

New frontiers in delivering public infrastructure

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Abstract

Delivering infrastructure in a timely and efficient manner to provide public value remains challenging despite the theoretical developments that have been made. What do we know that could help to deliver quality and energy-efficient infrastructure, what are current challenges and how could we overcome them? This State-of-the-Art Review article attempts to uncover underlying themes, including the governance of large infrastructure projects, the importance of innovation and contractual arrangements, and social and environmental acceptability. A current review of major Canadian contributions is offered, and promising research avenues are proposed.

Sommaire

La réalisation d'infrastructures de manière opportune et efficace en vue de fournir de la valeur publique reste un défi malgré les développements théoriques déjà réalisés. Qu'est-ce qui pourrait contribuer à fournir des infrastructures de qualité et à basse consommation d'énergie? Quels sont les défis contemporains et comment pourrions-nous les surmonter? Cet article tente de mettre au jour les thèmes sous-jacents, notamment la gouvernance de grands projets d'infrastructure, l'importance de l'innovation et des ententes contractuelles, ainsi que l'acceptabilité sociale et environnementale. Nous présentons une revue

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actuelle des principales contributions canadiennes et proposons des pistes de recherche prometteuses.

INTRODUCTION

Public infrastructure is mostly delivered through large-scaled ventures, commonly labelled as large infrastructure projects or megaprojects. Despite increasing interest on this topic internationally, megaprojects are still a neglected field of study in public policy and administration research (Esposito & Terlizzi, 2023). One of the leading authorities in this field, Oxford professor Bent Flyvbjerg, however has recently published a book for the general public that popularizes his last 30 years of research on the subject (Flyvbjerg & Gardner, 2023). The main finding is that megaprojects chronically underperform, as only 0.5% of those met the triple constraint of meeting deadlines, costs and requirements.

Understanding how large public infrastructure is delivered is essential to tackle current challenges—such as climate change adaptation and mitigation, ageing transportation networks and utilities, ageing population and increasing demands for hospitals and housing, etc.—and identify potential ways to improve efficiency. Construction is the biggest industry in the world, with its ecosystem representing 13 percent of global GDP, yet is not performing well, with productivity growing only 1 percent annually over the past two decades (McKinsey Global Institute, 2020). Public infrastructure is essential to the economy, to human development and to an overall quality of life. Their development and delivery should be driven by the public interest and public values, connected to our democratic accountability system of governance (Bozeman, 2007). Yet, we still face important challenges regarding how megaprojects are defined, governed and delivered. This short article attempts to identify these current challenges and potential solutions by surveying recent literature on this topic, and promising research avenues are proposed. We frame the themes under the concepts of project definition, project governance and project delivery, partly inspired by Romero-Torres and Brunet (2022).

PROJECT DEFINITION – WHAT TO BUILD AND WHY?

Generally speaking, any infrastructure project has a life cycle. It has a starting point, then it is planned, executed, monitored and controlled throughout execution, and closed. Then, the infrastructure has its own lifecycle; it must be maintained and repaired, until it is decommissioned several decades later. But before formal governmental approvals are given to undertake a project lays a specific phase that has attracted researchers' attention in recent years: the front end. For large infrastructure projects, this phase can take as long as decades, with important back-and-forth regarding important decisions taken, for example with the University of Montreal Health Centre or the Quebec city tramway (Dubé et al., 2021; Lacroix & Maheu, 2010). The project front-end should be taken with caution, as it can lead to a trap where energy and resources are spent without clear direction (Hudon & Floricel, 2023).

In this phase, a clear definition of the problem or the opportunity is needed, feasibility studies are carried out, and potential alternative solutions analysed. Although this phase might be associated with important media attention, in several cases this has been carried out without much public scrutiny, leading at later stages to conflicts regarding social acceptability. For example, in 2006, Strateco began the largest uranium exploration project in the province of Quebec, north of Chibougamau and close from the Cree community of Mistissini. After formal

opposition from the Cree and a judicialization of the controversy, the project was finally halted in March 2013. (Brunet & Baba, 2023). Research shows that investing time in this phase, carefully and transparently engaging with local communities and the civil society, translates to better projects outcomes and more social acceptability (Baba et al., 2021; Babaei et al., 2023; Chbaly & Brunet, 2023). In the case of the Quebec New Hospital project started in 2013, one of the largest in Canada with an estimated cost of about \$2 billion CAD, an inclusive approach allowed enhancing healthcare and delivering facilities with a better fit for purpose and use (Chbaly & Brunet, 2022). Thus, co-creating value by public and private stakeholders generates further project benefits (Toukola et al., 2023).

