COMPARE RISK ALLOCATION FOR DIFFERENT PROJECT DELIVERY METHODS IN CANADA

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Overview/Abstract

The transportation industry has been developing and maturing over time, with clients and owners requiring options in project delivery systems which increase cost certainty and reduce schedule delays. As owners look at the delivery systems, the question of risk must be answered and which party is best suited to control and price the risk. Through two separate experiences, we will examine the transfer of risk allocation decisions at a high level developed by the owner through previous experience of lessons learned. Worldwide aging infrastructure increases the need for improvements on the system, as well as environmental, safety, and quality improvements being demanded by societal change. Owners are looking to alternate project delivery methods to answer the call for guaranteed costs, assured timelines, and compliant quality, environmental, and safety in relation to ISO standards, value for money, and allocation of risks. This paper briefly discusses (at a high level) the allocation of risks to the owner and contractor on four predominant alternate delivery methods versus the Design-Bid-Build. They are Design-Build, Public-Private-Partnership, Construction Management at Risk, and Alliance Contracting. This paper also examines the high level differences between the various delivery models and then compares the risks associated with each during the various stages of the process. The paper will review the analysis performed through the case study on the Edmonton Light Rail Transit project "North LRT Extension - Downtown to NAIT" by the City of Edmonton, a western Canada municipality, and the risk allocation developed from lessons learned on the two initial P3's in New Brunswick, and the risk matrix developed for the "Route 1 Gateway Project" by the New Brunswick Department of Transportation, an eastern provincial government.

Concepts for Risk in Contracts and Value for Money

Risk has been defined as "exposure to the chance of injury or loss" in the Webster's College Dictionary. Risk can come to the project in the form of an opportunity, a positive event or a negative event, bringing to the project opportunity or consequences. Risk is then measured in terms of the effects of an event (positive or negative) and the probability of the event occurring or the combination of the two happening. All forms and levels of governments globally are being pressured to look for more effective means and methods in delivering programs guaranteeing cost certainty, quality and schedules. The concept of risk is different for every project and each client may have varying appetites or abilities to handle risk. Many clients may be risk adverse, while others are more willing to accept risk due to expertise within their organization. The PMBOK of the Project Management Institute states, "Project Risk Management includes the

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processes of conducting risk management planning, identification, analysis, response planning, and monitoring and controlling a project. The objectives of Project Risk Management are to increase the probability and impact of positive events and decrease the probability and impact of negative events in the project."(PMBOK Guide 4th addition)

It has become more difficult for governments to show value for money in traditional projects as cost and schedule certainties have become difficult to deliver. Competing dollars and changing societal values are the considerations facing the owners, both public and private, as they look to the alternative delivery methods to secure what the public expects. Warren Buffet, American Investor, businessman and philosopher has been quoted as saying "Price is what you pay. Value is what you get."

Literature Review

Kwak & Bushey (2000) explain that the Construction Management At-Risk project delivery method is a mixture of the 'low bid' method and the Design-Build method. The benefits of the traditional low bid method are compared to the Design-Build method. On a case study, Kwak & Bushey (2000) shows the benefits of the Construction Management At-Risk project delivery method on the construction of the Stormwater Treatment Area ¾, in the Everglades Construction Project.

Konchar (1997) empirically compares the cost, schedule, and quality of the three main project delivery systems: Construction Management At-Risk, Design-Build and Design-Bid-Build. The project delivery method comparison includes the analysis of critical performance variables. Relationship between the critical variables and key performance metrics are identified. Project delivery methods and performance metrics are discussed. The individual system performance is analyzed, and importantly, the methods of quantitatively supporting the selection of a specific project delivery system are presented on Konchar's research.

Juliana et al. (2005) present an overview of different project delivery approaches, particularly on the methods of Construction Management and Design-Build. Some key factors in the selection of the project delivery system are the project owner's specific tolerance for cost/schedule risk, the owner's requirement to a level of involvement in the detailed design selection process, and the level of project oversight during the design and construction. The project delivery method information is relevant to owners, design professionals, construction managers, contractors, subcontractors, and lawyers, since it is important for the various participants to be aware of the advantages and disadvantages of each system.

According to Miller et al. (2000), the single delivery method (Design-Bid-Build) traditionally used has restricted flexibility in the projects under analysis (Miller et al. 2000). Miller et al. (2000) present a new model, which is the simultaneous use of multiple project delivery reports. Case study research done by the Infrastructure Systems Development Research team at the Massachusetts Institute of Technology is presented, and includes the delivery selection support models for capital programming, as well as real applications applicable to municipal infrastructure.

