MEASURING UP

Key Performance Indicators for BC's Construction Industry

VRCA Vancouver Regional Construction Association

Building Excellence

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Authors

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1 Introduction

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BC's $20bn construction industry is the province's largest employer, providing well-paying livelihoods to over 250,000 British Columbians. Yet, there is no centralized industry-specific data collection or industry-level monitoring to paint a picture of how well the industry is doing. In a market where every effort is focussed on improving productivity and performance, it is not possible to manage what is not being measured.

In 2016, the BC Construction Association (BCCA) published the "Construction Innovation Project: A Vision for BC"[1], which proposed a series of "ambitions" framed within five vision statements to begin to lay out a path forward. As part of this initiative, an "industry insights" survey was conducted which found that 73% of industry respondents agreed that it would be useful if the performance of BC's construction industry as a whole was tracked and reported (Figure 1). The top three indicators were environmental (energy, GHGs, waste, etc.), client satisfaction and economic (GDP, etc.). Measuring performance is key to delivering on the BCCA's vision for change. Without industry-level metrics, it is difficult to not only celebrate accomplishments but also to pinpoint factors that may be affecting the industry's ability to deliver on time and on budget. Developing industry KPIs is also a key priority identified in the Vancouver Regional Construction Association (VRCA) 2017 – 2020 Strategic Plan, which aims to, "Develop/support benchmarking and reporting services to, a) support general business and productivity improvement and demonstrate ROI for funders / investors in construction innovation, and/or b) fill data gaps, then aggregate and monitor KPIs for industry and provide set-up assistance for companies to manage their own KPIs."

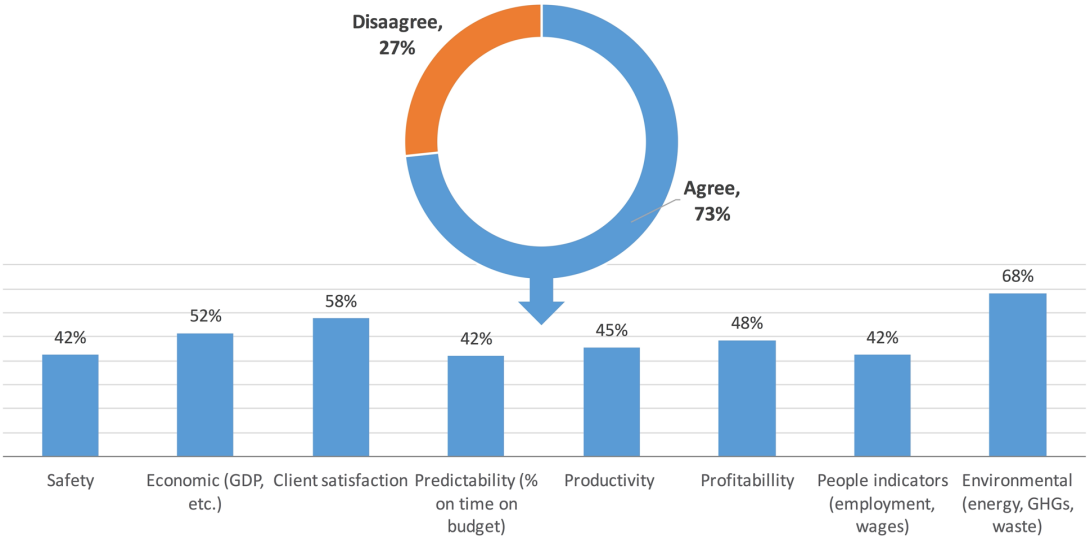


Figure 1 Results from a 2015 survey question posed to BC construction industry members, "Would it be useful if the performance of BC's construction industry as a whole was tracked and reported?" (n = 270)

Summary of next steps

The following steps are recommended to the VRCA as it moves forward with establishing a KPI program:

1. Publish an annual report of the twenty KPIs for which data already exists and seek grant funding to build an online "dashboard".
2. Work with industry leaders across the country to resolve data gaps and establish consistent definitions and data collection standards.
3. Ensure the data is handled properly by working with a neutral third-party data management company.
4. Minimize administrative intensity by coalescing a leadership group of progressive industry associations around a pilot project.
5. Be patient. Program growth will be slow and conditional upon regular communication with businesses.
6. Celebrate leadership.

"There are three kinds of lies: lies, damned lies, and statistics."

Mark Twain

Thirty KPIs have been identified for BC's construction industry. Of these, data is available for twenty KPIs today without requiring any involvement of construction firms directly.

Proposed industry-level metrics are presented in Part 1 of this report based on an assessment of programs and models elsewhere supported by consultation with local industry (see research methodology in Appendix A). A discussion about the state of performance benchmarking for construction, how the metrics were selected, and the analysis of various models is then set out in the second half of this report. Key "next steps" for moving forward with an industry KPI program for BC can be found at the end of the report and summarized in the side bar (left).

