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Timelines of Transportation Infrastructure Delivery 2000 to 2018 in Toronto, Canada and London, UK

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This paper explores the timelines of large transportation infrastructure delivery, from first proposal to construction and opening in London, UK and Toronto, Canada. The goal of the paper is to identify both how long it takes projects to go from idea to delivery, the relative time of different stages in the delivery process, and if projects with long timelines see physical or technological changes in their design. This work contributes to two ongoing discussions around the speed of infrastructure delivery,

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one that argues infrastructure moves too slowly and major efforts are needed to speed delivery and another that argues that good infrastructure thinking requires time to breathe and care should be taken in rushing through the delivery process. Detailed delivery timelines from initial proposal to construction or operation are developed for 26 transportation projects (16 in Toronto and 10 in London) between the years 2000 and 2018. For each project the timelines of inception, approval, planning, procurement, environmental assessment, construction and operational phases are identified and compared. Long informal gestation periods are identified for many projects, particularly for linear projects. In many instances the informal gestation period dwarfs the time projects spent in formal planning. This research highlights the need to expand the conception of timeliness of infrastructure delivery to include the lengthy periods of informal debate and planning that can span years and build up community expectations about the imminence of a project, even before it has received formal assessment or approval.

Keywords: Transportation infrastructure, delivery, timelines

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1. Introduction

This paper investigates the timelines of large transportation infrastructure delivery, from first proposal to construction and opening in London, UK and Toronto, Canada. The goal of the paper is to identify both how long it takes projects to go from idea to delivery and the relative time of different stages in the delivery process. This work contributes to two ongoing discussions around the speed of infrastructure delivery, one that argues infrastructure moves too slowly and major efforts are needed to speed delivery and another that argues that good infrastructure thinking requires ‘time to breathe’ and care should be taken in rushing through the delivery process. In this paper we examine the delivery timelines from idea to construction or operation of all major transportation infrastructure projects in London, UK and Toronto, Canada that have started construction or entered service from 2000 through 2018. We ask three questions about the projects:

- 1) how long has it taken each project to proceed from initial project proposal to construction or operation?
- 2) how long was spent in each stage across the project delivery timeline?
- 3) for projects that have long time gaps between proposal and start of construction (>10 years) did they change significantly – a potential indication of benefitting from time to breathe.

This work contributes to the current literature on large transportation project delivery through a detailed analysis of the time variable in infrastructure delivery, expanding the scope of analysis back to the original project proposal - many existing studies examine the construction phase - and including informal decision making structures by completing a near census of all large projects in London and Toronto, and by investigating if projects with long timelines take advantage of that time to materially change.

2. Research Context

For the purpose of this study, the term 'infrastructure' refers to key facilities, assets and physical networks such as highways, roads, bridges, railroads, airports, telecommunications systems, power plants, water supply systems, waste management facilities, schools, public housing, hospitals and libraries. Particular focus is placed on transportation infrastructure which is the topic of this study.

High quality infrastructure systems are vital for supporting economic activity and are generally considered as a critical factor for the welfare and well-being of cities and their inhabitants (World Bank, 1994, 2015). Infrastructure investment to address backlogs of infrastructure maintenance, rising populations, climate change, poverty and social exclusion (Intergovernmental Panel on Climate Change (IPCC), 2014; Kennedy and Corfee-Morlot, 2013; Organisation for Economic Development (OECD), 2006, 2012), and the objective of promoting economic prosperity and competitiveness, often feature highly on the political agendas of pro-growth coalitions (Altshuler et al., 2003; Marshall, 2012; Te Brömmelstroet and Nowak, 2008). This has led countries across the world to channel more funding into infrastructure. According to the McKinsey Global Institute (2016), today the world invests some \$2.5 trillion a year in transportation, power, water, and telecom systems. It has been estimated that through 2030, annual investments of about \$3.3 trillion are needed in critical infrastructure to support economic, social, environmental goals and individual needs (McKinsey Global Institute, 2016). In high income countries (especially Canada, Australia and the United States), the need to rapidly expand rail transport networks to eliminate dependence on the private automobile is a key step to reducing GHG emissions of associate climate change impacts (Fisch-Romito and Guivarch, 2019).

However, whereas it is evident that the possibility of creating better living conditions appears to depend more and more on the capacity to develop successful infrastructure plans, narratives of shortage and delay are a significant feature of the public and policy discourse on the current state of urban infrastructure (see, amongst others, (Arcadis, 2016; Flyvbjerg et al., 2003; Hall, 1980; Marshall and Cowell, 2016; Morris and Hough, 1987) *The Economist* (March 10, 2012, p. 55). The near-certainty of lengthy delays and large cost overruns in infrastructure planning and delivery has been described by Flyvbjerg (2003) as "the iron law of infrastructure projects". Communities and political leaders thus consistently criticize how long it takes to move major public works through from early conceptualization to completion, a timeline which, especially in the case of large-scale infrastructure projects, often stretches several decades (Cowell and Owens, 2006; National Infrastructure Commission (NIC), 2017). Further, there is debate about when projects start (Williams et al., 2019). Especially in high income countries, there is often a gap between when a project is first announced politically, to when funding is secured and again to when construction begins. This increases the perception of project delay in the populace for projects that from a technical perspective have not yet begun (Spurr, 2019).

Narratives of 'delay' and 'barriers to progress' on critical infrastructure projects have been used in many countries to rationalise a whole suite of institutional changes oriented towards the acceleration of infrastructure decision times (Cowell and Owens, 2006; Gross, 2015; Marshall, 2012; Marshall and Cowell, 2016). In the UK, for instance, discourses of lengthy and complex planning application processes and inquiry stages are at the heart of the Planning Act 2008 and the successive Localism Act 2011, in which measures for procedural streamlining and simplification, and actions to contain the duration of decision-making processes for major infrastructure featured prominently (King, 2015; Marshall, 2014). In Canada, efforts "to cut red tape" and speed infrastructure delivery have led to the widespread application of public-private partnerships that standardize key elements of the procurement process (Siemiatycki, 2015). More recently, the Ontario provincial government has been on a major push to speed up the delivery of infrastructure, proposing to expedite projects by cutting

the environmental assessment process for designated projects and streamlining land expropriation. What remains less clear is if these processes are meaningfully improving the speed of infrastructure and/or what is lost in the pursuit of speed.

