smart approaches to contracting, coordination of complicated processes, and standardization of redundant project components. Insights from this data analysis and research interviews also underscore the importance of strong public sector staff capacity and management skills, close collaboration between stakeholders, and the ability for planners to make prompt, firm decisions about projects.

These insights highlight our previous recommendation that project sponsors need to look beyond the United States to internalize best practices in governance, decision-making, and project delivery. More research is needed on how to infuse those best practices into the governance, processes, and standards of American public agencies, and will be the subject of forthcoming initiatives from this research program.

[1] Jeff Davis, "Biden Signs Bipartisan Infrastructure Bill Into Law," Eno Transportation Weekly, November 19, 2021.
[2] Jeff Davis, "USDOT Gets FY22 Highway and Transit Formula Funding Increases Out the Door," Eno Transportation Weekly, April 8, 2022.
[3] Eno Center for Transportation, "Saving Time and Making Cents: A Blueprint for Building Transit Better," 2021.
[4] World Population Review, "Democracy Countries" 2022.
[5] This research is limited to delivery of urban rail mass transit projects, in particular, trams, light rail, and heavy rail systems. What is in some places referred to as "metro rail" is designated as heavy rail throughout this report. Intercity and commuter rail projects are often categorized and governed differently and not evaluated in detail in this work.
[6] For more information, see: "Standard Cost Categories for Capital Projects," Federal Transit Administration, July 27, 2017.
[7] Washington University in St. Louis, "What is the Difference Between Common Law and Civil Law?" January 28, 2014; Lawrence Helman and Andréa Pekeur, "Legal Systems in South Africa: Overview," *Thomson Reuters Practical Law*, April 1, 2021.
[8] Eno Center for Transportation, "Saving Time and Making Cents: A Blueprint for Building Transit Better," 2021.
[9] Other models include design-build-operate-maintain (DBOM) and progressive design build.
[10] Minato Mirai 21, "Information," Volume 87, March 2016.
[11] For more detail, see: "Saving Time and Making Cents," Eno Center for Transportation, July 2021.
[12] Eno ""2021; Office of the Auditor General of Ontario, "2018 Annual Report Section 3.07 Metrolinx—LRT Construction and Infrastructure Planning," December 5, 2018.
[13] Australian Department of Infrastructure and Regional Development, "National Public Private Partnership Policy Framework," 2015.
[14] For more detail, see: "Utility Relocations – Challenges and Proposed Solutions," Federal Transit Administration. March 31, 2022.
[15] Sophie Power, "Environmental Approvals," Parliament of Australia, 2020.
[16] BMVI, "Gesetze zur Beschleunigung der Planungs- und Genehmigungsverfahren unter Federführung des BMVI in der 19. Legislaturperiode," May 4, 2021; BMVI, "Innovationsforum Planungsbeschleunigung, Abschlussbericht," May 24, 2017.
[17] "Environmental Assessments," *Metrolinx*, n.d.; Eno 2021.
[18] For greater detail, see: Eno Center for Transportation, "Saving Time and Making Cents: A Blueprint for Building Transit Better," 2021.



Eno
Center for Transportation

1629 K Street, NW
Suite 200
Washington, DC 20006

www.enotrans.org

@EnoTrans
/EnoCenterforTransportation
bit.ly/EnoLinkedIn
@EnoTrans
/EnoTransportation