Despite the fact that there are several well-established construction KPI models that have been operating successfully in other jurisdictions, there are several notes of caution that have been voiced by local industry leaders when considering the roll-out of an industry KPI program in BC. In particular:

- Fear of data overload: too many indicators may turn potential users away. It is important to start small.
- Construction businesses are busy and may be reluctant to complete onerous surveys, especially when the value of the KPIs may still be unclear. Metrics may need to be restricted to those alternatives from alternative sources – at least at the outset.
- Concern about the sensitivity of the data requested. Businesses may be reluctant to share corporate information if there is a risk that it is exposed to their competitors.
- There is a risk that certain indicators (or collections of indicators) may be selected, ignored and/or distorted to bolster an otherwise weak argument or a particular political agenda. An unbiased third party may need to take on the administration of the KPI program.

It is important to bear in mind that this report is a first foray into industry-level performance measurement for construction in Canada and, while it has been motivated by interest in BC, there is relevant activity emerging in other provinces. Alberta, in particular, is starting to apply performance measurement experiences within its oil and gas sector to buildings. Ultimately, industry performance measurement should be undertaken at a large scale. It is hoped that this report will stimulate discussions between regions and across the country.

PART 1 THE KEY PERFORMANCE INDICATORS

How to read the following tables:

Black – KPI data is available today.

Blue – KPI requires new data, but the methodology has been established and data can start being gathered within 12 months.

Grey - KPI requires new data, and the methodology has yet to be established. The earliest that data is expected to be available is 2020.

I. PERFORMANCE

KPI				IMPLEMENTATION	
Sub-category	**Measure**	**Value**	**Change (yr-yr)**	**Data source**	**Time frame**
A. Quality of service and product	1. Client satisfaction General satisfaction of clients based on 10-point rating (1 = very unsatisfied and 10 = very satisfied).	-	- -	Owner survey	New in 2019
	2. Reliability (cost and schedule) Percentage of projects (by number and value) that are "on budget" at substantial completion. Percentage of projects (by number and value) that are "on schedule" at substantial completion.	- -	- - - -	Owner survey	New in 2019
	3. Defects General perception of clients based on 5-point rating)1 = much more than expected and 10 = much less than expected).	-	- -	Owner survey	New in 2019
	4. Procurement quality (BC) Index	-	- -	BCCA	After 2020
B. Environment	5. Building energy use (GJ/m²) in BC Commercial Residential	 0.88 0.27	 4.3% ↓ 6.9% ↓	BC Government	2015 data
	6. GHGs from buildings and from construction activity in BC. Commercial/ Institutional (kt of CO_2e) Residential (kt of CO_2e) Construction activity (kt of CO_2e per million dollars of GDP)	 2,300 3,954 71	 9.7% ↓ 3.3% ↓ 7.6% ↑	BC Government	2015 data
	7. Construction waste diverted (tonnes)	125,000	34.9% ↓	Metro Vancouver	2015 data
C. Community	8. Complaints Total number of non-emergency construction-related complaints.	-	- -	Municipalities	After 2020
	9. Partnerships (BC) Index	-	- -	BCCA	After 2020
	10. Corporate Social Responsibility (CSR) Number of companies that have a CSR policy. Number of companies that have adopted the measures in the CCA's "Practical Guide to CSR" at: Level 1.0 Early Practices Level 2.0 Advanced Practices Level 3.0 Leadership Practices.	-	- -	Survey of companies	After 2020

II. PEOPLE

KPI					IMPLEMENTATION	
Sub-category	**Measure**	**Value**	**Change (yr-yr)**		**Data source**	**Time frame**
D. Workforce	11. Composition					
	Total number of workers (BC)	228,600	8.03%	↑	Statistics Canada	2017 data
	Industrial, commercial and institutional construction	16%			BuildForce	2018 data
	Residential construction (new and renovations)	60%			BuildForce	2018 data
	Engineering and non-residential maintenance	24%			BuildForce	2018 data
	12. Youth in construction				Statistics Canada	2017 data
	Number of workers aged 15 – 24 years	27,500	8.27%	↑		
	% of total workforce	7.78%	0.13%	↑		
	13. Wages				Statistics Canada	2017 data
	Union hourly wages (Vancouver	47.81	0.47%	↑		
	Non-union hourly wages (BC)	28.79	2.35%	↑		
	14. Unionization				Statistics Canada	2017 data
	Coverage (# / 1,000 workers)	32.8	10.07%	↑		
	15. Skilled trade satisfaction Index	-	-	-	BCCA	After 2020
E. Education	16. Qualifications (BC)				Statistics Canada	2016 data
	Number of registered apprentices and trade qualifiers	6,210	-11.35%	↓		
	Proportion of total workforce granted certification	2.9%	-0.5%	↓		
F. Safety	17. Construction industry workplace incident reports (BC)				WorkSafe BC	2018 data
	Number of time-loss claims	7,920	5.61%	↑		
	Number of serious injury claims	1,548	-3.67%	↓		
G. Diversity	18. Women in the workforce (BC)				BuildForce	2018 data
	Number of female workers	7,300	23.3%	=		
	Proportion of workforce	4.1%	-0.11%	↓		
	19. First Nations in the workforce (BC)				Statistics Canada	2017 data
	# of First Nation workers	18,500	8.83%	↑		
	Proportion of total workforce	10.7%	-	-		