Kwak et al. (2003) argue that the "Design, Build" (DB) project delivery method is an alternative to the traditional "Design, Bid, Build" (DBB). Kwak et al. (2003) considers that the DBB system results in shorter project times but has been found to have lower project performance, according to an analysis of 67 global projects documented in the Construction Industry Institute's database (Kwak et al. 2003). From this analysis, Kwak et al. (2003) sustain the idea that focusing on project management expertise and contractor experience can have a better impact on project performance than focusing only on the project delivery strategy.

Touran et al. (2011) have researched alternative project delivery methods and the factors used to decide a method. Touran et al. (2011) found that the most influential factor in selecting an alternative delivery method was schedule compression. The delivery methods studied include design-bid-build/multi-prime, construction manager-at-risk, design-build, and design-build-operate-maintain. The findings of the research, which included interviews, showed that the alternative delivery methods resulted in cost and schedule savings. Furthermore, the study showed that applying risk analysis in the project planning increased the chances of achieving the desired cost and schedule.

Contract Delivery Methods being used in Canada

Design-Bid-Build

Traditionally the transportation industry has actively utilized the Design-Bid-Build model. Design-Bid-Build (DBB) consists on an owner signing one contract with one contractor in order to carry out a project (Dorsey, 1997). In this case, the owner does not have to interact directly with subcontractors. The exception is if the law requires a separate contractor (i.e. a mechanical and an electrical contract in public work) in which case the owner has to sign contracts with the prime general contractor and the prime contractors of the other disciplines (i.e. prime electrical contractor and prime plumbing contractor). Another particular characteristic of the DBB is that the designer has no contract with any contractor (Dorsey, 1997).

In terms of risk allocation on a DBB delivery method, the owner typically prepares the risk allocation framework separate from any of the other parties involved in a project and is usually responsible for: design reviews, differences between design criteria and 100% design, errors/omissions revealed during construction, constructability of design, environmental impact reviews, coordination with other work, differing sub-surface conditions, design defects, unidentified utilities affecting site, hazardous waste, third party litigation, and warranty for facility performance. The previous responsibilities position the owner as manager of the different risks associated with each of the previous aspects of a project.

On a DBB, the contractor is responsible for: project site safety, coordination of construction, construction defects, and inflation (Lahdenpera, 2011); and therefore to the risks related to these project components.

This model has the risks and responsibilities for the risks allocated to different parties with the expectation that there will be the legal and commercial consequences if the party fails to execute the contract in an efficient and proper manner. The lack of discharging the contractual responsibilities has not always meant the owners have managed to move the legal and commercial responsibilities to other parties, but in most cases have created an adversarial environment that leads to legal battles and costs for legal and accounting outside of the project. The reason is because the risk profile setup by the owner on commencement of the project changes and does cause unexpected consequences for the contracting party.

Table 1: Risk Allocations for the Design-Bid-Build

Design –Bid - Build	**Design**	**Construction**	**Operations**	**Maintenance**	**Financing**	**Ridership**	**Collection**
Design Build/Finance/ Operator/Maintain	Private/ Public	Private	Public	Public	Public	Public	N/A

Public-Private Partnership (PPP or P3)

The early days of transportation P3 consisted of the private sector trying to get the government to allow design-build, which in the early 1990's was a radical departure from the more traditional design-bid-build. The focus then turned to innovative finance as state governments began to explore alternative ways to pay for highway infrastructure (D.J.Gribbins, 2011).

On a Public-Private Partnership the contractual agreement is between a public owner and a private contractor (Johannsen, 2009). Gupta (2011) has presented the allocation of risks for the different ways of performing a P3 Delivery Method. Table 2: Risk Allocation for P3 Projects shows an adaptation of Gupta (2011) risk allocation table for P3 by identifying if the risks are allocated to the private or to the public party of the partnership.

Table 2: Risk Allocation for P3 Projects

Public-Private Partnership	**Design**	**Construction**	**Operations**	**Maintenance**	**Financing**	**Ridership**	**Collection**
Design Build/Maintain	Private	Private	Public	Private	Public	Public	Public
Design Build Finance Maintain (Availability Payment)	Private	Private	Public	Private	Private	Public	Public
Design Build Finance Maintain Operate (Availability Payment)	Private	Private	Private	Private	Private	Public	Public
Design Build Finance Operate (Real User Fee)	Private	Private	Private	Private	Private	Private	Private

Design-Build

On the Design-Build delivery method the contractual agreement is between a public owner and the design-build contractor.