Increasing pressures for speeding up infrastructure decision-making processes have also gone hand in hand with a trend towards privatisation and financialization of infrastructure systems, a phenomenon which is particularly prominent in countries such as the UK, Canada and Australia and underpins the transformation of infrastructure into an investable asset class (O'Brien and Pike, 2017; O'Neill, 2013). Indeed, excessively lengthy planning procedures, potentially creating uncertainty over both project completion and outcomes, are hardly tolerated by international investors, who seek relatively predictable, safe and steady returns (Dimitriou, 2009).

Whilst the length of the technical infrastructure planning and decision-making processes have received a lot of coverage by media and press in the past few decades, and currently represents a highly debated topic in planning studies, a systematic investigation of this issue has not been undertaken (Marshall and Cowell, 2016). Moreover, examinations of the political processes of agenda setting and project prioritization that occur during the early phases of infrastructure planning are largely excluded from the literature, even though these can stretch over decades. The political nature of projects and the presence of narratives of delay suggest project timelines are far more than technical constructs or plans to guide delivery of infrastructure. Megaprojects often exhibit a strong cultural dimension (Van Marrewijk, 2015). Recent analysis of the early stages of project development (Williams et al., 2019) have highlighted their importance from a project management perspective. The cultural dimension, however, points to the public nature of much deliberation on infrastructure and the significance of the point at which projects enter public debates and thus the public imagination. Therefore, a deeper and more thorough investigation of the time variable in infrastructure decision-making is both timely and necessary.

With trillions of dollars invested every year in infrastructure across the world, research on project success and critical success factors has gained increasing relevance. Traditionally, project success had been assimilated to the capability of planning, managing, and delivering projects on time, within budget and in line with the technical specifications (Cooke-Davies, 2002, 2004). Performance measurement in construction projects had thus been dominated by the conventional measures of time, cost, and quality, also referred to as the 'iron triangle' (see Atkinson, 1999) or the 'triple constraint' (see Pinto, 2004). In the course of time, however, many authors (see, amongst others, Baccarini, 1999; Cooke-Davies, 2002; Munns and Bjeirmi, 1996; Samset, 2012, 2010; Wit, 1988) have highlighted the need for expanding this definition. According to these authors, project success should be considered as an aggregated measure, deriving from two main dimensions, namely process success and product success. The former can eventually be evaluated primarily in terms of time, cost, and quality. By comparison, product success focuses mainly on the performance of the project after it has been delivered and its capacity for meeting the agreed project objectives. Whilst it is evident that arriving at an objective measure of the success is challenging there is a general agreement on time being an important component of this assessment.

A general consensus also exists over the fact that large-scale infrastructure presents long development cycles, which often exceed schedule targets. For instance, according to a study on 52 major infrastructure projects belonging to different sectors and located in 16 countries, more than 60% of the projects were not able to meet their construction schedule target (Merrow, 1998). Another similar study, investigating the performance of 60 major projects across the world, in the field of electricity production, oil and gas, public transportation, and complex technical systems, concluded that almost one third of these projects were completed behind schedule (Miller and Lessard, 2000). An analysis of 30 selected major transport projects in ten countries undertaken by the OMEGA Centre, showed that

20 projects (67%) were behind schedule in delivery with an average 19 month delay (OMEGA Centre, 2011). Numerous other studies have indicated that the time allocated for project planning and delivery often turns out to be optimistic (Flyvbjerg et al., 2003; Hall, 1980; Hertogh et al., 2008; Megaproject, 2015; Morris and Hough, 1987; Samset, 2012). A clear accounting of project delay is dependent on an agreement of when the project started and was due to finish. Existing research on project timelines has mostly focused on delivery compared to an announced expected completion date. Such expected opening dates are generally announced at the start of detailed design and construction planning. This excludes the time it takes to move projects to the starting line which also takes a large amount of time.

A review of the academic and grey literature on infrastructure planning reveals the presence of two contrasting positions on the time taken to make decisions on major projects. The former position, supported mainly by business groups, multinational engineering and consultancy firms (see Arcadis, 2016) but also by some scholars (Flyvbjerg et al., 2003; Merrow, 1998), presents the time spent in planning in a rather negative light. According to this perspective, mainly grounded on a financial and economic rationale, lengthy planning procedures and delayed decisions are the product of an inefficient approach to infrastructure provision and ultimately lead to an increase in the costs for both project developers and the economy as a whole. Arcadis (2016), for instance, contends that, in 2015/16, the impacts of infrastructure spending delays and cancellations cost the UK economy £4.6bn.

Against this argument for expediting infrastructure planning and approvals, a second position that underlines the possible benefit of long decision-making procedures must be considered. Although recognizing the capability of meeting schedule targets as an important factor for determining project success, this alternative viewpoint, promoted mainly by academics (see Hertogh et al., 2008; OMEGA Centre, 2012; Pressman and Wildavsky, 1973), underlines the necessity, especially in the case of large-scale infrastructure projects, for undertaking detailed investigations, comprehensive analysis and meaningful public deliberations before decisions are finally made. Indeed, it is widely recognized that, different from conventional and smaller scale infrastructure investments, mega projects frequently entail consequences that go far beyond the physical assets that are being delivered.