III. GROWTH & RESILIENCE

KPI				IMPLEMENTATION	
Sub-category	Measure	Value	Change (yr-yr)	Data source	Time frame
H. Economic performance	20. Industry size (BC)			Statistics Canada	2017 data
	GDP added ($ billions)	19.9	9.8% ↑		
	Proportion of BC's total GDP	8.88%	0.55% ↑		
	21. Productivity			Statistics Canada	2017 data
	GDP contributed per worker in BC ($)	87,208	1.57% ↑		
	22. Business size & formation				
	Total number of construction businesses in BC	93,786	2.1% ↑	BC Stats	2017 data
	Number of businesses with employees	24,347			
	1 to 4 employees	15,021			
	5 to 9 employees	4,990			
	10 to 19 employees	2,368			
	21 to 49 employees	1,376			
	50 to 199 employees	523			
	200 plus employees	69			
	Average annual revenues			Industry Canada	2016 data
	Construction, all	427,000	- -		
	Architect & Engineering	346,000	- -		
	Non-residential construction	622,000	- -		
	Proportion of business that are profitable (SME's up to 99 employees)			Industry Canada	2016 data
	Construction, all	82%	- -		
	Architect and engineering	85%	- -		
	Non-residential construction	79%	- -		
I. Project Pipeline	23. Proposed projects			BCCA	2017 data
	Total value of proposed projects	325B	1.24% ↓		
	24. Building permits	15.7B	18.5% ↑	BC Stats	2017 data
	25. Capital expenditures			Statistics Canada	2017 data
	Investment in new housing construction in BC				
	New dwellings, All types	12.25B	7.1% ↑		
	Apartments	5.21B	9.9% ↑		
	Investment in non-residential tangible assets by sector.				
	Mining, quarrying, and oil and gas extraction	4.80B	-15.15% ↓	Statistics Canada	2017 data
	Utilities	4.29B	10.13% ↑		
	Transportation & warehousing	4.06B	0.37% ↑		
	Public administration	2,72B	-0.55% ↓		
	Educational services	797M	-26.88% ↓		

III. GROWTH & RESILIENCE

(continued)

KPI				IMPLEMENTATION	
Sub-category	**Measure**	**Value**	**Change (yr-yr)**	**Data source**	**Time frame**
J. Business costs	26. Industrial product price indices in Vancouver (2010 = 100)			Statistics Canada	2017 data
	Asphalt	107.5	1.12% ↑		
	Softwood (SPF)	199.8	39.03% ↑		
	Ready-mix concrete	94.3	38.88% ↑		
	27. Cost to build (median square foot) in Vancouver (dollars per square foot)			Altus Group	2018 data
	Condominium (13-39 storey)	295	4.4% ↑		
	Low rise wood frame residential (5-6 storey)	195	11.4% ↑		
	Office, class A (5-30 storey)	305	1.6% ↑		
	Warehouse	107.5	4.9% ↑		
	Elementary school	230	9.5% ↑		
	28. Interest rates	1.75%	0.75% ↑	Bank of Canada	2018 data
K. Technology	29. R&D spending in BC (dollars)			Statistics Canada	2013 data (archived). New data after 2020
	Construction	7.0M	33.33% ↓		
	Architecture and engineering	58.0M	1.69% ↓		
	30. Technology adoption Index	-	- -	BCCA	After 2020

2 What are KPIs and why are they important?

"KPIs are … an accepted way for companies to measure their own progress against overall industry performance. They can even be used by businesses to demonstrate their track record to clients and win work."

UK Industry Performance Report 2012, Based on the UK Construction Industry Key Performance Indicators[2]

"The construction market place is increasingly rewarding for companies which can demonstrate their performance in a holistic way and can show how they benchmark against the rest of the industry."

KPIs and Benchmarking Best Practice Guide, Constructing Excellence, 2004

Construction KPIs paint a picture of the health of the industry as a whole. They also provide a set of tools that can be used by companies across the sector to evaluate their performance and raise their game against their peers, bringing lasting benefits to the whole industry.

Whether it is for a company or for an industry as a whole, factual data is essential in order to build value and achieve sustainable growth. Key Performance Indicators (KPIs) are measurable values that demonstrate the general health of the industry and provide a basis from which to work collaboratively in order to lift industry performance overall, and thereby bring about economic and social benefits to the industry and broader community. Jurisdictions that operate construction KPIs have developed valuable insight into how their industry is responding to market challenges and opportunities. They have found that publication of KPI data has done a lot to raise awareness of performance measurement[3] and further interest has been fuelled by additional factors such as:

- **Client pressure:** Construction clients have demanded evidence of benchmark performance when selecting suppliers.
- **Public procurement** on 'Best Value' has driven organizations to measure performance on a wider range of issues than simply cost or price.
- **The Quality Management Standard ISO 9001:2000** now places an obligation on organizations to measure their performance.
- **Organizations interested in continuous improvement** have found KPIs to be a simple and effective way to establish a baseline for improvement and measure progress.

Hard numbers and facts are often what precipitate and drive change. Without relevant and timely data, it is difficult to gauge how companies are faring in the face of regulatory, technical, demographic, macroeconomic and consumer change. This makes it difficult for businesses and governments to know if and/or to what extent support in the form of policies, R&D investment or education may be needed. The lack of public and private investment in transformative solutions for Canada's construction industry to date is, in large part, due to a lack of understanding of where and how best to deploy investment dollars.