The owner is responsible for hazardous waste and third party litigation. The design-build contractor is responsible for design reviews (reviews of compliance with design criteria), errors or omissions revealed during construction (if negligent), project site safety, constructability of design, coordination of construction, coordination with other work, quality control and quality assurance, design defects(if negligent), and unidentified utilities affecting site (Lahdenpera, 2011). In other words, the contractor is responsible for zoning compliance, building code adherence, design correctness and completeness, comprehensive field operations, site safety, quality of work, schedule, cost control, and liability exposures (Lahdenpera, 2011).

The Design-Build model is for a project that will not require financing and maintenance by the design-build contractor and where the owner is prepared to step back and allow some control to go to the design-build contractor, in this case the design control. In the DB model the design risk is moved over to the design-build contractor, requiring the project meet specified standards or guidelines. The owner will provide certain elements of the project such as conceptual plans, and possibly preliminary engineering. The owner quite often will want a large component of inspection (QA/QC) and have a heavy degree of quality monitoring conducted to provide confidence that the project is being built to the standards contracted and that value for money is being achieved.

Construction Manager

On a Construction Manager Project Delivery method the owner contracts separately with a designer and a construction entity (Lahdenpera, 2011). Dorsey (1997) provides a Matrix of the project responsibilities and the two main construction managers project delivery methods (Agency construction management and At-risk construction management). Table 3: Risk Allocation for Construction Manager Project Delivery Method shows a summary of the information provided by Dorsey (1997).

Table 3: Risk Allocation for Construction Manager Project Delivery Method

Activity	**Agency Construction Management**	**At-Risk Construction Management**
Preconstruction phase services	As reviewer and advisor (VE and constructability)	As reviewer and advisor (VE and constructability)
Design responsibility	By design team	By design team
Trade contracts/subcontracts	Owner holds the trade contracts	Construction manager holds subcontracts
Trade subcontractor and subcontractor work competitively bid	Yes (by trade contractors)	Yes (by subcontractors)
Trade contractor and subcontractor selection	CM recommends/advises, owner selects	CM decides/selects with owner approval of subcontractors
GMP	No	Optional
Construction phase services	Administer contracts (Agents/advisor)	Directly controls the work (Constructor)

Guarantee of : -Cost -Schedule -Quality -Performance	 -No -No -No -No	 -Optional (with GMP) -Optional -Responsible -Responsible
Responsible for -means and methods -safety	 -No -No	 -Yes -Yes, with subcontractors
Hazardous Materials	Owner	Owner
Concealed conditions	Owner	Owner
Force majeure	Owner	Owner
Compensation	CM Fee, Reimbursables	CM fee, Reimbursables
Payment	Owner to CM (fee). Owner to trade contractors. No certification for CM application. No retainage on CM application but retainage typically held on trade contractors. CM review of trade contractor applications	CM fee, Reimbursable. CM to Subcontractors. AE certifies CM application during construction Retainage typically held on subcontractors; optional on CM CM review of subcontractor applications
Indemnity	CM to owner Owner to CM Trade	CM to owner Subcontractors to owner and CM
Insurance -CM general Liability -Trade & subcontractor general liability -Owner Liability -Professional liability (for design -Builders risk -Wrap-up (if used)	 -By CM -By trade contractors -By owner -By designer -By owner -By owner or CM	 -By CM -by subcontractors -By owner -By designer -By owner -By owner or CM
Dispute resolution -Owner-CM -Owner-Trade Contractors	-Discussion, mediation, arbitration -CM may advise	-Mediation, arbitration -N/A

Alliance Contracting

Alliance contracting is a form of project delivery system often used for complex projects which require speed of delivery and cost certainty. Usually owners seek outstanding alliance outcomes through an integrated team characterized by aligned goals and commercial drivers, innovative thinking and collaborative behavior. (Morwood, Scott, Pitcher, 2008)

For alliance contracting, the contractual arrangement consists of collaboration between the owner and contractor. This means that the different participating entities share the risks and rewards. The different participants co-operate, accepting risks, and develop risk management strategies (Juliana et al, 2005)

