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UNDERSTANDING THE DRIVERS OF TRANSIT CONSTRUCTION COSTS IN CANADA: A COMPARATIVE STUDY

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ABSTRACT

The expansion of mass transit infrastructure is crucial for accommodating the rapidly growing population in Canadian metro areas and promoting a shift toward sustainable modes of transportation. However, these initiatives are becoming increasingly costly, threatening the timely delivery of necessary infrastructure to bridge the current sustainable mobility gap.

Our investigation delves into Metrolinx's project portfolio in the Toronto area, comparing it with transit initiatives in global cities. We categorize expenses into soft and hard costs, identifying specific cost drivers linked to project scope and design choices. Comparisons with peer cases reveal four primary cost-driving factors: design choices, procurement, risk management practices, and external constraints.

Drawing upon international cases where rapid transit is constructed more affordably, our study proposes reforms in project planning, delivery, and cost estimation that can be implemented across Canada. It particularly emphasizes reforms in project planning and delivery to expedite and reduce construction costs, and strategies to enhance cost estimation for better project management.

AUTHOR BIOGRAPHIES

Jedwin Mok is a research fellow at Metrolinx. He aims to help the agency understand the factors behind transit construction cost escalation. In addition to being a researcher at the Urban Cycling Institute in Amsterdam – where his work focuses on regional rail and cycling integration in the Netherlands – he also serves as the creative director of CityUX, an urban consultancy based in Tallinn, Estonia. Previously, he studied Computer Science and Planning at the University of Toronto, where he cooperated on a proposed redesign of Riga's bus network and directed the popular YouTube series "Navigating Urban Transit" on transportation in European cities.

Balthazar Crane is a senior transportation planner on Metrolinx's Project Planning Team. He is passionate about solving complex interdisciplinary challenges to advance the planning and delivery of transit projects in the GTHA. Balthazar has planned and developed business cases for several rapid transit and rail projects. He has a Master's in Engineering and Public Policy from McMaster University and a Bachelor of Applied Science in Engineering Science from the University of Toronto.

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Amer Shalaby is a professor and Bahen/Tanenbaum Chair in Civil Engineering at the University of Toronto, as well as the founding director of the Transit Analytics Lab. Dr. Shalaby specializes in transit planning and scheduling, intelligent transit systems, transit operational management, transit system resilience, automated and connected transit technologies, emerging mobility systems, transportation planning for large-scale events and megacities, and simulation and modelling of transportation systems. His research program has produced innovative analytical tools, and studies that enriched the state of knowledge and practice in transit planning and management. Dr. Shalaby has won several awards nationally and internationally.

INTRODUCTION

Canadian cities are currently facing a critical infrastructure deficit. With rapidly increasing urban populations, municipal and regional governments are experiencing greater pressures in housing, labour, and transportation. At the forefront of these issues is a severe lack of public transit infrastructure in urban areas that is critical for more space-efficient, environmentally friendly, and economically productive access to opportunities.

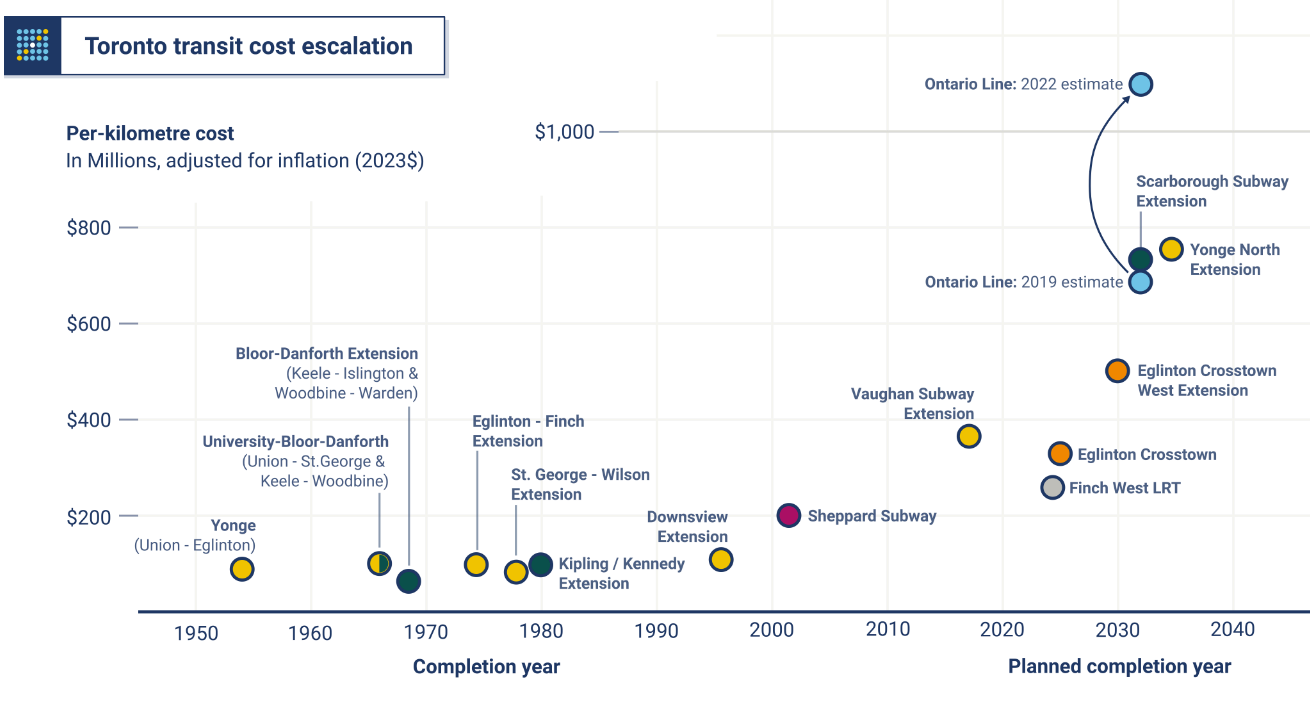
In an attempt to close the transit infrastructure gap, cities across Canada are investing tens of billions of dollars into capital expansion through the construction of additional mass transit infrastructure. This year, the federal government announced the Canada Public Transit Fund (CPTF), a $30-billion investment over 10 years to be spent on capital projects across the country.[1] Support for transit expansion comes from provincial and municipal governments as well. For example, Canada's largest and fastest-growing metropolitan region, the Greater Toronto and Hamilton Area (GTHA), is receiving more than $80 billion in provincial investment into new transit infrastructure, with projects predominantly led by Metrolinx, its regional transit authority.[2] In fact, this expansion program is the single largest in North America: three subway extensions, a new downtown subway, six new tram lines, and a massive regional rail modernization program. These new rapid transit lines will transform the lives of millions of Canadians, providing an unprecedented level of access to jobs and other activities.