While this study was intended to establish the value and viability of industry-level KPIs for BC's construction industry, a taste of some of the findings uncovered during the research process are presented below.

1. By 2015, GHG emissions from construction activities in BC had been reduced by 44 per cent over 2007 levels. Emissions reductions from commercial/ institutional and from residential buildings was 22 per cent and 16 per cent below 2007 levels respectively.

2. Between 2011 and 2015, there has been a 35 per cent overall reduction in construction waste being disposed of in Metro Vancouver's landfills. Most significantly, there has been a 75 percent reduction in asphalt, 96 per cent reduction in concrete and a 98 per cent reduction in rubble entering the waste stream.

3. There are only nine real estate and AEC B-Corp Certified firms in Canada of which only one is a construction company.

4. Despite efforts to attract youth into construction, the proportion of young workers aged between 15 and 24 years in BC's construction workforce has declined by 26 per cent between 2008 and 2017.

5. 16 per cent of BC's construction workers are involved with new industrial/commercial/institutional projects compared to 33 per cent who work in new housing.

6. The major trade groups (carpenters, electricians, heavy equipment and crane operators, plumbers, pipefitters and steamfitters, refrigeration and air conditioning mechanics, sheet metal workers, welders) have collectively seen the number of certificates granted to registered apprentices and trade qualifiers go down by 30 per cent between 2012 and 2017.

7. BuildForce forecasts that the proportion of women in BC's construction workforce will remain at around 4 per cent through to 2027.The wage gap between male and female workers is largest for carpenters at 31 per cent and smallest for plumbers at 12 per cent.

8. The proportion of aboriginal workers in construction and manufacturing in BC has gone up by 23 per cent between 2008 and 2017.

9. The workplace injury rate for construction workers in BC has remained at between 3.9 and 4.1 per 100 workers for the past five years which is 80 per cent higher than the overall workplace injury rate for BC.

10. In 2017, GDP generated from residential construction in BC was $9.5bn compared to GDP from non-residential construction which was $2.4bn.

Proposed KPI categories for BC

Figure 2 Categories and sub-categories of proposed KPIs for BC

3 KPI framework

The BCCA and the VRCA both agree that BC can be home to world class construction expertise and that BC firms can lead the way on innovative and sustainable solutions to housing and infrastructure.

Three categories of KPIs are proposed for BC – performance, people and growth and resiliency (Figure 2). In the following pages, each category, sub-category, and metric is presented in detail as follows:

- **Metric:** description of how the KPI is measured.
- **Data collection methodology:** the means of acquiring the data (the data source if it exists, the means of collection).
- **Implementation timeframe:** there are three options based on data availability and/or expected roll out of partner KPIs (e.g., BCCA's proposed metrics):
  - [**Year] data:** the data is available today and the most recent metric is from [Year]
  - **New in 2019:** the metric is currently not being tracked but to do so would require a modest amount of effort (e.g., Via an annual survey of owners)
  - **After 2020:** although the metric has been identified by an industry stakeholder, data collection methodology has not been established.
- **Rationale:** description of the KPI and why it is important.

Where data exists, charts are presented spanning up to the last 10 years (2008), except for data related to climate change policy which spans back to 2007 when the first greenhouse gas emission targets were established.

Pilot client satisfaction survey

As part of this project, a selection of brief survey questions were developed for industry advocates to use for future engagement. The intention is to illustrate how to take the pulse of customers of construction products and services. The survey questions are presented in Appendix B.

Over time, it is hoped that the same questions would be extended to private clients and construction firms.

Recognizing that even collecting basic data around the reliability of construction projects in terms of cost and schedule can be complex, survey respondents would be required to have the following data to complete the survey:

- The number of active projects in the previous 12 months.
- The value of all active projects in the previous 12 months.
- The number of substantially complete projects in the previous 12 months.
- The tender price and the completion price of all projects achieving substantial completion in the previous 12 months.
- Whether the substantially complete projects were completed "on time" (i.e., by the finish date per the contract at tender award).

I. PERFORMANCE

A. Quality of service

1. Client satisfaction

Metric: General satisfaction of clients based on 10-point rating where 1 = very unsatisfied and 10 = very satisfied.

Data collection methodology: annual survey of owners and clients.

Implementation timeframe: new in 2019.

Rationale: Customer service is a top priority for many firms. The score provides a high-level assessment with how clients feel about contractor performance on their respective projects. The owners' survey question is as follows:

Q. **Please rate your overall satisfaction with the projects that you have been involved with over the past 12 months:**

- Consultant design services
- Contractor construction services
- Consultant-contractor construction coordination
- The quality and performance of the building at substantial completion
- The quality and performance of the building at the end of the 1-year warranty

2. Reliability (cost and schedule)

Metrics:

- Percentage of projects (by number and value) that are "on budget" at substantial completion.
- Percentage of projects (by number and value) that are "on schedule" at substantial completion.

Data collection methodology: annual survey of owners and clients.

Implementation timeframe: new in 2019.