Hirschman (1995), for instance, defines major infrastructure projects as 'trait making', as opposed to ordinary, 'trait taking' projects. Whilst the latter merely fits into pre-existing physical structures and urban fabrics, without any attempt to significantly modify them, the former is designed to ambitiously change these structures. Echoing Hirschman's opinion, the OMEGA Centre (2011 and 2012) argues that large-scale infrastructure and mega transport projects in particular, frequently become critical 'agents of change' for the traversed territories and the served communities owing to the multiple spatial, institutional, political, financial, economic, environmental and social impacts that such projects produce on the regions in which they are placed. Discussions about the transformational impacts of mega projects and their change agent role can also be found in the work of many other authors (Belli et al., 2008; Greiman, 2013; Olds, 1995, 2001; Saxe and Kasraian, 2020).

Whilst promising great benefits, mega projects may also entail substantial adverse impacts (e.g. loss of natural land, damage to existing communities). Unsuccessful mega project developments, unable to meet the original expectations and entailing cost overruns and/or technical problems, benefit shortfalls and severe social, health and environmental consequences have been extensively documented in the international literature (Altshuler et al., 2003; Cedolin, 2010; Flyvbjerg et al., 2003; Hall, 1980; Miller and Lessard, 2000; Morris and Hough, 1987; OMEGA Centre, 2011; Samset, 2012). Furthermore, by crossing different territories and operating at different scales, mega transport projects tend to generate a mismatch between costs and benefits (Dean, 2018 and 2020). Empirical evidence reveals that such projects often result in uneven distributions of the gains and losses over space and consequently amongst stakeholder groups, thus raising issues of social and territorial justice.

Time is thus required to facilitate engagement and consultation with the broad range of project stakeholders so as to allow for the identification of the multiple project objectives to be achieved and issues to be addressed. In some cases, a period of reflection in the preparation of infrastructure projects may also be necessary and beneficial to ensure a re-examination of past decisions in light of emerging objectives and new issues to avoid unexpected and negative planning outcomes (Hertogh et al., 2008; OMEGA Centre, 2012). More broadly, meaningful public engagement and consultation can create political legitimacy for large, complex, contentious projects. Such arguments for more time and scope for reflection often stem from a desire to facilitate greater engagement and thus potentially greater legitimacy alongside improved project outcomes. It is also true that such engagement will take time which is at odds with arguments towards rapid delivery. We do however need to be cautious in assuming that slower process automatically leads to better engagement, consultation and outcomes; delay can also be a tactic deployed by range of actors. Furthermore, given the allocation of power within the planning and delivery of infrastructure it can also be that it is wealth and status that has a greater bearing on the ability to influence timescales (Raco et al., 2018).

3. Approach, methods and data

The first step in this research was to build a database of large transport projects in London, UK and Toronto, Canada. London and Toronto were selected because both are the largest cities in their country, share a similar democratic political system, have delivered a significant number of major transportation projects in recent decades, and have had a robust public discourse about the length of time it takes to complete major transportation projects. The national government in the UK and the provincial government in Ontario have both brought forward high-profile policy and legislation aimed at accelerating major transportation infrastructure projects.

Yet, the two cities have different planning approaches and regulatory frameworks for large infrastructure. The UK has a structured mega-project delivery model with designated stage gates, standardized technical guidance documents, and mandatory public inquiries (DCLG, 2014; Morphet, 2011). Strategic planning is carried out by Transport for London, the transport authority for the city, established, funded and overseen by the Mayor and Greater London Authority. The national UK government, however, still retains a significant role in decision making and funding of major transportation infrastructure in London. The Canadian system is more *ad hoc*, administratively fragmented, and the process for delivering transportation varies significantly by project (Filion, 1999; Kipfer and Keil, 2002). In Toronto local authorities and the provincial agency Metrolinx both develop strategic transportation plans, but the provincial government holds much of the ultimate decision making authority for selecting the road and transit projects that proceed. The federal government is engaged in a more limited way as a co-funder of transport infrastructure prioritized by other levels of government. As such the two cities provide an interesting comparison to explore how (and if) two different planning systems grapple with the impetus to deliver projects quickly and to see if the different approaches (more technical vs more political) lead to different outcomes in terms of time. While not necessarily generalizable to all other urban contexts, the findings from London and Toronto highlight infrastructural policy and political dynamics that are common in many cities globally.

In each city, detailed data was gathered on the time taken to move the project from idea to reality. The choice to focus on the transport sector was dictated by its critical role for the functioning of labour and housing markets, the flows of goods and services, urban development, reducing greenhouse gas emissions, as well as productivity, competitiveness and social and economic inclusion. To ensure basic similarity of projects and data, transport projects have been selected based on their construction cost (i.e. only projects costing over £500 million, in the London Region, and over \$500 million, in the

Greater Toronto Area, have been selected as they deliver roughly the same scale of infrastructure in both countries) and their year of completion (i.e. projects completed before 2000 or with construction that started after 2018 are outside the scope of this research). Project age was limited to post 2000 completion to facilitate reflection on modern processes that are most relevant for informing decision making about future projects. Projects included both node (e.g. rail station development) and linear projects (e.g. new highway) Some of the studied linear projects extend out of London and Toronto respectively.

The methodology of this analysis can be described in three main steps 1) development of a database of projects, 2) quantitative analysis of the amount of time spent in different stages for each project, 3) qualitative analysis of change in projects with long gestation periods (>10 years) in their timelines.

3.1 Database of major urban infrastructure projects

To identify projects to be included in the database several sources have been used including government reports, newspapers and websites. For London, useful sources of information encompassed the HM Treasury and the Infrastructure and Projects Authority websites, containing an analysis of the UK national infrastructure and construction pipeline; the UK Planning Inspectorate website, containing information regarding National Significant Infrastructure Projects; the National Audit Office Committee website; The Department for Transport Website; and the Transport for London website. For Toronto, the website top100projects.ca provided a database of all major projects in Canada going back to 2007. For 2000-2006, GO Transit (the regional rail provider), Ontario Ministry of Transportation Reports, Canadian Environmental Assessment reports, municipal records, and newspaper articles were used to develop the database.

The case studies focused on infrastructure delivered in the entire metropolitan region. For Toronto, projects in the Greater Toronto Area (GTA) are considered a part of this study as the GTA is a contiguous urban area and many infrastructure projects are built to cater to the long-term regional needs of Toronto. In London, the geographic scope of analysis included projects within or connecting to the London region and included the 32 Boroughs of London and the City of London.