However, over the past two decades, the cost of building new transit infrastructure in Toronto (and across Canada) has increased significantly, at a rate far beyond inflation (see Figure 1). According to data compiled by Stephen Wickens,[3] cost estimates publicly announced by Metrolinx for its latest subway projects are seven times greater per kilometre, adjusting for inflation, than Canada's first subway, the Yonge line, built in 1954. Recent reports quote the Ontario Line project at more than $1 billion per kilometre, ten times greater than the original Yonge subway.[4]

"Over the past two decades, the cost of building new transit infrastructure in Toronto (and across Canada) ***has increased significantly, at a rate far beyond inflation."***

[1] Housing, Infrastructure and Communities Canada, *Canada Public Transit Fund*.
[2] Metrolinx, "Exciting progress on North America's largest transit expansion."
[3] Wickens, "Station to Station."
[4] Callan and D'Mello, "Estimated Cost for Ford Government's Signature Ontario Line."

Figure 1: Toronto transit cost escalation, in 2023 $INT (millions)



Data Sources: Stephen Wickens (RCCAO Ontario) and Metrolinx business cases

Toronto has experienced a dramatic escalation in the costs of its rapid transit projects since 2002. The cost of rolling stock, operations and maintenance, and financing were removed where possible.

Unfortunately, the alarming rise of transit construction costs in Toronto is being replicated in many cities across the nation. As explored further in this chapter, cost estimates for rapid transit projects across Canada's largest cities have skyrocketed in recent years, making them among the most expensive (per kilometre) in the world.

In response, local and regional jurisdictions have resorted to scope reduction, such as removing stations, shortening lines, or even cancelling projects entirely.[5] The problem of cost escalation thus threatens the outcomes of transit expansion and investment. If construction costs can be meaningfully reduced, more ambitious projects with greater benefit and larger scope can be built at lower costs. On the other hand, if the current trend of cost escalation continues, our rate of transit expansion will grind to a halt, and we will be unable to close the infrastructure gap and serve the transportation demands of Canada's fast-growing urban populations.

[5] Pantitlán, "Out of Their Depth."

Figure 2. An at-grade tramway in Toronto vs. similar projects in lower-cost countries.

Finch West LRT, Toronto
INT$ 249M/km

Shinbundang Line, Seoul
INT$ 149M/km

M5, Istanbul
INT$ 130M/km

Länsimetro, Helsinki
INT$ 148M/km

Above: The Finch West LRT, though much simpler to construct, cost significantly more per kilometre than the mostly underground, automated express metro line in South Korea.[6]

Below: Transit projects in Turkey and Finland, both low-cost countries that deliver cost-effective rapid transit, with costs at or below global averages.

Estimates exclude the costs of operations & maintenance, financing, and insurance.

Images: Wikimedia Commons.

Despite the scale of this cost crisis, researchers and policy-makers must remember that another way is possible. Developed nations such as Italy, Turkey, Sweden, Finland, Spain, and South Korea deliver transit projects comparable to those in Canada at as low as one-tenth the price per kilometre.[7] Our study contends that high transit construction costs are not an inevitability; rather, they are the result of a project delivery regime antithetical to global best practices.

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[6] Aevaz et al., "Saving Time and Making Cents"; Goldwyn et al., "Transit Costs Project."

[7] Goldwyn et al., "Transit Costs Project"; Chitti et al., "Italian Case" Ensari, Goldwyn, and Levy, "Istanbul Case"; Wickens, "Station to Station."

METHODOLOGY AND DATA

Leveraging various data sources from quantitative cost breakdowns to qualitative reports, our investigation aims to present a holistic and nuanced perspective about the current state of rail transit construction in the GTHA. We conducted a comprehensive literature review to understand the current landscape of research on global transit construction costs and project delivery. This included examining the design choices, procurement and management practices, external constraints, and best practices from various case studies around the world.[8] We also conducted qualitative interviews with more than 30 agency, academic, and industry experts to place these findings in the Canadian context.

Next we conducted a global benchmark of transit construction costs that placed the quantitative cost data obtained from Metrolinx's major rail transit projects in the context of other jurisdictions.[9] In total, the database we compiled and cleaned for this benchmark consists of 1,083 rail transit projects (tram, metro, and regional rail) across 60 countries with actual or projected completion dates between 1971 and 2036. All project costs were adjusted for purchasing power parity into International Dollars ($INT) and for inflation (into 2023 dollars) to account for economic variances across national borders. Since projects in the datasets varied in length and scope, we have used per-kilometre costs as the main determinant of cost magnitude throughout the study. While this approach has potential limitations in terms of detail, it allows for improved comparability, as it isolates the variable of project length.

Lastly, we conducted detailed case studies of several Metrolinx projects and compared them with projects from around the world. Leveraging detailed cost data from the agency's extensive portfolio of transit projects (both completed and in-progress) together with internal knowledge from the agency's capital projects staff, we were able to analyze the project cost estimates. We broke down costs for each major project into consistent items and sorted them into two main categories:

- **Soft costs**, such as land acquisition, management, planning and design, and contingencies (i.e., costs related to overhead).
- **Hard costs**, such as tunnels, viaducts, embankments, stations, systems, equipment, rolling stock, and operations and maintenance facilities (i.e., the actual cost of the infrastructure).

As part of a larger research project conducted in cooperation with Metrolinx, the team was provided access to cost estimates, engineering designs, and internal reports. However, due to non-disclosure agreements to protect the commercial confidentiality of ongoing projects, only findings extracted from publicly available data (including Metrolinx-published business cases) will be shared.

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[8] Flyvbjerg, Bruzelius, and van Wee, "Comparison of Capital Costs per Route-Kilometre in Urban Rail"; Goldwyn et al., "Transit Costs Project"; Aevaz et al., "Saving Time and Making Cents"; Wickens, "Station to Station"; Sharma and Chow, "Reducing US Transit Costs"; Levy, "So You Want To Do An Infrastructure Package"; Barone, Vitullo-Martin, and Pichardo, "Building Rail Transit Projects Better for Less."

[9] Goldwyn et al., "Transit Costs Project"; Aevaz et al., "Saving Time and Making Cents"; Wickens, "Station to Station."

HOW DOES CANADA COMPARE? A GLOBAL BENCHMARK

A wide range of studies have explored the reasons behind transit construction cost disparities. The Transit Costs Project and Eno Center for Transportation have produced several reports and case studies to analyze transit project delivery in a global context.[10] Additionally, RCCAO Ontario, Regional Plan Association, and C2 SMART have used global case studies to contextualize escalating costs in Toronto, New York City, and Manchester/Portland respectively.[11] Based on this data, a consensus has been reached that costs are correlated on a primarily national basis, despite the presence of outlier cities that have exceptional political economy landscapes like New York, Singapore, and Hong Kong.[12]

Thus, our benchmark adopts this framework, focusing on national average per-kilometre costs. Out of the 60 countries in our data, Canada ranks ninth highest in average costs per kilometre at $396M/km. For context, the global average for all 1,083 LRT, metro, and mainline rail projects in our database is markedly lower, at $242M/km. The three most expensive countries on average are New Zealand ($1,037M/km), Qatar ($949M/km), and Hong Kong ($949M/km), while the three least expensive are Chile ($89M/km), Spain ($95M/km), and South Africa ($105M/km).