Fostering a culture of performance measurement

Construction companies may be more willing to adopt a new business process if their clients demand it.

Although it is not expected to result in an industry KPI, it is suggested that the first KPI survey of owners include the following question to benchmark the degree to which owners undertake performance measurement within their organization:

Q. Please describe the metrics your organization uses to track the predictability, reliability and performance of your projects.

Rationale: These are two of the most important metrics for describing overall industry performance. In the absence of project-level data (e.g. as might be gathered and aggregated by a business benchmarking tool), it is important for survey respondents to provide quantitative information.

The reliability of cost metric helps to demonstrate the accuracy of contractors' tender bids. It can also provide evidence of prevailing market conditions (e.g., degree of volatility). For the purpose of this survey, "on budget" is taken to mean the price at tender and/or in the original contract agreement.

The reliability of schedule metric tracks the percentage of projects that are completed within the contract's original substantial completion date. It reflects scheduling accuracy and good construction planning.

The owners' survey questions are as follows:

Q. Of the projects completed in the previous 12 months, what proportion were "on budget"?

- Total NUMBER of projects within +/- 5% of the tender price:
- Total VALUE of projects within +/- 5% of the tender price:
- The % difference between tender price and the price at substantial completion cumulative of all projects:

Q. If there were price differences between tender and substantial completion, what were the causes?

Q. Of the projects that your organization completed in the previous 12 months, what proportion were "on schedule"?

- Total NUMBER of projects that were completed on or before the predicted date:
- Total VALUE of projects that were completed on or before the predicted date:

Q. If there were changes between predicted and actual substantial completion date, what were the causes?

3. Defects

Metric: General perception of clients based on 5-point rating where 1 = much more than expected and 10 = much less than expected.

Data collection methodology: annual survey of owners and clients.

Pilot survey questions related to defects and call backs:

Q. Considering all of your projects that achieved substantial completion in 2018, the number of defects and call backs were:

- Much more than expected
- More than expected
- As expected
- Less than expected
- Much less than expected

Q. The most common causes of defects and call backs were (select all that apply):

- Incomplete Construction Documents
- Poor workmanship
- Compressed construction schedule
- Compressed design schedule
- Poor communication between owner & consultants
- Poor communication between consultants & contractor
- Other (please specify)

Implementation timeframe: new in 2019.

Rationale: Defects and call-backs are a proxy metric for overall quality of a building project on and after completion. Although the goal would be to hand over buildings with zero defects, quantitative data is not available yet.

The first survey results will simply serve as a benchmark of clients' perceptions of the industry and will highlight the most common types of defects – some of which may be outside the construction company's control. Ideally, the results (good or bad) will also motivate industry leaders to work with owners and clients to refine the data collection methodology, develop standard definitions and establish metrics. The findings may also point to a prevalence of defects that require a multi-disciplinary approach to resolve.

4. Procurement quality index

Metric: index

Data collection methodology: BCCA

Implementation timeframe: after 2020.

Rationale: Defects and call-backs are a proxy metric for overall quality of a building project on and after completion. Although the goal would be to hand over buildings with zero defects, quantitative data is not available yet.

Rationale: This metric is intended to provide an index score that represents procurement professional's assessment of quality and competitiveness of contractor procurement submissions, or the quality of owner's bid documents. BCCA has identified that they will start tracking this metric within their 2017 – 2020 Strategic Plan.

B. Environment

5. Building energy use

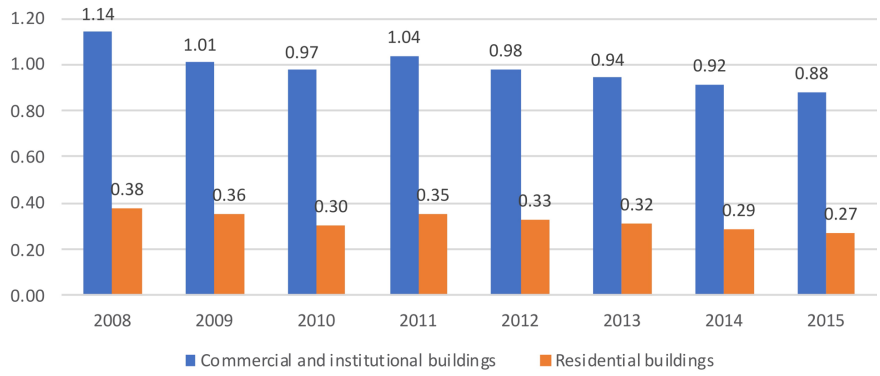
Metric: Energy intensity in gigajoules per gross square metre of floor area (GJ/m^2) of all residential and commercial and institutional buildings in BC.

Data collection methodology: Office of Energy Efficiency at Natural Resources Canada.

Implementation timeframe: Immediate - 2015 data available.

Rationale: The energy used by all residential and commercial/ institutional building types is released annually by the federal government. This metric is important for tracking the success of building sustainability outcomes in terms of both new construction and building retrofits.