In total this paper analyses data from 26 large infrastructure projects 16 projects in Toronto and 10 in London. These 26 projects met the assessment criteria and had sufficient publicly available data to allow for detailed study of the infrastructure provisioning process. This represents a near census of all large transportation infrastructure projects in both regions that at least started construction during the study period.

Table 1 lists the studied projects and provides brief descriptions.

Table 1. Overview of transport case studies

S. N.	Project Name	Location	Description	Cost (2018 million)	Gestation years	Construction start	Year of opening
1	East Rail Maintenance Facility	GTA	Rail maintenance facility of 500,000 sq.ft. of infrastructure to meet GO Transit's operational requirements	\$906	8	2015	NA
2	Eglinton Crosstown LRT	GTA	19 km LRT corridor along Eglinton Avenue between Mount Dennis and Kennedy Station, including 25 stations and an 11 km underground track	\$8700	50	2016	2021*
3	Georgetown South Service Expansion	GTA	14.8 km of corridor expansion as well as the new proposed Union-Pearson Rail Link includes 60 km of new track, numerous retaining walls, sound walls, utility relocations and, site grading and drainage	\$1265	25	2010	2015
4	GO Bus Station-CIBC Square	GTA	Construction of two new commercial buildings, joined by a one-acre elevated park over the rail corridor near Union Station and a new Union station GO bus terminal	\$2040	10	2017	2023*
5	Highway 407 ETR	GTA	Highway 407 toll highway runs 108 km between Burlington and Pickering and includes 197 on- and off-ramps, 156 bridges, 41 interchanges and 23 grade separations	\$4529	28	1987	1997
6	Highway 407 East Extension	GTA	Phase 1 extended Highway 407 East 22 km from Pickering to Oshawa including 11 interchanges and phase 2 extends Highway 407 East 22 km from Oshawa to Clarington and constructs 8 interchanges	\$2366	53	2012	2016

S. N.	Project Name	Location	Description	Cost (2018 million)	Gestation years	Construction start	Year of opening
7	Highway Expansion	427 GTA	6.6 km extension from Highway 7 to Major Mackenzie Drive and 4 km road widening	\$628	16	2017	2021*
8	Leslie Barns	GTA	Streetcar maintenance and storage facility built to house and service the majority of TTC's flexity light rail vehicles	\$547	5	2012	2016
9	Pearson Airport Redevelopment Project	GTA	Project consisted of a single unified terminal complex designed to replace the aging Terminals 1 & 2, expanded airfield infrastructure, and better, more simplified public access	\$6575	3	1998	2007
10	Queen Elizabeth Way Widening	GTA	Four contracts involving widening of the QEW highway and adding high-occupancy vehicle (HOV) lanes	\$508	4	2005	2011
11	Toronto-York Spadina Subway Extension	GTA	8.6 km extension of Line 1 subway service to the Vaughan Metropolitan Centre from Sheppard West station. It includes three new stations	\$3207	42	2011	2017
12	Union Express Line	Pearson GTA	3 km rail line extension to the Air Rail Link and a new passenger station at Terminal 1 of Toronto Pearson International Airport	\$518	22	2011	2015
13	Union Station Infrastructure Renewal Program	GTA	The scope of work includes a new storage yard for 10 commuter trains, a new platform with associated underground passenger circulation facilities, track additions and upgrading, replacement of the 90-year old signaling system with new state-of-the-art LED signals, communications, power supply, CCTV, and SCADA systems	\$795	7	2010	2019*

S. N.	Project Name	Location	Description	Cost (2018 million)	Gestation years	Construction start	Year of opening
14	Union Station Revitalization Project	GTA	Restoration of many of the station's heritage elements, creation of 160,000 square feet of retail space and expansion of the GO concourses	\$817	10	2007	2019*
15	Wilson Facility Enhancement and Yard Expansion	GTA	The project includes expansion of Wilson Carhouse for the maintenance of fixed six-car TR subway trains; construction of an overhaul shop; additional tracks and connections and a new access roadway	\$536	7	2014	2018
16	York Viva Bus Rapid Transit Expansion	GTA	Addition of more than 35 kilometres of dedicated bus lanes	\$1554	15	2017	2020*
17	London Underground's Northern Line Extension	GLA	~3 ¼ km extension of the Northern Line in south west London intended to open up the Vauxhall, Nine Elms Battersea Opportunity Area for development	£1000	7	2015	2021*
18	London City Airport DLR Extension	GLA	.4 km extension adding four stops including a connection to London City Airport	~£200	5	2004	2005
19	East London line extension ("London Overground")	GLA	A two-phase project affecting 30 stations it reintroduced disused former underground lines and connect them to the city's overground network	£1250	29	2005	Phase 1 2010, Fully 2012
20	CTRL	GLA	108 km high speed rail line linking London to the Channel Tunnel	£17000	29	1998	2003

S. N.	Project Name	Location	Description	Cost (2018 million)	Gestation years	Construction start	Year of opening
21	Crossrail 1 ("Elizabeth Line")	GLA	118 km connection between Reading and Heathrow Airport in the West and Essex and Abby Wood in South East London linking 40 stations 10 of which are new and including 42 km of tunnels	£14800	34	2009	2021*
22	West Coast Main Line upgrade	GLA	A program intended to increase capacity and enable higher train speeds on the UKs busiest rail line running from Glasgow to London's Euston Station	~£9100	15	1998	2008
23	Thameslink Programme	GLA	A combination of station improvements, track upgrades and new technologies introduced to ease congestion and link the northern and southern rail networks via central London	£7000	19	2009	Phase 1 2011, Phase 2 2019*
24	The London Underground Victoria Station Upgrade	GLA	Enlarging and improving access to London Undergrounds third busiest station	£700	5	2009	2018
25	Heathrow Terminal 5	GLA	A 35 million passenger capacity terminal with road and rial (both underground and airport express) connections and baggage handling system for London's main airport	£5600	19	2002	2008
26	DP World Gateway	London	GLA Deep see port and logistics park containing its own rail terminal	£1500	10	2010	2013