At this point when the project is still in the development phase, uncertainty is paramount, as there are many unknown and unforeseen elements; risks are high, costs are very often underestimated and benefits tend to be overestimated (Samset & Volden, 2016). Integrated Impact Assessment is worth pursuing early, which might cover the dimensions of economic viability and financing, environmental and social impacts (Marchand & Brunet, 2019). Institutional and narrative instruments should be used to tackle the inherent complexities of the project and mobilize the main stakeholders, to make them converge until the approval is obtained (Esposito & Terlizzi, 2023; Floricel et al., 2023; Migone et al., 2023). Institutional instruments include laws, regulations, procurement schemes, among others. Narrative instruments are used by policymakers to shape a project vision, for example with the use of stories, labels, and comparisons (Ninan & Sergeeva, 2022). Marketing the project helps shape a strong vision and articulate the main benefits that will result from it, as was done in the case of the Samuel De Champlain Bridge Corridor Project (Drouin & Brunet, *In Press*; Drouin & Turner, 2022). On the contrary, the Muskrat Falls megaproject in Newfoundland turned from a promising hydroelectric sustainable energy facility into one of the most impressive and notorious megaproject failures (LeBlanc, 2020). Another example relates to the Keystone XL pipeline development project, which had considerable delays and setbacks, in large part due to varying justifications for and against the project at both the local and national levels (Baba et al., 2021). Timeliness of decisions is essential to adopt a development pace and a progress pace leading to successfully reaching the end of the front-end (Ben Abdallah et al., 2022).

PROJECT GOVERNANCE – WHO IS INVOLVED AND HOW DO WE ORGANIZE?

Project governance is a well-researched topic in project management, also covered extensively regarding public projects (Müller et al., 2023; Sanderson & Winch, 2017). A governance framework for public infrastructure projects is “an organized structure established as authoritative within the institution, comprising processes and rules established to ensure projects meet their purpose” (Klakegg et al., 2008). Several countries have developed governance frameworks to shape megaprojects decision-making and procedures, with Norway and the United Kingdom leading the way after they faced significant performance shortcomings with several projects in the past with soaring costs and delivering less benefits than expected (Volden & Samset, 2017). As these governance frameworks have been operationalized over the last 20 years or so, it is now possible to evaluate the success of projects that have been managed using these. Researchers in Norway found that public projects are often more successful than people think (Volden & Welde, 2022).

Although such a governance framework has existed in Canada for some time, there is still, to the best of our knowledge, no academic research on how this works, and whether

the projects under this scheme attain success (Brunet & Choinière, [Forthcoming](#)). In Quebec, a governance framework for large infrastructure projects has been in place since 2008, first addressing Public-Private Partnerships (PPP), then being enlarged to address all major projects (over \$50 million CAD) (Secrétariat du Conseil du trésor, [2016](#)). Although the three main objectives are to gain greater government legitimacy, accountability and efficiency in delivering megaprojects (Brunet & Aubry, [2016](#)), recent research suggest that different actors have different interests, making it difficult to attain an optimal equilibrium (Brunet, [2021](#)). It is also difficult to align the interests of politicians, who tend to have a short-time view, with those of the megaprojects happening over longer time scales, for example with the long-term procurement in the Canadian Surface Combatant project (Migone et al., [2022](#)).

The project owner, most often the public entity requesting the infrastructure, should have strong strategic, commercial and governance capabilities, the latter comprising quality-assurance processes, project coordination and asset integration (Winch & Leiringer, [2016](#)). But given that megaprojects tend to be quite complex and might have several owners (co-owners, mostly public entities), overarching interorganizational governance should be considered, for example with the use of special purpose vehicles as often used in PPPs (Sainati et al., [2020](#)). Recent research suggests that four types of mechanisms help for collaborative governance: structural, procedural, sensemaking, and relational mechanisms (Brunet et al., [2023](#)). Thus, designing the (inter)organisational architecture should be carefully planned and considered (Denicol et al., [2021](#)). Building and leading strong collaborations in project teams is also highly desirable (Caniëls et al., [2019](#)). The projects most prone to extreme cost overruns are those that suffer from a lack of planning, those that are out of the ordinary and require untried innovations, or those that cannot rely on replicability and modularity to foster learning along the way (Flyvbjerg & Gardner, [2023](#)).