Risk is not 'allocated' in an alliance in a traditional legal sense, but through the operation of the pain share/gain share model. The risks are shared equitably and quite precisely under the pain share arrangements up to the point where the margin (corporate overheads and profits) of each of the Non Owner Participants (NOP) has been lost. Beyond that point the risks are borne solely by the Owner Participant (OP). (Morwood, Scott, Pitcher, 2008)

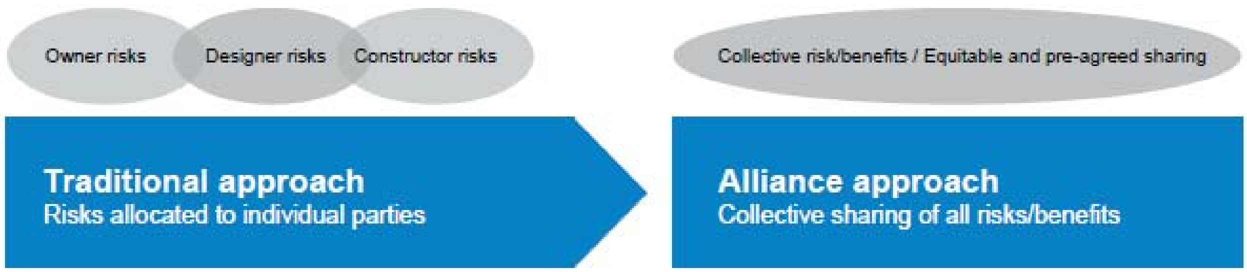

Figure 1 Traditional versus Alliance Risk Sharing Approach (Morwood, Scott, Pitcher, 2008)

Case Study of the NLRT Edmonton

The Edmonton North LRT Extension from Downtown to NAIT (NLRT) is a 3.3 km urban LRT expansion in a densely built area of central Edmonton. The project features a 700 m underground tunnel segment, three new stations, extensive civil work (roadworks, structures, utilities, drainage) and complex LRT communications, power, and control systems. Edmonton's recent South LRT Extension program provided several lessons learned to the project management team. With a myriad of technical, financial, and political risks, the City initiated a review to identify the lowest cost project delivery method.

A project delivery method (PDM) analysis was conducted on the NLRT project in order to determine the optimal delivery method for the project. The methodology used to conduct the analysis is based on the procedure suggested by Transportation Research Board (Transportation Research Board of the National Academies, 2008). The process involves three steps as shown in **Error! Reference source not found.** and can be defined as follows:

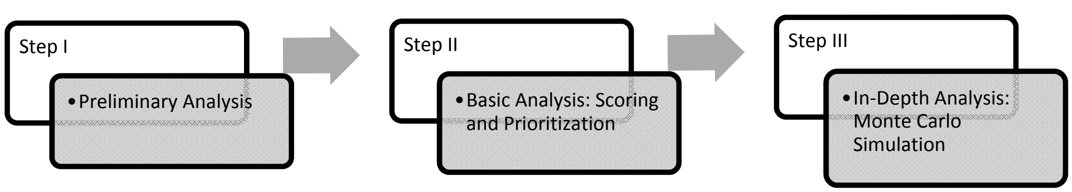

Figure 2: Process for PDM Analysis

Step I – Preliminary Analysis:

Defining project goals/constraints and examining how the delivery methods being analyzed contribute to meeting the project goals and fit within the project constraints. This level is aimed at weeding out any obvious exclusion from further analysis.

Step II – Basic Analysis: Scoring and Prioritization

This step focuses on determining and prioritizing the relevant decision-making factors to be used in the analysis, examining the advantages and disadvantages of the PDMs under each factor and then quantifying the PDMs based on how well they satisfy each factor. Scores are then totalled for each PDM to determine if there is a clear winner based on the score and priority level for each factor. For example, if a PDM has a higher overall score but falls short in a key area such as cost, then Step 3 should take place in order to determine the best option for the project.

Step III – In-depth Analysis:

Step III consists of an in-depth analysis of the risks and costs for each PDM. This is conducted through a detailed review of the risk factors, allowances, and all other costs associated with each delivery method. This analysis utilizes a simulation based approach to determine the possible range of risk allowances and costs on the projects for each method given their level of uncertainty.