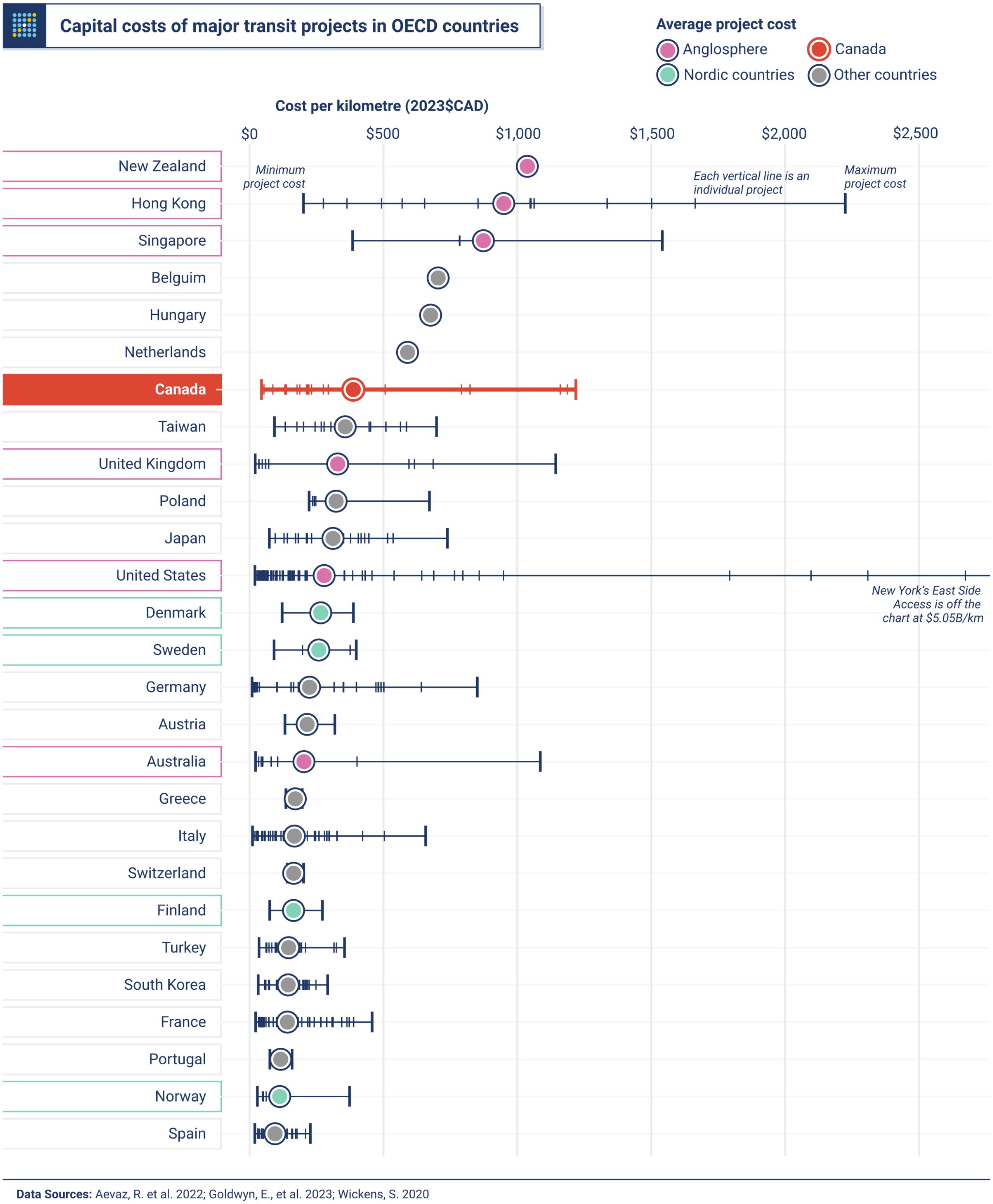
Why do average costs vary so wildly across countries? Some would argue that construction costs are determined by environmental, market, or other external factors. Canadian governments and news outlets have frequently attributed the country's high transit construction costs to the high cost of living, housing, and labour. Our benchmarking analysis, however, reveals only a slight correlation between average construction cost and contextual factors such as GDP, unionization rates, or cost of living. Even among OECD nations high on the human development index, average per-kilometre costs range across the full spectrum of our database (from $100 million to $1 billion): Spain is a low-cost country, Hong Kong a high-cost one, and France in between.

[10] Goldwyn et al., "Transit Costs Project"; Goldwyn et al., "New York Case"; Goldwyn et al., "Boston Case", Chitti et al., "Italian Case"; Ensari, Goldwyn, and Levy, "Istanbul Case"; Levy, Ensari, and Goldwyn, "Sweden Case"; Aevaz et al., "Saving Time and Making Cents"; Lewis, "On the Right Track."

[11] Wickens, "Station to Station"; Barone, Vitullo-Martin, and Pichardo, "Building Rail Transit Projects Better for Less"; Chetan and Chow, "Reducing US Transit Costs."

[12] Levy, "State Capacity and Infrastructure Construction Costs."