Having flexible governance arrangements has proved to help deliver projects more efficiently (Florice & Miller, [2001](#)). For example, PPPs are a specific type of procurement implying tailored governance models that have been studied extensively given their predominance. Siemiatycki ([2015](#)) highlighted some important issues for Canadian PPPs related to high upfront costs, limited community consultations, and a rigid procurement process inhibiting innovations. The trend in Canada is that these are tending to wane, as “new models of public sector contracting are being explored to align partner interests and risk, at the behest of governments and firms” (Mwesigwa & Siemiatycki, [Forthcoming](#)), such as integrated project delivery (IPD) which we will discuss below. We now turn to review the main challenges and potential solutions regarding project delivery.

PROJECT DELIVERY – HOW SHOULD WE DO IT?

Public owners have historically relied on traditional project delivery models such as design-bid-build. While there are some advantages, such as familiarity with the contractual language and process, its limitations have been widely documented. Fragmentation of teams and adversarial relationships lead to low levels of trust and collaboration, which in turn causes poor quality works and discourages innovation (Lichtig, [2006](#)). These limitations, coupled with increased project complexity, caused by demands for resource efficiency, advances in building technology, requests for sustainable production as well as more demanding regulations (Engbø et al., [2020](#)), can be exacerbated by the volatility of the economical context such as

market overheat and rise of construction costs. This is the epitome of transactional contracting, characterized as single, discrete transactions rather than ongoing relationships as represented by relational contracting (Macneil, 1973). The procurement field, typified by power-based relationships, silo-thinking and heavy use of standardized contracts which are not always fit for purpose (Frydinger et al., 2021), are now giving way to more collaborative approaches, such as IPD and Alliance, for example in the case of the Union Station project in Ontario and the Cowichan Hospital in British Columbia. But what makes these procurement and contractual approaches collaborative?

Collaborative, or relational, contracts can reduce transaction costs in projects (Haaskjold et al., 2020). Therefore, IPD projects such as Defense Construction Canada's Royal Canadian Dragoons Facilities that used the CCDC-30 contract, rely on pain-and-gain sharing mechanisms, open-book accounting and unanimous decision-making, coupled with liability waivers or limitations to ensure commercial interests are aligned (Lahdenperä, 2012). However, the adoption of relational contracts by public owners has been hindered by legislation and regulations providing for budgetary rationality over other dimensions of public interest such as environmental, social or lifecycle considerations. The State's contractual power is still based on the premise that the best co-contractor is the one who, at the end of the most open competition possible, offers the lowest compliant bid (Jobidon et al., 2018; Pellerin, 2021). Rather, research has found that best value or value-for-money procurement facilitates value creation and innovative organizational processes, notably in megaprojects (Ying et al., 2022). Other societal objectives, namely sustainability and circular economy, can also be achieved through procurement, such as favouring small and medium enterprises participation, local purchasing and energy efficient infrastructures (Sönnichsen & Clement, 2020).

Even if collaboration is contractually formalized, it is not sufficient and must be complemented by trust, culture and governance choices (Galvin et al., 2021). Collaboration and innovation are also enmeshed and feed off each other (Poirier et al., 2016). Researchers have found that innovation can be cultivated through dissonant activities, such as ideation tools and processes like mind mapping, brainstorming and rapid ideation, to achieve a better rhythm of team learning (Harvey et al., 2023). In a complementary way, indicators can measure collaboration to ensure selecting the right team for a project and to facilitate governance throughout its lifecycle (Coulombe et al., 2023). Recent research has also focused on the importance of integration, whether organizational, contractual or operational, which sheds light on how collaborative contracts integrate people, structures and systems in construction projects (Rankohi et al., 2024). These findings resonate with other design processes and approaches favoring innovation which could benefit from more collaborative contracting. This is the case for design for manufacturing and assembly (Rankohi et al., 2022), lean project delivery (Mesa et al., 2019) and target value delivery to reduce waste while increasing value to the stakeholder (Ballard, 2020), as well as digital processes and technologies such as building information modeling (Jobidon et al., 2021).