Figure 3 Energy intensity (GJ/m^2) of all residential and commercial and institutional buildings in BC from 1990 to 2015 (Source: OEE NRCAN)



6. GHGs construction activity

Metrics:

- Kilo tonnes of carbon dioxide and equivalents (kt CO_2e) from all residential and commercial and institutional buildings in BC and for construction processes scaled by $100k value blocks.
- Tonnes of carbon dioxide and equivalents (t CO_2e) per million dollars of GDP.

Data collection methodology: BC government statistics.

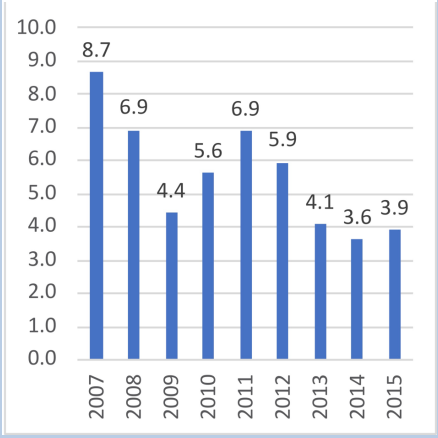
Provincial GHG emission reduction targets

By law the province of British Columbia is required to reduce emissions 80 per cent from 2007 levels by 2050.

In 2008, BC created a benchmark within that reduction, committing to get to 33 per cent reductions by 2020. While this interim goal has since been rescinded, it is worth noting that by 2015 BC's construction industry had already achieved a 44 per cent reduction from 2007 levels. Further, emissions from BC's commercial/institutional and residential buildings were 22 per cent and 16 per cent below 2007 levels respectively.

Excluding the impacts of the manufacture and transportation of materials, construction in BC is a very low emission industry when its emissions are compared per unit of GDP (Figure 4). Since 2007, emissions have more than halved from 8.7 tonnes to 3.9 tonnes per $million contributed to BC's GDP.

Figure 4 Tonnes of GHG emissions per $ million contributed to GDP by BC's construction sector (Source BC Government and Statistics Canada)



Implementation timeframe: Immediate - 2015 data available.

Rationale: Total GHG emissions are available from the BC GHG inventory[4] for residential and commercial / institutional buildings (Figure 5) and also for construction processes (Figure 6).

This metric is important because buildings are a major source of GHG emissions in Canada. Data tracking starts in 2007 which is the benchmark year against which BC's GHG emission reduction targets are set. Given the pace of adoption of new codes and the City of Vancouver's target of most new buildings being zero emissions by 2025, it would be useful to have current data and be able to break out new construction projects.

Figure 5 Total space heating GHG emissions excluding electricity from residential, commercial & institutional buildings in BC (kt of CO2e) (Source: BC Government)

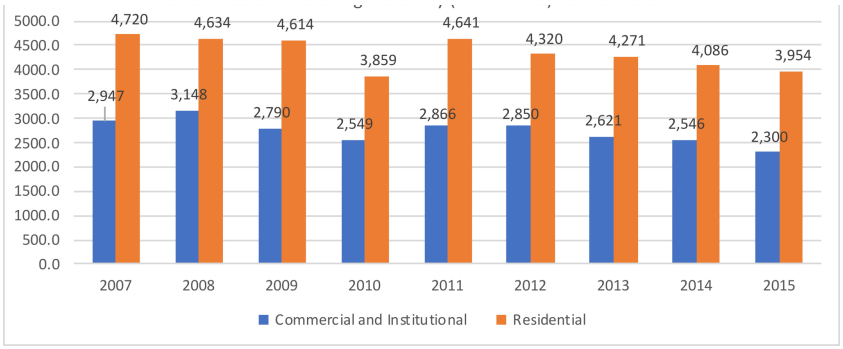
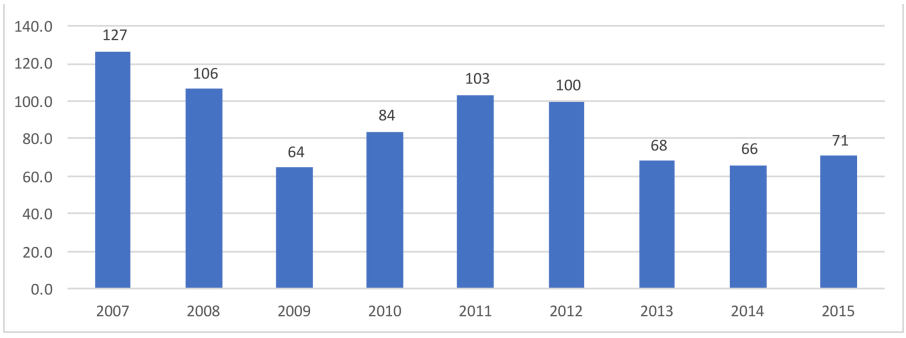


Figure 6 Total GHG emissions excluding electricity from construction activities in BC (Mt of CO2e) (Source: BC Government)



7. Construction waste diverted

Metrics: Tonnes of construction and demolition (C&D) waste diverted in licensed landfills in Metro Vancouver.