Figure 3. Transit capital cost distribution in OECD nations

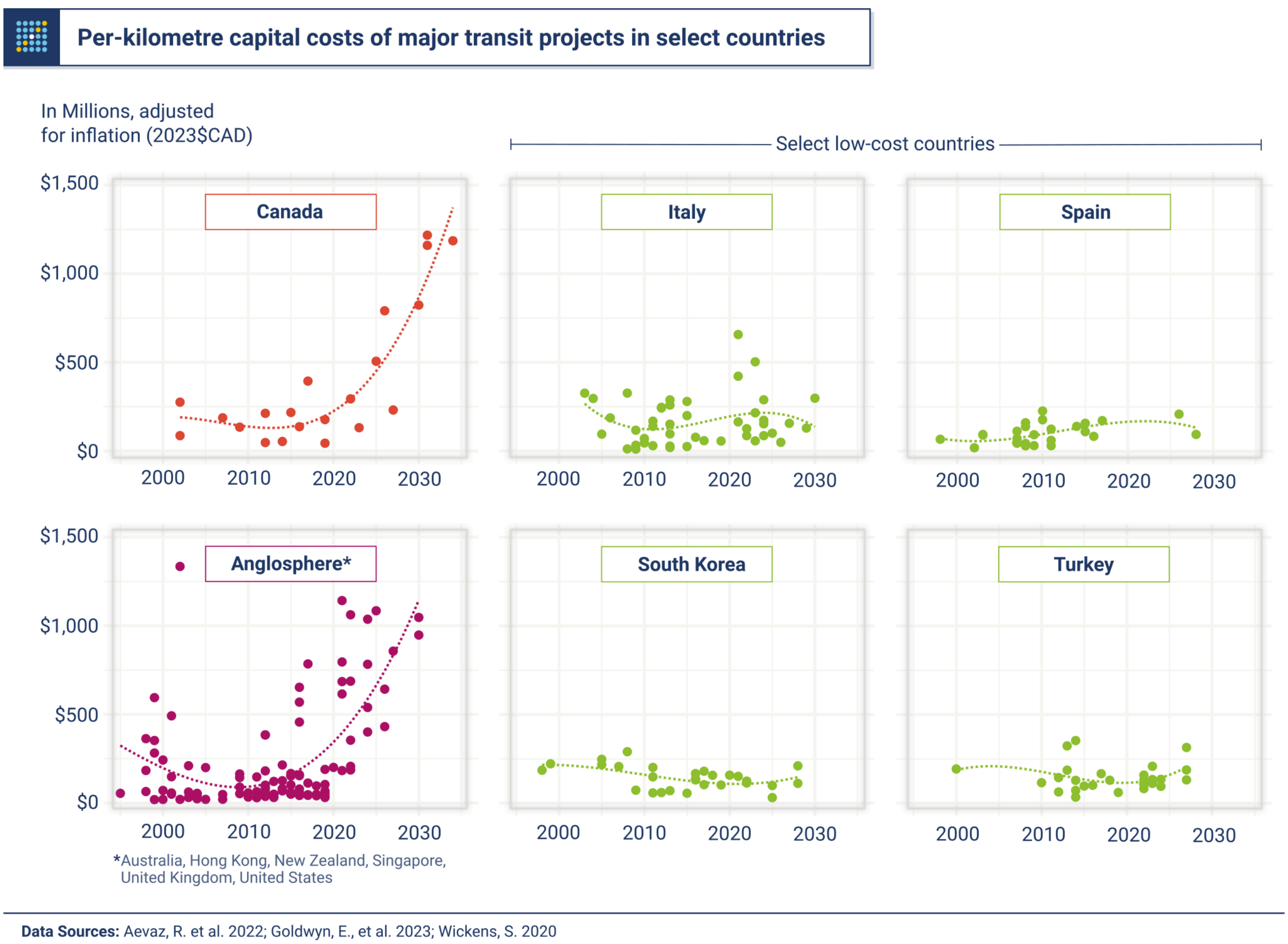


The most expensive project, an extreme outlier – New York's East Side Access ($5.05 billion/km) – was excluded for readability.

Instead, another pattern emerges: the Transit Costs Project argues that cities in the "Anglosphere" (countries with English as the primary language) experience the greatest cost premiums compared to their global counterparts.[13] Other studies have found that Anglophone countries are uniquely insular in their project delivery practices, from procurement to design and stakeholder engagement, which results in higher costs.[14] In fact, every country with a transit project over $1 billion per kilometre speaks English as its primary language.

The six countries that have the widest distribution of costs (the United States, Hong Kong, Singapore, Canada, United Kingdom, and Australia) are also all English-speaking countries, indicating that these nations have experienced the greatest cost escalation over time. As shown in Figure 4, the inflation-adjusted per-kilometre cost in low-cost countries has remained steady or declined between 1995 and 2035, in contrast to the exponential rise experienced in Canada and the larger Anglosphere.

Figure 4. Scatter plot of capital cost distribution in low-cost countries between 1995-2035, compared to Canada and other English-speaking nations



[13] Goldwyn et al., "Transit Costs Project."

[14] Aevaz et al., "Saving Time and Making Cents"; Lewis, "On the Right Track"; Goldwyn et al., "New York Case"; Levy, "State Capacity and Infrastructure Construction Costs."

The problem is not so much with English itself; rather, that these nations share a common institutional history, exchange ideas, and learn from one another. As such, our benchmarking investigation concurs with other studies of global transit costs, strongly indicating that national costs are associated most closely with project delivery practices, policies, and governance. In fact, several domestic cases of low-cost transit construction demonstrate that effective project delivery is possible in the Canadian context with a shift away from traditionally Anglophone project delivery practices: Montreal's REM, Vancouver's Canada Line, and Kitchener's ION LRT were all built at costs comparable to global averages at their time of completion.[15] In the following section, we will build on this finding, examining how rail project delivery in Canada differs from global peers through a careful analysis of Metrolinx case studies. In the words of Alon Levy,

> Because the greatest innovation in high-quality, low-cost public works is not … really in any country where English is the primary language, [North] American governments should maintain global curiosity."[16]

> ***"Every country with a transit project over $1 billion per kilometre* speaks English as its primary language."**

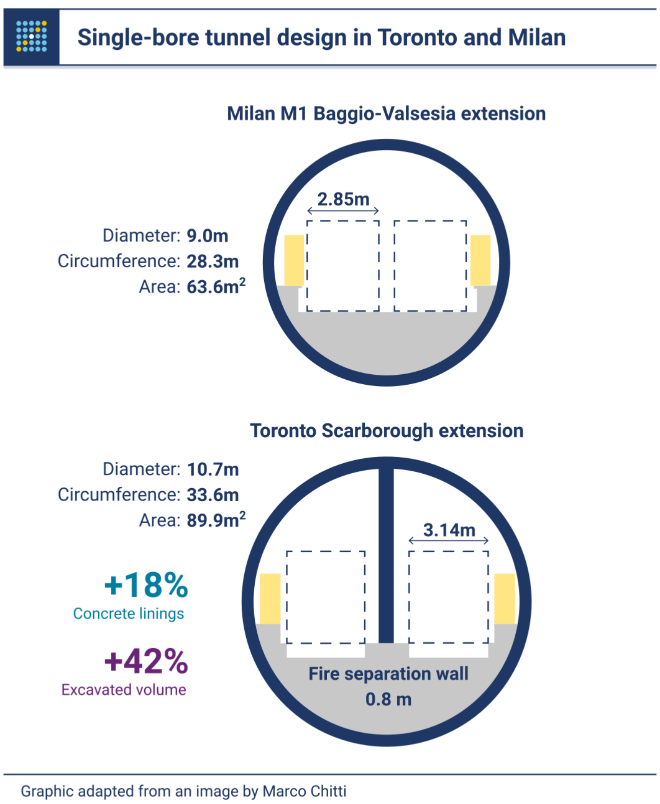
[15] English, "How Montreal Built a Blueprint for Bargain Rapid Transit"; Martin, "Eglinton Crosstown Is Delayed Again"; Martin, "Reece Martin: How to Get Canada's Endlessly Troubled Transit"; Canadian Council for Public-Private Partnerships (CCPPP), "Waterloo Light Rail Transit."
[16] Levy, "So You Want To Do An Infrastructure Package," 16.

WHAT DRIVES TRANSIT COSTS?