More and more public owners in Canada rely on hybrid versions of project delivery methods such as progressive design-build, used for a detention center and a high school in Quebec as well as the Ottawa Hospital in Ontario, or relational ones such as alliance for the Union Station project in Ontario and the Cowichan Hospital in British Columbia. While this does not mean the industry has moved substantially away from the use of standardized contracts and traditional construction methods, signs certainly point to more relational, human-centered, bespoke procurement processes and contracts.

FUTURE RESEARCH AVENUES

Table 1 summarizes the main arguments made in this short review and connects it to promising research avenues to explore.

From a broad perspective, research should address value generation, notably through the inclusion of local communities, and a deeper understanding of the mechanisms behind social acceptability. The impacts of participatory governance (Esposito & Felicetti, & Terlizzi, 2023) and of participatory democracy (Pellerin, 2020) on project performance and acceptability would benefit a wide range of stakeholders. Megaprojects should also be considered as tools to address societal challenges and as contributors to answer the current transition towards net zero emissions (Ika & Munro, 2022).

The internal perspective for the megaproject should focus on core capabilities, with strong delimitations of the different parties involved, notably when the inter-organisational project implies several organisations, such as in a heterarchy (Brunet & Cohendet, 2022). Given the current trends of innovations in construction, their adoption should be considered and carefully monitored, especially regarding their intertwinement with external and internal

TABLE 1 Summary of themes, challenges and potential solutions and research avenues.

Themes	Challenges	Potential solutions	Research avenues
Project Definition			
Vision	Limited information	Articulating sound costs and benefits analysis	Megaprojects value generation
Contributions to the common good (public value)	Alternative analysis and evaluation of the best option	Narrating a compelling vision	Social acceptability of megaprojects
	Stakeholder engagement and management	Engaging institutions and communities	Megaprojects to address grand challenges
Project Governance			
Decision-making	Defining a strong owner	Designing the system architecture	Interorganizational design for megaprojects
Roles with accountability	Organizing for efficiency	Building and leading collaborations	Participatory governance
	Anticipating risk and uncertainty	Adopting flexibility	
Project Delivery			
Contract formation	Adversarial relationships and silo-thinking	Empowering and incentivizing teams through relational contracting	Trust and collaboration in megaproject teams
Contract adjudication	Value-creation during procurement is hindered by laws and regulations	Procurement to ensure best value or value-for-money	Procurement strategies and megaproject performance
Project execution		Integrating the supply chain and adopting innovative design processes	Supply chain integration and coordination

factors. Interfaces between owners, private actors, tools, and the wider public also become focal points of interest.

Project delivery methods and contracts should be documented, as many different forms have not yet been systematically reported. For example, comparative analyses of mass transit infrastructure projects across Canadian jurisdictions to identify patterns in project delivery methods and contract language could be conducted. Same goes for case studies which greatly lack in collaborative contracting (Engebø et al., 2020). Whereas integrated and collaborative project delivery has been developed over the years, they are at the extreme end of a spectrum of alternative delivery, the other end being the traditional methods. Literature is mostly non-existent regarding design-build and progressive design-build methods abundently used in Canadian jurisdictions. Innovations and flexibility are needed, and researchers would need to investigate how these work and what benefits are to be learned and replicated to other projects. Specific case studies of megaprojects successes and failures are necessary to uncover underlying patterns, interviewing key leaders and external stakeholders. Learning from those single megaprojects is a challenge, but if we are to get a wider, institutional and national understanding on this critical topic, we could develop interesting insights regarding overarching policy design, implementation and evaluation of megaprojects.

As highlighted by Esposito and Terlizzi (2023), research in policy and megaprojects is still scarce, and demands high interdisciplinarity between public administration, politics, law, project management and governance, engineering, environmental and social acceptability scholars. Yet, even more critical is the need to ensure data and information regarding those megaprojects is more accessible to researchers. An interesting avenue is with increased collaboration with governments, elected politicians and civil servants, using action research to help resolve practical problems while developing theoretical knowledge (Brunet et al., 2023). Transparency is paramount to uncover lessons from the past and build on knowledge and to give more levers to civil society, local communities, and nongovernmental organizations.

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