Note: * denotes the year of expected construction completion

3.2 Definitions of project stages

The central question of this work was identifying different stages of project delivery and their duration. A first step was to identify and define each project stage. This was done inductively through review of project documentation for the 26 case study projects. Eight stages, approval, planning, procurement, environmental assessment, construction and operational have been identified to describe the delivery of the projects from idea to construction/opening. Table 2 defines the stage terms used in this research. Most projects proceed in series through the project stages. However, given the complex nature of large infrastructure delivery in many instances overlaps occurred between stages, particularly in London where stages overlap as part of the official process. Sometimes, projects reverted to an earlier stage before later again proceeding. For example, The Eglinton Subway in Toronto was cancelled after construction had started and returned to an earlier stage before later proceeding again into construction.

For each of the 26 projects included in the database, a mix of qualitative and quantitative data was collected with the view to investigating the time, steps and the key milestones required to move the project from inception to construction/completion. Factors such as planning, policy and institutional frameworks; financing and funding schemes; project stakeholders were reviewed.

Table 2. Definitions of project development stages

Stage	Definition
Inception	When the project is in conceptual stage. Proposals are made and discussed but not yet formal.
Approval	Period when application for project approval is submitted to grant of approval by City Council/regional government as relevant
Planning	All techno-commercial feasibility studies; planning, design and consultation reports and other project documents prepared before or during project implementation
Procurement	Main stages of procuring financial, engineering and construction services/ rolling stock towards implementing the project via tendering or competitive bidding.
Environmental Assessment	All stages of applicable environmental assessment regulation, including studies and public consultations undertaken
Construction	Period from the start of construction of any section or component of the project till the completion of all components
Operations and Maintenance	Start of service operations and infrastructure maintenance

For clarity we have presented the stages as discreet with start and end dates. The stage shown reflects the dominant process at the given time if there was overlap. In this work, project inception begins at the first mention of project concept in a planning document, politician's announcement, press release, or government report. Approval indicates consideration by relevant political bodies and votes to advance the project and was based on records of votes in government. The planning phase is calculated based on dates in published planning reports. Procurement on issuing of invitations for Expression of Interest (EoI), Requests for Proposals (RfPs), and contract awards. Dates for the environmental assessment (EA) are based on public EA reports for the studied projects. Construction dates relate to major works, and operation dates based on records of when projects went into service. For example, Figure 1 illustrates the timeline for the Union Pearson Express project in Toronto with key milestones and reference points noted. Throughout this document the word gestation is used to refer to the combined pre-construction time of each project.

To be certain, there is a level of subjectivity in determining precisely which stage a project is at and when, particularly during the long gestation period for projects. As Williams et al. (2019) note, research into the front-end phase of project planning is limited. Public agenda setting around

transportation priorities can blend with periods of early internal technical planning by various state departments and staged approvals that ultimately lead up to the final decision to proceed with a project. In our study we have sought to use the publicly available records and a consistent set of stage definitions to categorize the progress of the projects under review.

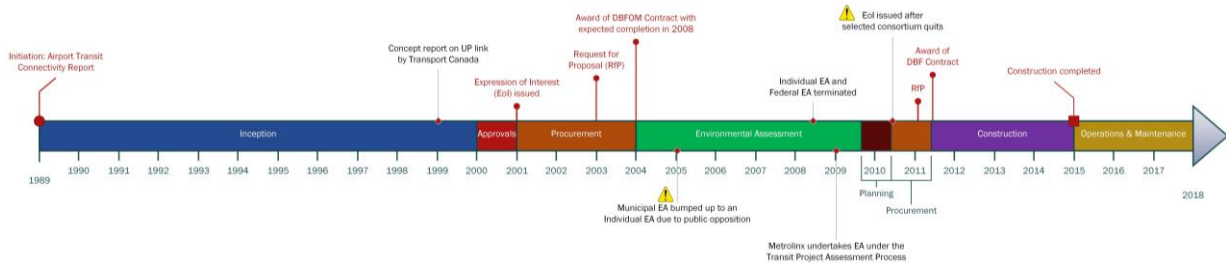


Figure 1. Example timeline for Union - Pearson Express train in Toronto

3.3 Time to breathe in projects?

The second question in this research investigated if some long timeline infrastructure projects are benefitting from a slower approach, that allows the project 'time to breathe'. In other words, was the project executed as originally proposed or was the final outcome an altered version arrived at through public discourse and taking advantage of the decade plus gestation period. In this work we did not investigate directly if projects have improved as this would require an, inherently subjective, definition of improvement. This work investigates if projects have changed during long gestation periods. Change is a prerequisite for improvement and would indicate that long gestation (slow) projects may have benefitted from sober second thought. Projects that remained the same overtime arguably did not need or did not take advantage of "time to breathe".

Projects which have undergone a gestation period of more than 10 years have been filtered from the case study projects for qualitative analysis with regard to changes before the start of construction. These have been investigated further to ascertain if the plan and vision for the project underwent change from the original proposal. The study focusses on two types of changes in the development of the projects that have most commonly occurred during the period before the construction stage: 1) physical changes in the hard infrastructure plan and 2) technological changes. Changes during construction are excluded as by definition these would occur after approval and outside of the time to breathe planning window. Physical changes can be characterized by a change in the length or alignment of a linear infrastructure such as a highway or transit line; number or location of transit stations; elevation of the infrastructure (above, at or below grade); and size/capacity of the facility. Technological changes in a project may include a change in propulsion technology; type of rolling stock; signalling and communication technology; and methods of construction. All of such changes alter the cost and construction timeline as well as the impact of the project on its surroundings and users. Data for both physical and technological changes were gathered from public statements about the projects, planning reports and newspaper articles reporting on project plans. Other aspects of the potential benefits of time to breathe, for example building community support, are outside the scope of this research.