To further grasp how Canadian rail project delivery mechanisms, practices, and policies affect costs, we have conducted multiple detailed case studies of Metrolinx rail transit projects in various phases of the project life cycle (in procurement, under construction, and completed). In this paper, we present a high-level aggregate of four Metrolinx business-case-level cost estimates, chosen for their comparability and data cleanliness.[17] This aggregate displays the proportion of overall cost for each cost category that we analyzed in this study. From this data, we have identified four important cost drivers that will be explored in further detail: overbuilding and overdesign, a lack of knowledge retention in the public sector, financial allocation of risk, and external constraints.

Overbuilding and overdesign

Figure 5. Comparison of single-bore tunnel designs: Toronto vs. Milan



Our benchmarking analysis contains 23 Canadian tram and metro projects with actual or projected completion dates between 2002 and 2034. The average per-kilometre cost of these projects with more than 50% of their alignment tunnelled is $751M/km; for those with less than 50% it's $137M/km. The average among fully grade-separated projects (both elevated and tunnelled) is $557M/km, while those with at-grade interactions is $154M/km. Thus, our data confirms the finding that reducing the complexity, scope, and burden of construction within projects reduces overall per-kilometre costs. However, other jurisdictions are able to complete projects of higher complexity at lower costs. For example, Milan was able to deliver the first phase of its fully underground, automated M5 line for $108M/km, significantly less than the much simpler at-grade tramway projects in Canada.[18]

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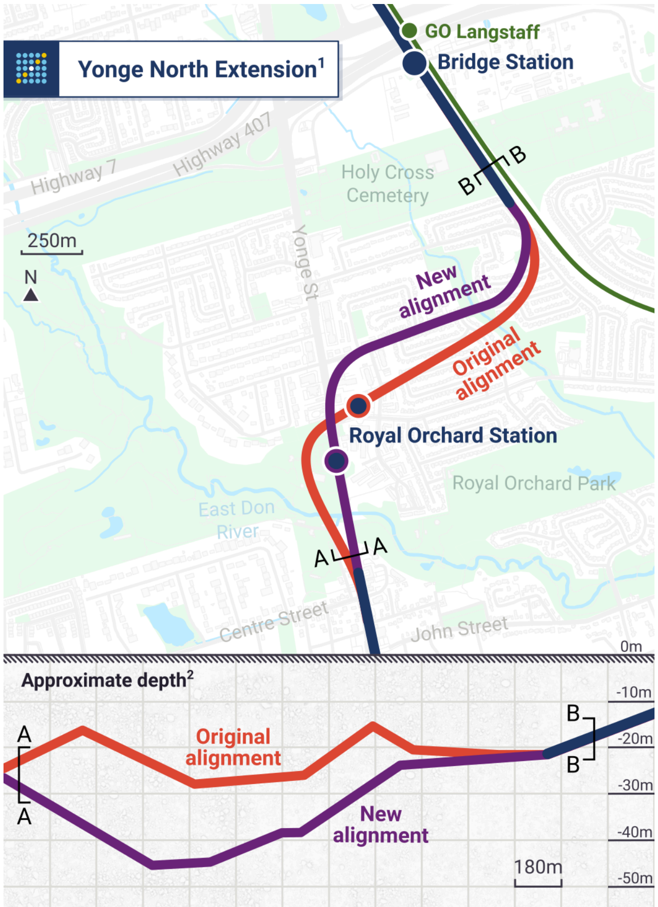
[17] Metrolinx, "Eglinton Crosstown West Extension Initial Business Case"; Metrolinx, "Ontario Line Preliminary Design Business Case"; Metrolinx, "Scarborough Subway Extension Preliminary Design Business Case"; Metrolinx, "Yonge North Subway Extension Initial Business Case."

[18] Chitti et al., "Italian Case."

Figure 6. Ontario Line metro route through the Royal Orchard neighbourhood in Toronto



[1]Only showing the section from John Street to Highway 7
[2]Figure redrawn from Metrolinx slide deck (16/12/2021)

Data Sources: Metrolinx; OpenStreetMap

How is this possible? One reason is that other jurisdictions avoid overbuilding and overdesign.[19] Canadian transit agencies tend to overbuild in multiple ways, with larger and deeper tunnels and stations – a result of greater risk aversion. Our study of Metrolinx's project portfolio reveals two key types of risk aversion behind overbuilding.

The first of these is building for the worst case scenario. Canadian transit agencies tend to use stricter interpretations of global safety standards, than other, more cost-effective jurisdictions. For example, the interpretation of National Fire Protection Code 130 fire regulations used in building Toronto's Scarborough Subway extension necessitated thicker concrete linings and a fireproof barrier between trains, creating a larger tunnel diameter than is found in other projects reliant on the same safety standards (see Figure 5).

The second aspect of risk aversion that is in play is letting external stakeholders drive design. To build political support and avoid the risk of litigation, many Canadian transit agencies allow external stakeholders (e.g., community groups, municipal governments, and business interests) to extract concessions from transit projects. However, these often come at high cost. For example, Toronto's Yonge North Subway Extension was forced to tunnel deeper than previously anticipated under the affluent suburban community of Royal Orchard, while preserving station access,[20] because of resident concerns about noise and disruption from tunnel boring (see Figure 6).[21] Transit researcher and activist August Pantitlán argues that this capitulation to local interests sets a poor precedent, encouraging other resident groups to fight for costly aesthetic mitigations (as happened later with the Ontario Line through Leslieville).[22]

[19] Aevaz et al., "Saving Time and Making Cents"; Lewis, "On the Right Track."
[20] Verster, "Open letter to the Residents of the Royal Orchard Community."
[21] Metrolinx, "Yonge North Subway Extension Initial Business Case."
[22] Pantitlán, "Out of Their Depth"; Hune-Brown, "Behind the Scenes."

In contrast, through clever alignment selection, minimized station size, and widespread standardization, low- and medium-cost jurisdictions build what is strictly necessary to deliver a project's tangible transportation benefits. And instead of allowing design choices to be driven by risk aversion or external stakeholder interests, these jurisdictions make cost-effectiveness the first priority.

Table 1. Planning and engineering strategies used by other jurisdictions to reduce overbuilding

Alignment selection	Low- and medium-cost jurisdictions minimize the use of tunnelling (e.g., by selecting elevated, at-grade, or trenched alignments) and reuse existing rights-of-way within project alignments wherever possible. Where tunnelling is strictly needed, low-cost methods (like cut and cover) are prioritized over more expensive methods (tunnel boring or mining).[23] Although low-cost tunnelling is often more disruptive, other jurisdictions are often willing to take on greater disruption for expedited timelines and lower costs.[24]
Station depth and size	Figure 7 shows that stations make up the largest proportion of hard costs – 17.9% of total costs, a finding confirmed by the literature.[25] Thus, reducing the size and depth of stations has the largest impact on the hard costs of a given project. Low- and medium-cost jurisdictions reduce unnecessary back-of-house space and build underground stations as shallowly as possible. Where deep stations are absolutely necessary, the volume of excavation is minimized by eliminating full-length station mezzanines, or maintaining access exclusively through elevators.
Standardization	Standardizing designs, components, and materials across an infrastructure project allows projects to be delivered in a modular and iterative manner, enabling continuous improvement in the costs and speed of project delivery.[26] Low-cost jurisdictions standardize within a given project, and also implement national guidelines and best practices for design and construction.[27] This lowers not only hard costs (through economies of scale), but also soft costs, since the burden of design and engineering work can be reduced.