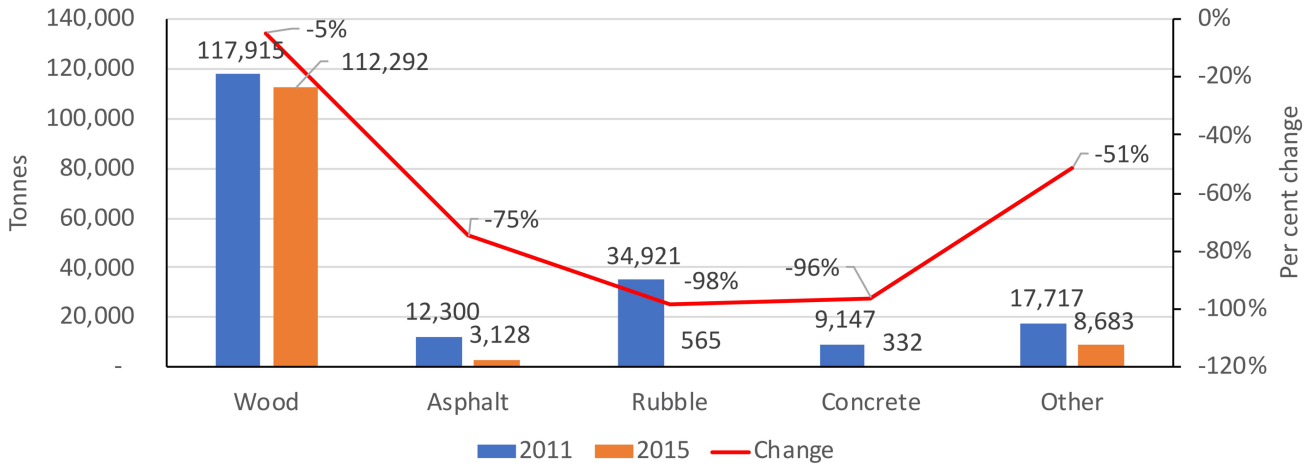
Data collection methodology: BC government GHG inventory.

Implementation timeframe: Immediate - 2015 data available.

Rationale: Construction, renovation, and demolition of buildings makes up a third of the Metro Vancouver region's solid waste stream. The construction industry has been working hard to reduce the amount of waste disposed in landfills – concrete has seen a 96% drop. While Metro Vancouver estimates that 75% of construction waste is recycled, current data on waste diversion and recycling rates can be hard to find and there is no tracking of progress over time.

Metro Vancouver does monitor construction waste generated and undertakes periodic audits of waste going to local landfills. Data is not published annually. Instead, data is available for both 2011 and 2015 on the materials that are not recycled (). Statistics Canada does tracks waste at the provincial level but does not break the data out by industry sector. It also does not collect information on the volume of waste managed privately, direct-to-recycler or by other means.

Figure 7 Estimated construction waste disposed annually in Metro Vancouver landfills in 2011 and 2015 (tonnes) (Source: Metro Vancouver)



Collecting data on complaints

Non-emergency public concerns about construction work are mostly lodged with the local municipality. These can include:

- No permits for construction that is in progress or completed
- Messy construction sites
- Unsafe construction or building conditions
- Hazardous materials coming from a demolished building
- Construction messes in streets and lanes
- Blocked streets and sidewalks

Emergency calls where there is a possible danger to someone or a property are received by 911, dangerous gas or electrical conditions are directed to the utilities.

C. Community

8. Complaints

Metric: Total number of non-emergency construction-related complaints.

Data collection methodology: survey of local governments.

Implementation timeframe: After 2020.

Rationale: Tracking the number of complaints is an important metric for demonstrating the extent to which the industry is improving its work practices and becoming a more considerate "neighbour" to local communities. However, tracking and reporting on construction-related issues is challenging.

Complaints can be submitted to a number of organizations, not all of which will release their data. When they do, the data is not organized in a useful way. For example, the City of Vancouver tracks and reports all the calls received by its 311 central contact number via the City's Open Data Catalogue[5] but a good deal of work is required to organize the data into a metric that would be useful for the construction industry.

9. Partnership index

Metric: index

Data collection methodology: BCCA.

Implementation timeframe: After 2020.

Rationale: This metric is intended to provide an index score that represents the level of collaboration and networking in the industry. BCCA has identified that they will start tracking this metric in their 2017 – 2020 Strategic Plan.

Corporate Social Responsibility in the Canadian construction industry

The Canadian Construction Association's Practical Guide to CSR illustrates how CSR in the Construction Industry can be practiced. It identifies how value can be created for stakeholders while also creating value for the firm in the form of brand recognition, employee retention, cost savings, enhanced risk management, among other benefits. This Guide shows how CSR can be applied to companies of all sizes and specialties, no matter where they are located.

CCA CSR Policy Statement

Canadian Construction Association (CCA) recognizes that corporate social responsibility (CSR) is a rapidly evolving issue and affects companies differently depending on their size, location, and specialization. CCA recognizes the importance of CSR and encourages companies to voluntarily undertake initiatives that enable them to operate in an economically, socially and environmentally sustainable manner.

10. Corporate social responsibility (CSR)

Metrics:

- The number of companies that have a CSR policy.
- The number of companies that have adopted the measures in the CCA's "Practical Guide to CSR" at:
  - Level 1.0 Early Practices
  - Level 2.0 Advanced Practices
  - Level 3.0 Leadership Practices.