4. Findings

4.1 Timeline of delivery

Figure 2 illustrates the timelines of the 16 Toronto projects and Figure 3 illustrates timelines for the 10 London projects. The timelines for each project are illustrated from its initiation to 2018. Some projects have very long gestation periods, during which they may undergo changes in design or concept or funding. In Toronto, the average inception stage took in Toronto 10.1 (STD 14.1),

London 9.8 (STD 9.5) years. The cumulative time before start of construction in Toronto was on average 18.8 (STD 16.2) years and in London, 18.4 (STD 10.7) years. As such, in both cities more than half of the preconstruction time was on average spent in political rather than technical processes.

For this analysis, we have considered a longstanding proposal to be a single project if the objective and primary scope have not changed (e.g. a rapid transit line in the same location). Multiple construction phases or failed and re-executed procurement contracts do not mean different projects. This provides a different perspective on a project than one that views each new proposal as a new project. It is similarly better aligned with the way the public views long-running infrastructure proposals that may be redesigned, renamed or acquire new champions but still retain an association with the original plan. The gestation periods of projects is political in nature as projects vie for priority, funding and attention

Sixteen of the 26 examine projects had gestation periods longer than 10 years. In nearly all cases the gestation period was longer than many technical assessment periods that are targeted for efficiency to increase project speed (e.g. environmental assessment). Similarly, for the majority of the cases the gestation period was also significantly longer than construction (with the caveat that some case studies did not complete construction within the study period).