Our study finds that planners looking to reduce hard costs should aim to be creative and forward-thinking with alignments (preserving and re-using existing rights-of-way), make cost-effective design choices (smaller stations and shallower tunnelling), and maximize the standardization of technologies and components.

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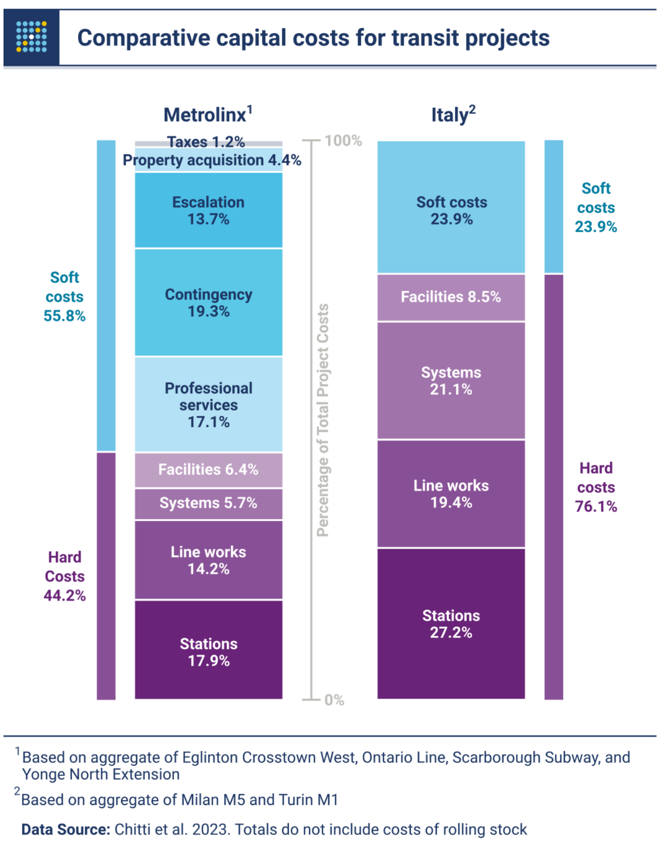
[23] Aevaz et al., "Saving Time and Making Cents"; Goldwyn et al., "Transit Costs Project"; Wickens, "Station to Station."
[24] Goldwyn et al., "Transit Costs Project."
[25] Aevaz et al., "Saving Time and Making Cents"; Goldwyn et al., "Transit Costs Project"; Wickens, "Station to Station."
[26] Flyvbjerg, "Make Megaprojects More Modular."
[27] Chitti et al., "Italian Case."

Lack of knowledge retention

State (or "in-house") capacity is "the ability of the state to execute projects that are either in the public sector or contracted out to the private sector but with state interest."[28] Jurisdictions with robust state capacity possess the expertise and knowledge to make decisions quickly, perform complex tasks in-house, retain public-sector technical experts, and minimize the use of private-sector consultants.[29] In contrast, agencies that rely more on external consultants for design, planning, engineering, and management experience higher soft costs than those that rely on in-house staff for the same services.[30] Like many North American transit agencies, Metrolinx relies extensively on external consultants for project delivery – not just for professional services, but also for management-level positions. The Ontario Auditor General found that "25% to 30% of all staff positions in the Capital Projects Group… [including] 25% of management positions… are filled by external consultants."[31]

Figure 7. Percentage breakdown by cost category of the aggregate of the four selected Metrolinx rail transit projects, compared to two Italian metro projects



The costs of rolling stock and financing have been removed to retain comparability with global case studies.

As shown in Figure 7, the proportion of professional services in the Metrolinx projects studied is very high compared to peer projects, and the total proportion of a project's soft costs is significantly higher than in a low-cost jurisdiction such as Italy. In fact, the proportion of just the white-collar labour in the Metrolinx projects (17.1%) approaches the entire soft-cost proportion of the Italian cases (23.9%).

The abnormally high proportion of professional services does not seem to stem from a lack of in-house personnel. Rather, the heavy reliance on external consultants impedes the retention of knowledge and expertise within the organization, leading to a scenario where there is minimal learning and an excessive managerial focus among public servants.[32]

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[28] Levy, "State Capacity and Infrastructure Construction Costs," [4].

[29] Levy, "So You Want To Do An Infrastructure Package."

[30] Aevaz et al., "Saving Time and Making Cents"; Goldwyn et al., "New York Case."

[31] Office of the Auditor General of Ontario, "Value-for-Money Audit."

[32] Personal interviews with anonymous informants, 2024.

As we explore in the next section (Risk Management), this lack of internal reflection prompts a reactionary approach where the scope and budget become over-inflated due to perceived complexities in all aspects of project management. The literature concurs with this finding that an overreliance on consultants can hinder project management, where projects have "a structural organization… that impede[s] efficient collaboration and decision making."[33] Lacking the necessary expertise, consultant-laden agencies struggle to rein in a project's scope and vision, as was found with consultant-driven scope escalations in Boston and New York.[34]

Agency capacity can also have significant impacts on the procurement process. Many Canadian projects enter the bidding stage with 1% to 10% of design completed, a result of lacklustre in-house capacity that necessitates large public-private procurement contracts that welcome private sector involvement early to fill gaps in expertise.[35] Lower-cost cities like Paris, Milan, and Istanbul, on the other hand, generally enter bidding only when the public sector has developed 30% to 70% of the design.[36] Allowing designs to reach more detailed stages before procurement also solidifies the scope of the entire project, a factor critical to reducing construction risk and costs for private sector bidders.[37] Even when contract models with greater private-sector involvement are used, a competent public sector leads project management, issuing smaller contracts with clear deliverables and limited scope. Most importantly, advancing project design in-house empowers civil servants to take ownership of and make decisions on projects, increasing cost confidence and controlling soft costs by minimizing change orders and delays.[38]

Thus, to reduce cost, Canadian transit agencies must focus on building expertise in-house. Though it may be a daunting task, many low-cost jurisdictions also previously lacked the capacity to deliver large-scale transit projects efficiently. However, learning and adopting practices from abroad has proven critical to their long-term success in controlling costs, as shown in Table 2.

[33] Goldwyn et al., "Transit Costs Project."
[34] Goldwyn et al., "Boston Case"; Goldwyn et al., "The New York Case."
[35] Personal interviews with anonymous informants.
[36] Aevaz et al., "Saving Time and Making Cents"; Chitti et al., "Italian Case"; Ensari, Goldwyn, and Levy, "Istanbul Case."
[37] Aevaz et al., "Saving Time and Making Cents"; Goldwyn et al., "Transit Costs Project."
[38] Aevaz et al., "Saving Time and Making Cents."