The simulation approach used is a Monte Carlo Simulation in which a given number of iterations are performed for the value of each of the cost elements of the project estimate. Also, in a similar manner, a given number of iterations are carried out for each of the project risk factors in order to quantify them. The input data of the simulation is from expert opinion elicited in workshop settings, and cost estimates from the project team. After the simulation is performed, the outputs of the simulations are analyzed statistically to acquire the minimum, mean, 85^{th} percentile, and maximum values of the output data. This output is used to represent the range values into which the project costs or project risk might fall.

The PDM analysis performed on the NLRT completed all three of the above mentioned steps in order to determine the optimum method for the project. The following 2 sections provide results of the analysis.

Total Project Costs

The Total Project Costs (all-inclusive) are shown in “Figure 3: Total Project Costs (all-inclusive)” in 2009 dollars as well as in escalated dollars for both a General Contractor (GC) and a Construction Manager (CM). The total costs for a GC are on average $5.2M more than for a CM in 2009 dollars and $0.76M more than a CM in escalated dollars. During the simulation, the costs for the GC were observed to be larger than the CM 62% of the time in 2009 dollars (see Figure 3: Total Project Costs (all-inclusive)). In either case, the CM scenario represents a slight savings for the project as a whole. This can mainly be attributed to higher risk allowance and engineering fees for the GC scenario. The difference in risk allowance is shown in the next section; the difference between engineering fees is $5.3M in favour of a CM (expected cost of $34.3M for a GC and $29M for a CM).

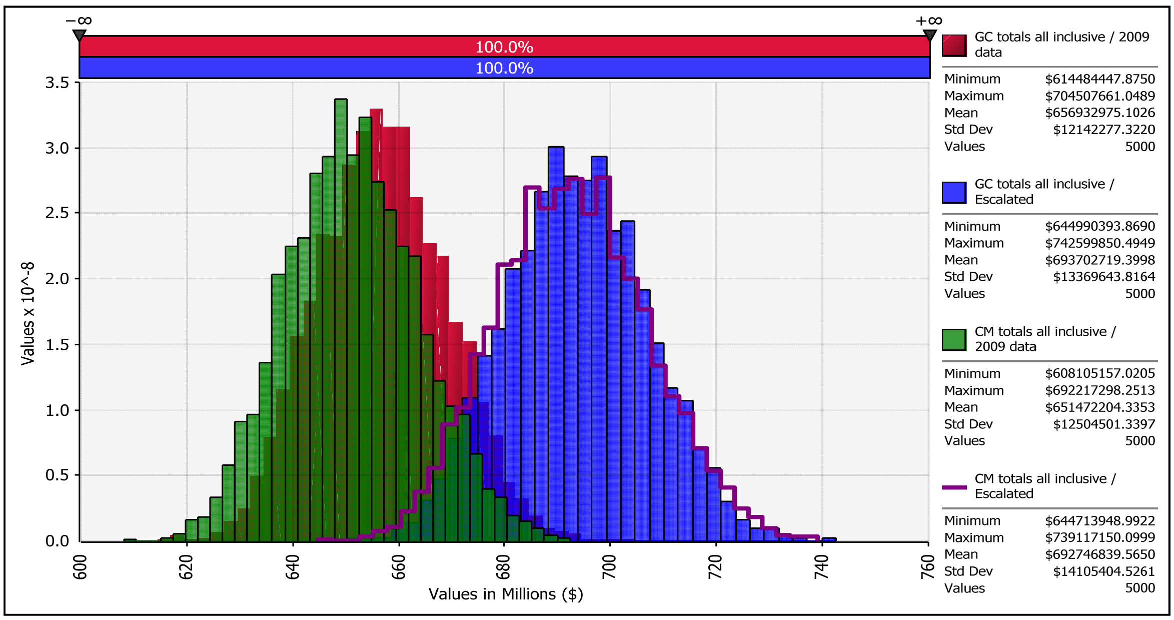

Figure 3: Total Project Costs (all-inclusive)

Risk Allowance

A detailed comparison of the risk allowance under a GC and under a CM was conducted on the project. The initial risk register for the NLRT has been developed under the assumption of a Design-Bid-Build. This register has been used in the analysis to represent the GC scenario. The CM scenario has been built off of the same register and customized to reflect the conditions under a CM mode of delivery for the project. The simulation resulted in a mean risk allowance of $81.1M for a GC and $69.0M for a CM. The mean difference between the two allowances is $12.2M, and 92% of the time during the simulation the GC requires a higher risk allowance than the CM.

The results demonstrate that the risk allowance is significantly higher for the GC compared to the CM.