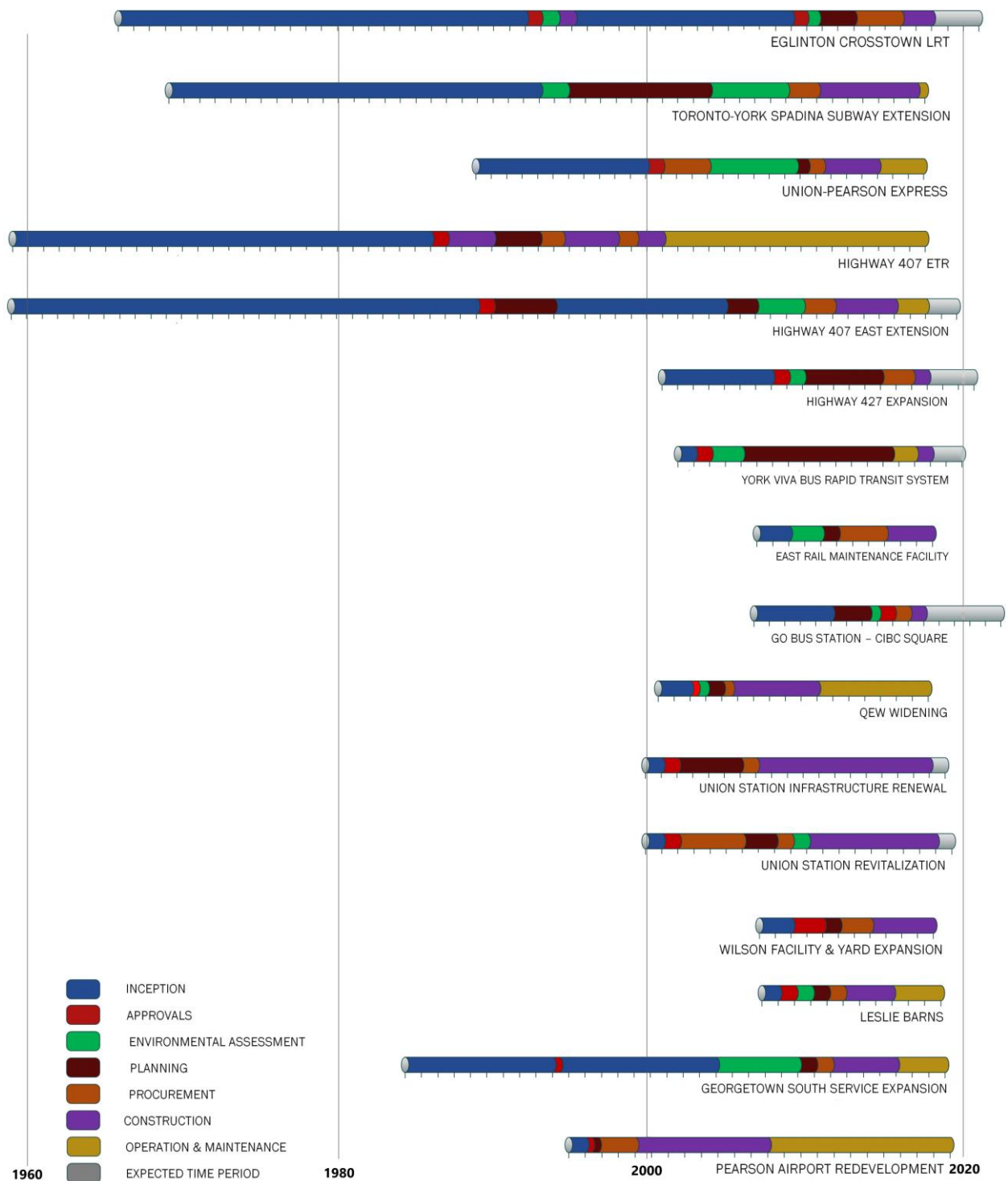


Figure 2. Timelines of Toronto projects

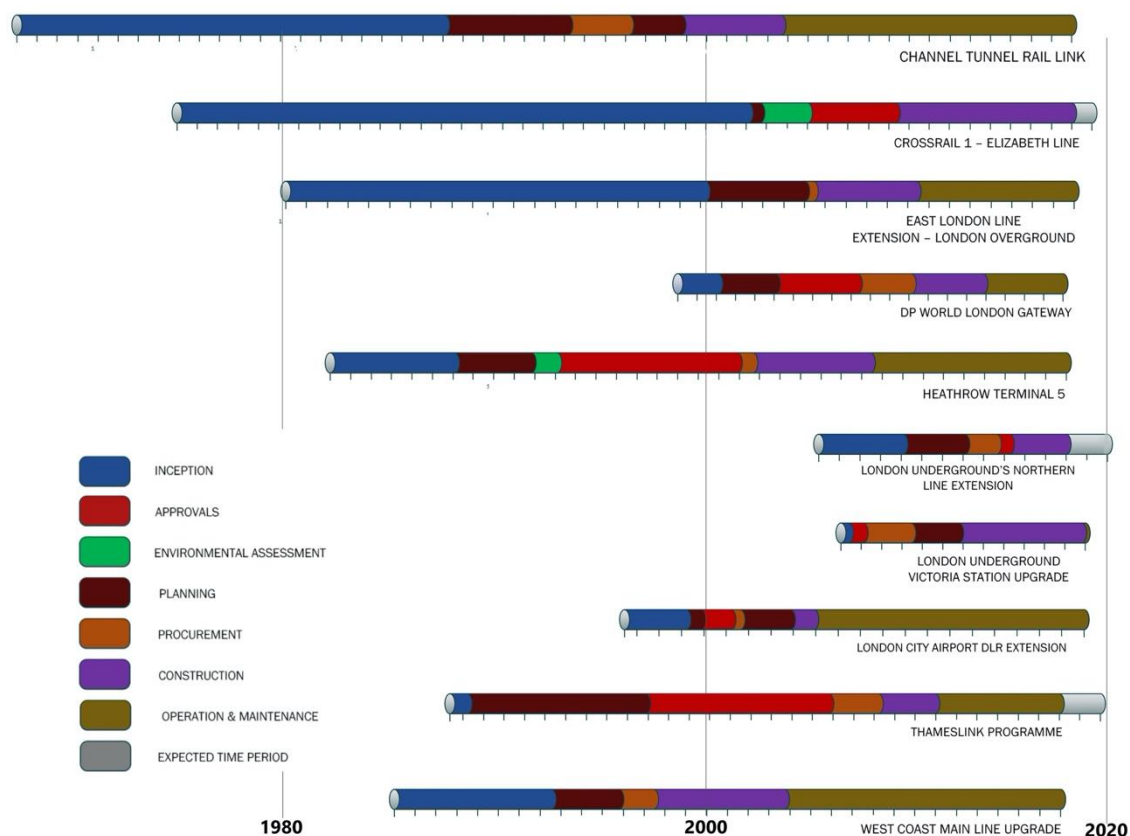


Figure 3. *Timelines of Greater London Projects*

4.2 Qualitative analysis of change in projects

There are 10 projects in Toronto characterized by a gestation period of 10 or more years; 5 transit projects (linear), 2 stations (node) and 3 road projects (linear). Overall, node infrastructure projects as described in the section above saw few changes with the two exceptions below. Three road projects have gestation periods ranging from 16 - 53 years, but did not undergo any changes in the plan, alignment or length and were constructed close to how originally envisaged. Two out of the 5 transit projects changed little across their long gestation periods. York Viva BRT expansion took almost a decade of design and engineering for the roadways, intersections and stations while the Georgetown South Service expansion stalled after getting approvals due to funding constraints but did not undergo notable physical or technology changes. The five Toronto projects that underwent changes before construction started are discussed in Table 3 below.

In London, 6 of the studied projects had gestation periods of 10 years or more including 4 linear rail projects, one transit node, an airport terminal and a port. Of these six, five saw changes. The 6th, the DP World Port was delayed primarily due to financing and was delivered much as originally proposed. For the three London rail projects with long gestation periods physical changes occurred through a formal process of optioneering and route choice. Changes in the UK tended to occur more as part of the technical evaluation process reflecting the UK's more structured approach to project evaluation and selection (e.g. during consenting).

This research has not examined the utility change associated with project change or lack thereof. This would be a valuable avenue for future research. However, the findings highlight that even in long gestation projects changes are often minor and long periods of stability in non-advancing projects are common. Across the projects a common finding was the lack of funding more than a

reconsideration of the physical or technological dimensions of the project prevented its advancement.

Table 3. Long gestation projects with physical of technological change

Project	Location	Gestation period (years)	Project Type	Physical Change	Technological change
Eglinton Crosstown	Toronto	50	Rail, linear	Different above and below grade alignments were proposed with the final alignment agreed in 2012. The same year station numbers were reduced from 27 to 25	Across its gestation phase the proposed technology changed from highway, busway, subway and finally to light rail.
Union GO Bus Station-CIBC Square	Toronto	10	Transit, node	A physical change in the floor plans took place in 2015 during the approval stage to adjust for required heritage protections to the original Union Station	
Union Pearson Express	Toronto	22	Rail, linear	Addition of two stations between Union and Pearson, second station added in 2005.	The project passed the environmental assessment on the condition that diesel trains be upgraded from Tier-3 to Tier-4 emission standards and built with the potential to be converted to electric propulsion in the future
Toronto-York Spadina subway extension	Toronto	42	Rail, linear	The project underwent many physical changes in route alignment, length and number of stations. Proposals in 1969, 1985, 1991, 1994, 2001 and 2006 each proposed different alignments and numbers of stations. The last change in 2006 extended the route past York University to Vaughan Metropolitan Centre.	