Table 2. Case studies of three low-cost jurisdictions that actively built institutional knowledge over time

	Turin was able to construct its first metro line at low cost with limited initial in-house experience by learning from others. "Leveraging the experience of Rennes, a city that had deployed the same VAL 208 system only a few years before, Turin's GTT quickly built up the necessary in-house skills to deliver the complex project on time and on budget."[39] *Image: Wikimedia Commons.*
	In Istanbul, agency staff consulted and learned from foreign experts, hired to bolster domestic capacity and knowledge. Through years of knowledge exchange about construction experiences, agencies developed the internal capacity to streamline processes and increase efficiency.[40] *Image: Wikimedia Commons.*
	To execute the construction of Seoul's Metro in the 1970s, South Korea boosted the city's capacity by partnering with local and Japanese institutions for research, financial, and technical assistance. Today, the government sponsors several Korean research institutes, such as the Korea Transport Institute (KOTI) and the Korea Railroad Research Institute (KRRI), which in turn consult on reducing the construction and operating costs of systems, infrastructure, and policy around the world.[41] *Image: Wikimedia Commons.*

Decision makers, planners, and agency staff must be open-minded and proactive in seeking out best practices from abroad. Detailed learning requires sending ordinary civil servants and researchers – not just executives – to conferences and exchange programs (which public servants in Canada are typically discouraged from attending) on a regular basis to gather new ideas and build long-term connections.[42]

Planners from Deutsche Bahn (the German State Railway) regularly make exchange trips of several weeks to several months to other European countries and even to Japan and Russia.[43] In fact, the agency's participation in the GO Expansion in Ontario was an explicit part of such an exchange, with the company expecting the knowledge transfer and experience of Canadian technology and culture would improve rail development in Germany.[44]

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[39] Chitti et al., "Italian Case," 69.

[40] Ensari, Goldwyn, and Levy, "Istanbul Case."

[41] Lewis, "On the Right Track."

[42] Personal interviews with anonymous informants; Levy, "Institutional Issues."

[43] Levy, "Institutional Issues."

[44] Deutsche Bahn E.C.O. Group, "An Order Worth Billions in Canada."

Risk management

Predicting the final cost and timeline of a transit capital project is a difficult endeavour that often results in inaccuracies. It is almost inevitable that projects will encounter difficulties during the construction process – from unforeseen soil conditions and water ingress to litigation from property owners. Additionally, unpredictable factors like inflation, market instability, and high-impact global crises can compound the risk of building large-scale projects.[45] As is well documented in the literature, these risks often lead to cost underestimates for transport infrastructure projects, resulting in cost escalation and overruns.[46] To minimize the risk of overruns, transit agencies often set aside a "contingency" pool of money that provides an extra buffer within the project budget. Used in moderation, contingency budgets can account for greater risk during the design (e.g., scope uncertainty), procurement (e.g., volatile construction markets) or construction (e.g., unpredictable soil conditions) phases. However, excessively large contingencies can lead to "budget laxism," where the incentive to control costs over a project life cycle is low and money, having been allocated, is unnecessarily spent.

The Metrolinx cost percentages in Figure 7 illustrate a habit of loading budgets with several layers of contingencies. Not only is project risk accounted for ("contingency," 19.3%), there is also allowance for the risk of inflation ("escalation," 13.7%). All told, risk provision accounts for 33% of the budget – more than the total soft-cost proportion of the Italian cases (23.9%). Recent North American projects seem to have resorted to high contingencies to prevent budget overruns, managing risk with financial means upfront.[47]

While allocating contingency funds may seem prudent, the way Canadian agencies perceive and manage risk is at odds with the concept of contingency itself. Theoretically, contingencies should never be entirely spent, and should shrink as project risks are managed through the design and engineering process. However, the continuously escalating per-kilometre costs in Canada indicate a persistent trend of overpadding, where budgets are regularly inflated due to 1) prescriptive risk management practices and 2) the absence of resistance to increasing costs. This leads to an iterative process of cost escalation, driven by the ongoing identification and financial accommodation of new risks. The trend of budget padding can be observed even more strongly in other Anglosphere projects, as shown in Figure 8. For example, over 40% of the budget for the Los Angeles Southeast Gateway Line consists of contingencies, with increased risk being the primary reason cited for the project's continuously increasing costs. In another case, the latest estimate for the Projet structurant de l'est tramway in Montreal allots nearly $10.5 billion of the project's $18-billion price tag to risk management.[48]

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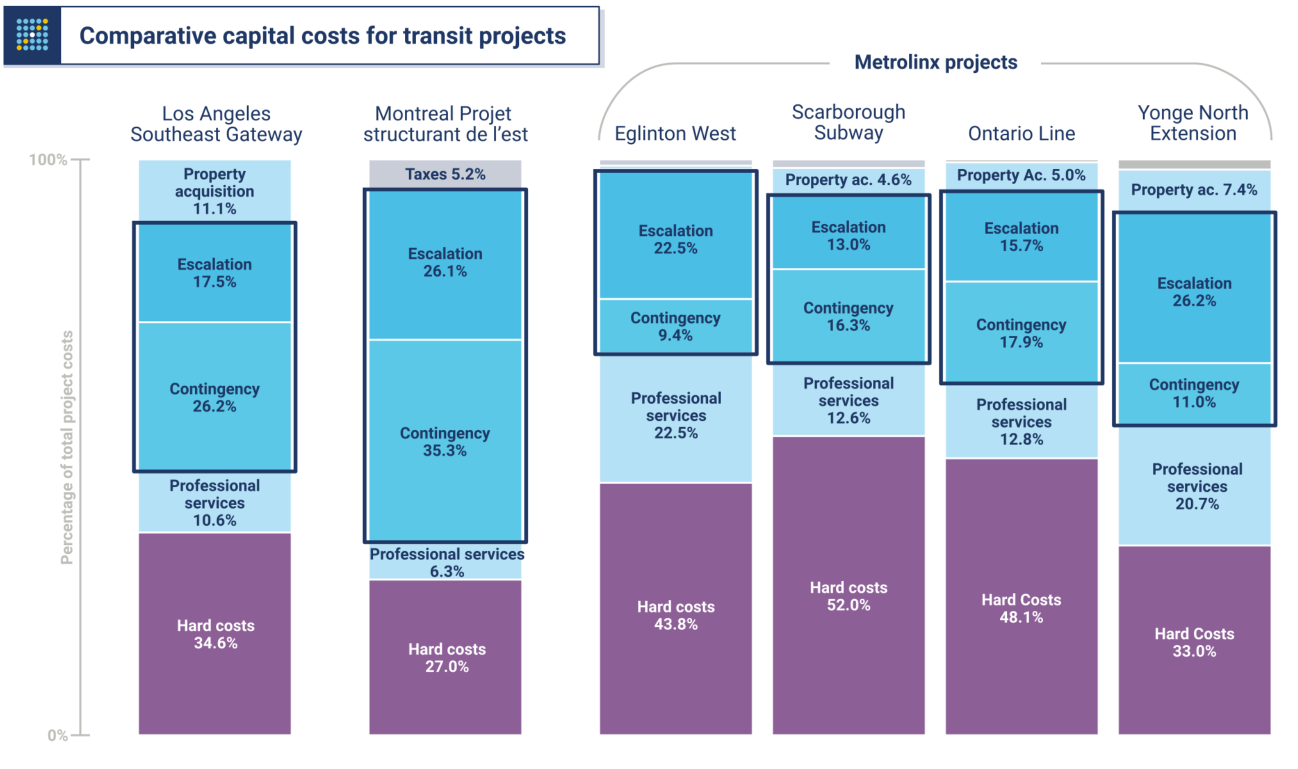
[45] Galante and Bruzzone, "Large Program Cost Estimating."