Route 1 Gateway Project

The Route 1 Gateway Project is the third highway project in the Province of New Brunswick to be executed under the P3 arrangement. New Brunswick, being a provincial government with an aging population and with progressive thinking, has managed to meet the challenge of delivering updated infrastructure as the gateway for the other Atlantic Provinces to the United States and Upper Canada.

New Brunswick has used the P3 model successfully with the first P3 completed in 2001, a 195 kilometre four-lane highway from Fredericton to Moncton (FMHP) and the second P3 completed in 2007 consisting of a 275 kilometre four-lane highway from Longs Creek to the Quebec Border and Route 95. These initial two P3's are the basis for the Route 1 Gateway Project Risk model. Lessons learned were incorporated into the RFQ/RFP process in developing the contract for the operations of 230 kilometres from St. Stephen to Riverglade and the construction of 55 kilometres of new four lane highway. Table 4: Lessons Learned and Solutions shows the previously referenced lessons learned.

Table 4: Lessons Learned and Solutions

FMHP	**TCHP Solutions**
The Independent Agent	No Independent Agent – Audit by TCHP Co.the Province of New Brunswick
ISO Compliant Systems	ISO Certification Requirement
Materiality of Scope Change	Defined in Agreements
Transfer of Existing NBDOT Work	Defined Timeframe – Operator Audit Rights
External Communications	External and Internal Communications
Arbitration	Dispute Resolution: Board of DB Arbitration for Work, OMR
Progress Payment during Construction	Full payment on completion
Variable Operations Payments	Fixed Operations Payment
Renegotiate OMM Price – 20 years	Price Bid for Term of Projects
Conformance Based	Key Performance Indicators and Asset Management
Hand Back Standards	3rd Party Asset Inspection Added Requirement

From the lessons learned, the provincial government developed the risk matrix that was placed in the RFP process for the procurement of the Route 1 Gateway Project (see Table 5: Key Risk Allocation). One can clearly see from the lessons learned that there was a transfer of risk to the proponents with the expectations of improved party relations. Although the Route 1 Gateway Project is currently underway, there will be improvements to future project agreements that will see the risk allocated to provide improved value for money for the Province.

Table 5: Key Risk Allocation

Risk	**Government**	**Developer/Operator**
Price		X
Schedule		X
Scope Change	X	
Weather		X
Soil Conditions		X
Insurance and Bonding		X
Environmental Approval	X	
Environmental Permitting		X
Quality Management		X
Safety Management		X
Strikes		X
Archaeological Finds (known)		X
Pollution (known)		X
Right of Way Acquisition	X	

The risks outlined above clearly show that the proponents are responsible for anything on site unless it is unexpected. In short, if the Province has taken the time to research the project and pass these findings on to the proponent, then it becomes a proponent risk. Unforeseen risks that the proponents could not have been aware of are borne by the Province.

Summary

This paper has conveyed that there are numerous tools available to clients and owners today in our global environment. Each project has to be evaluated on the individual merits of the project and the selection of the delivery model will depend for the most part on the owner's acceptance of risk and release of control over aspects of the project, the expertise available to the owners in the consulting industry as well as in house. Alternate delivery projects that have not met all of the criteria set out in the beginning generally are due to a learning process on behalf of all parties. As we look to the future, the outlook is bright for infrastructure industry and the growing use of alternative methods. In our global environment we must be proactive in renewing our infrastructure assets, or we will fall behind other jurisdictions and hurt our competitive position in the global community. In a recent paper presented to the ACEC conference in the United States in March 2011, the AECOM paper states, 'Inadequate Infrastructure spending contributes to weaker short-term and long-term economic prospects. According to the WEF, "Extensive and efficient infrastructure is critical for ensuring the effective functioning of the economy, as it is an important factor determining the location of economic activities or sectors that can develop in a particular economy."'

Recognizing this fact, the alternative models will be with us for some time, and the fact that traditional funding sources cannot keep pace with the need for upgrading infrastructure means agencies will require looking at alternative delivery models. That means letting go of control over traditional processes and accepting risks that, in the past, have tried to be passed onto others. In Canada we have seen forward thinking with the development of BC Partnerships, Ontario Partnerships, and most recently Partnerships New Brunswick at the provincial level to work with the Federal counterpart in PPP Canada. These agencies all have expertise in alternative delivery methods to assist other provinces, and municipalities in developing and using one to the models mentioned in this paper.

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