Union Station revitalization project	Toronto	10	Transit, node	The revitalization project underwent numerous physical changes in scope and floor plan. Changes were made to accommodate changes to the station made by the rail authority and to provide more retail space.	
CTRL	London and the South East of England	29	Rail, Linear	Four route options originally considered by British Railways in the early 1970s. The final proposal was based on proposals made by ARUP in 1990. During the consenting process a number of changes to alignments, bridges mitigation measures and station approaches were introduced.	
Crossrail 1 ("Elisabeth Line")	London (Berkshire and Reading)	34	Rail, Linear	Numerous proposals and failed attempts since the 1970s. In 2003 the preferred route was selected amongst six shortlisted corridor options. Local changes to mitigation measures were made as part of the Hybrid bill process. The final successful proposal included ten new stations created by linking the line to existing underground, overground or DLR stations	Additional mitigation measures (Floating Slab Track) were required by the Hybrid bill Committee
West Coast Mainline Upgrade	England and Scotland with significant	15	Rail, Linear		Original plans for the addition of the European Rail Traffic Management System (ERTMS), new signalling technology, and the Network Management Centre were removed as the

	sections in London				institutional arrangements were altered with a new delivery body (The Strategic Rail Authority). The introduction of the former was continued through a separate government programme
Thameslink Program	London East Anglia and the South East of England	19	Rail, Linear	Numerous options explored since the early 1990s, during the development phase e.g. alternative routes (overground or underground) as well as different configurations of stations and key bridges	Key elements such as rolling stock were procured as part of the programme - delays were due largely to decisions to roll the service out more slowly and problems of integrating organisations, technology and staff
Heathrow Terminal 5	London	19	Airport	Changes to the related river diversion scheme, reductions in carparking spaces and a rejection of proposed road widening	

5. Discussion and conclusions

The collected data on the 26 case studies highlight three key findings. First, long time periods are common between initial project proposals and the commencement of technical processes of project delivery. Second, while much attention has been placed on project delays during the technical project processes (planning review, permitting, construction) these delays are often short in comparison to the years to decades long political process of advancing a project proposal. Third, many projects even with long gestational phases experience little change or experience change mostly early in their long gestation phase. In both cities, the average inception stage (~10 years) and gestation periods (~18 years) were surprisingly similar given the different planning and geographic realities. However, in London, with more formal consideration of alternatives, there was more preservation of options into the technical process.

A key insight from this study is that the longest phase of project delivery, the gestation period, is not filled with time spent radically innovating to invent new technologies or ideas that make a project viable. Nor was the time spent finding ingenious technical fixes to complex delivery or operation requirements. Rather lengthy and often unpredictable planning processes are actually a result of the ways in which political power is mobilized, wielded and legitimized. Long project planning periods and delays in the delivery of major projects are indicative of the fragmented and often fractious ways that communities make decisions and allocate scarce resources. By the very nature of their size and scope, transportation mega-projects have the potential to be transformative, conferring major benefits for some stakeholders while incurring huge costs for others. There is also a clear opportunity cost in that building one mega-project comes at the direct expense of others, due to limited funding and capacity. For these reasons, it is not surprising that mega-projects are frequently contentious as each project is in competition with others for funding and prioritization.

At its core then, the delivery of major transportation projects takes a long time because in a democratic system it can take time to determine what should be built, and how and who should

pay for it. As illustrated by longer timelines for linear vs. node projects our findings show that the more stakeholders impacted by a project and the larger the number of actors and organizations that are required for project funding and approval, the longer it takes. It takes longer to identify, plan and approve long linear transit projects like a subway line that cover large territory and require funding, approval and action from multiple partners, then it does to approve single node investments like a new maintenance yard or roads that have a more centralized approval and funding structure.

Moreover, planning and approving transportation projects is both a technocratic and a political process. The findings of this study show that a significant, and often under recognized amount of the idea generation stage takes place within an informal inception period when debate is often lengthy, wide-ranging and unstructured amongst many different stakeholders. During this period, proposals are conceptual and may come from many different quarters, from politicians, to community groups and business leaders, to local government planners. In Canada in particular, there is a strong model of bottom up federalism. Ideas for mega-projects typically emerge from local actors before gaining support from provincial and federal, rather than the other way around. In the UK, the unitary system means that the national government plays a more significant role in guiding priorities for major investments in the nation's capital alongside local stakeholders.

In democratic countries like the UK and Canada, there is a governance norm to separate priority setting and decision making by elected political officials, from the management and implementation of projects by an independent civil service. Once projects rise to the top of the informal prioritization process and garner sufficient political support, in both countries they enter a more formal assessment period, complete with mandated public consultation/inquiries (in the UK), environmental assessments, and reporting. It is also at this stage that formal applications for funding are made, often from different levels of government. These processes are designed to ensure fairness, transparency and accountability in the way that projects are selected, provide impacted stakeholders with a voice in the process, and to apply technical evidence towards the selection of projects that will deliver the greatest benefit beyond potentially narrow political goals. It is this period that has been the primary focus for critiques about planning delay on major projects, though our research shows that they are not the primary cause of lengthy delivery processes, which has often already been long in motion before these formal processes are begun.

Nevertheless, in both the UK and Ontario, measures are now being taken to streamline the formal technocratic phase of project implementation, primarily by populist governments that see political prioritization and speed as having primacy over technocratic planning procedures. In the UK, new measures have recently been passed to 'cut red tape while maintaining quality'. The Ontario government has also adopted a new approach of decisively selecting a small number of priority transit mega-projects and proceeding rapidly with their planning and procurement. This despite strong pockets of public opposition and internal government technical documents and business cases showing that the projects have poor benefit cost ratios and value for money. The Ontario government has also passed legislation to streamline the technical assessment and delivery process for their priority projects. In both cases, the UK and Ontario governments are attempting to consolidate power over decision making as a strategy to accelerate the delivery of priority projects. As priority projects proceed at pace, is this a sign of decisiveness, or potential wastefulness and the undue politicization of decision-making?

Indeed, this research highlights the need to expand the conception of timeliness of infrastructure delivery to include the lengthy periods of political debate and planning that can span years and build up community expectations about the imminence of a project, even before it has received technical assessment or approval. A government that wants to speed infrastructure delivery should focus on effectively resolving the conflicts around resource allocation and priority setting rather than limiting oversight or planning evaluation process. There are substantial risks that project delivery models optimized for speed that does not include sufficient venues for

independent technical evaluation and community input from impacted stakeholders will lead to poor outcomes.

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