[46] Love and Ahiaga-Dagbui, "Debunking Fake News in a Post-Truth Era"; Love et al., "Understanding the Landscape of Overruns in Transport Infrastructure Projects"; Love, Ahiaga-Dagbui, and Irani, "Cost Overruns in Transportation Infrastructure Projects"; Flyvbjerg, Skamris holm, and Buhl, "How Common and How Large Are Cost Overruns in Transport Infrastructure Projects?"; Flyvbjerg, "From Nobel Prize to Project Management"; van Wee, "Large Infrastructure Projects."

[47] Personal interviews with anonymous informants.

[48] Autorité Régionale de Transport Métropolitain, "Projet structurant de l'est (PSE)."

Figure 8. Percentage breakdown by soft-cost category of the four selected Metrolinx projects, alongside two North American tramway projects in the planning stage



Data Source: Chitti et al. 2023. Totals do not include costs of rolling stock

Risk provision categories are highlighted. The North American projects are the Los Angeles Southeast Gateway Line and Montreal's Project structurant de l'est. The costs of rolling stock and financing have been removed to retain comparability with global case studies.

In contrast, low-cost jurisdictions have managed to deliver more complex projects of higher risk with lower contingency budgets. For example, Italy and Turkey have adopted policies that prescribe percentage maximums on contingency budgets (ranging from 7% to 12% including risk of inflation). Such limits serve as an incentive for agencies to prioritize controlling the absolute cost of projects rather than plan for the risk of budget overruns.[49]

In addition, low-cost jurisdictions emphasize public transparency, enabling more cost-effective planning and decision-making. They avoid lump-sum contracts that make costs opaque and change orders more difficult to track.[50] In comparison, high-cost jurisdictions like New York and Toronto consider cost estimates to be akin to trade secrets, citing their commercial sensitivity to prevent public disclosure.[51] In fact, Ontario explicitly "preserve[s] the confidentiality of… construction cost estimate[s]," including "risks, costs, … schedule[s],… unit prices, and bid prices" as part of its "information sensitivity" guidelines, according to the provincial Ministry of Transportation.[52]

[49] Chitti et al., "Italian Case"; Ensari, Goldwyn, and Levy, "Istanbul Case."

[50] Goldwyn et al., "Transit Costs Project."

[51] Goldwyn et al., "Transit Costs Project"; Goldwyn et al., "New York Case"; Wickens, "Station to Station"; Infrastructure Ontario, "Our Approach to Transparency."

[52] Ontario Ministry of Transportation, "Draft Cost Estimating Guide For Designers."

However, low-cost jurisdictions have shown that the opposite is necessary: publicly available cost benchmarks released regularly by governments in Turkey and Italy, for example, have proven to be important for the symmetry of knowledge between clients and contractors, stabilizing market bids.[53] In addition, transparent unit costs allow agencies to gain in-depth knowledge of costs and manage change orders effectively.[54] The literature indicates that transparent delivery processes are critical to reducing risk and ensuring lower costs – and important for building institutional knowledge and garnering public support.[55]

External constraints

Factors like the need for additional third-party agreements, political micromanagement, high labour costs, and lack of competition in the construction sector have been shown to affect project delivery.[56] In Ontario specifically, the volume of housing and infrastructure projects has pushed the province's construction capacity near its limit, resulting in higher materials and labour costs.[57] Political micromanagement has also been well documented throughout Toronto's history, from the cancellation of the Eglinton West subway to the advent of Transit City.[58] Although these influences are somewhat outside of the control of agencies, they are critical for establishing the context in which to examine a project's delivery. However, detailed analysis of these external factors is beyond the scope of this paper; further research is required to determine the exact magnitude of their impacts on costs and timelines in Canada.

[53] Ensari, Goldwyn, and Levy, "Istanbul Case"; Chitti et al., "Italian Case."
[54] Goldwyn et al., "Transit Costs Project."
[55] Aevaz et al., "Saving Time and Making Cents"; Goldwyn et al., "Transit Costs Project"; Wickens, "Station to Station."
[56] Aevaz et al., "Saving Time and Making Cents"; Goldwyn et al., "Transit Costs Project"; Goldwyn et al., "New York Case"; Goldwyn et al., "Boston Case."
[57] Wickens, "Station to Station."
[58] Horak, "Building Rapid Transit in Canada"; English, "The Better Way."

CONCLUSION

Our literature review, global benchmarking, and examination of Metrolinx projects make clear that high construction costs are not inevitable. Developed countries like Spain, Turkey, South Korea, and Italy show that with comprehensive procurement reforms, the nurturing of in-house capabilities, and an embrace of global best practices, high construction costs can be driven down. Likewise, high costs in Canada and other English-speaking nations aren't a result of factors inherent to these places (like cost of living, governance, or wealth); rather, they are the result of ineffective planning, costing, procurement, stakeholder engagement, and governance practices, some of which can be observed in Metrolinx projects.

There is no single driver of transit construction costs, nor is there a silver bullet to bring high-cost projects in line with low-cost counterparts, nor is the problem of high costs unique to Metrolinx. High-cost jurisdictions, like Toronto, experience cost escalation through a series of compounding factors highlighted above – from planning and construction to institutional and procedural inefficiencies.[59]

This chapter is just the beginning of a discussion to question our institutional practices – practices that have exponentially driven up the cost of building rapid transit in Canada. To better understand specific aspects such as procurement models and agency governance, future research should delve deeper into these topics and develop precise indicators for measurement. By making this issue a priority, Canada can effectively reduce transit construction costs and close the infrastructure gap.

"Developed countries like Spain, Turkey, South Korea, and Italy show that ***with comprehensive procurement reforms, the nurturing of in-house capabilities, and an embrace of global best practices, high construction costs can be driven down."***

[59] Aevaz et al., "Saving Time and Making Cents"; Lewis, "On the Right Track"; Goldwyn et al., "Transit Costs Project"; Chitti et al., "Italian Case"; Barone, Vitullo-Martin and Pichardo, "Building Rail Transit Projects Better for Less"; Chetan and Chow, "Reducing US Transit Costs."

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