Data collection methodology: Survey of companies

Implementation timeframe: After 2020.

Rationale: The first step to incorporating CSR into a business is the development and adoption of a CSR policy. Recognizing that good corporate citizenship is good for business, the CCA issued a policy statement and published a practical "how-to" guide, that helps a business of any size to get started. Using the criteria set out in the guide, a survey of companies will reveal the extent to which companies have adopted CSR from early engagement to leadership practices.

In the future, a survey of company websites and financial filings (for publicly traded companies) can reveal a great deal about the state of sustainability and CSR reporting within the construction industry. There are also a few leading firms that are B-Corp certified[6] (Figure 8).

Figure 8 B-Corp Certified Real estate, design and construction firms in Canada

II. PEOPLE

D. Workforce

11. Composition

Metrics:

- Total number of workers in the BC's construction industry
- Distribution by industry sector

Data collection methodology: Statistics Canada, BuildForce

Implementation timeframe: Immediate - 2017 (Statistics Canada) and 2018 (BuildForce) data available.

Rationale: Construction is BC's largest employer and as such, there are lots of data about the composition of the workforce. Information can be broken out by trade, age, gender, etc. Much of it is too granular for an industry level "pulse check" but can easily be added over time.

To start, it is important to track the overall number of workers employed in construction in BC (Figure 9), and their distribution by industry sector (residential, ICI, etc.) (Figure 10). BuildForce then provides a good summary of the change in supply and demand of workers – an important indicator of the degree to which the labour force is meeting industry demand (Figure 11). This compares the number of workers leaving the industry (e.g., via redundancy or retirement) with the number of new entrants and those moving into BC from elsewhere to meet demand.

Dealing with more than one data source

For some metrics, there are several data sources, each of which may have a different collection methodology. For example, published numbers for workforce composition according to BuildForce may be different to Statistics Canada or BCCA. In this case, it is suggested that Statistics Canada data is the default source based on its quality and longevity even if it is not the most up to date.

Figure 9 Total number of workers in BC's construction industry, thousands (source Statistics Canada)

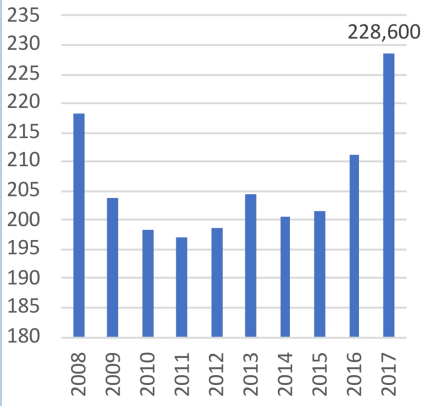


Figure 10 Distribution of BC's construction workforce by sector, 2018 (source BuildForce)

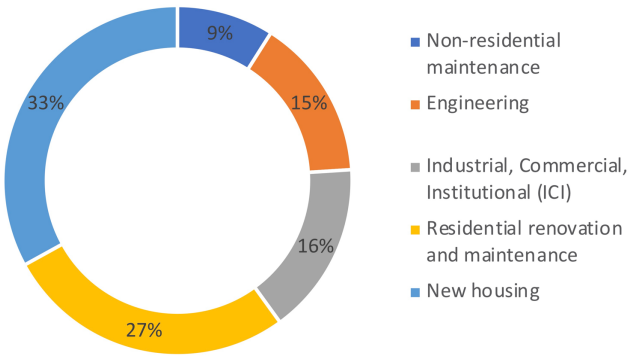
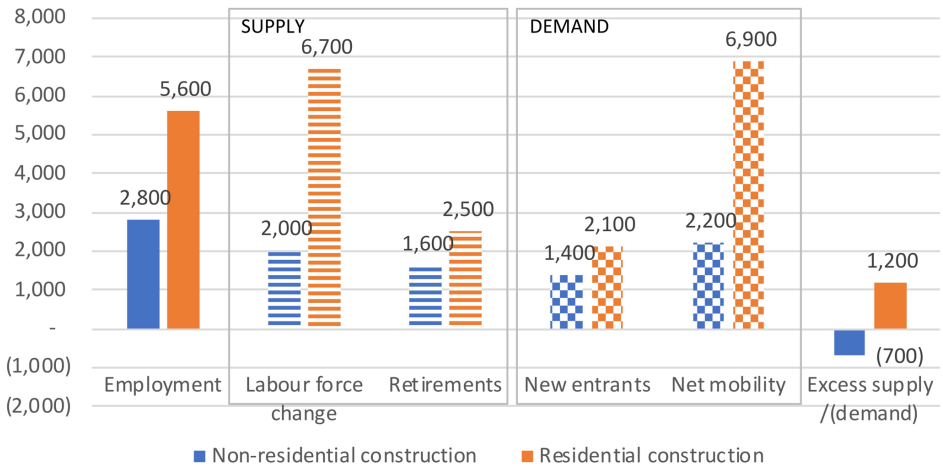


Figure 11 Change in workforce supply and demand in BC, 2017 (source BuildForce)



12. Youth

Metrics: The total number of persons working in BC's construction industry aged between 15 and 24 years old (both sexes) and the proportion of young workers to the total construction workforce.

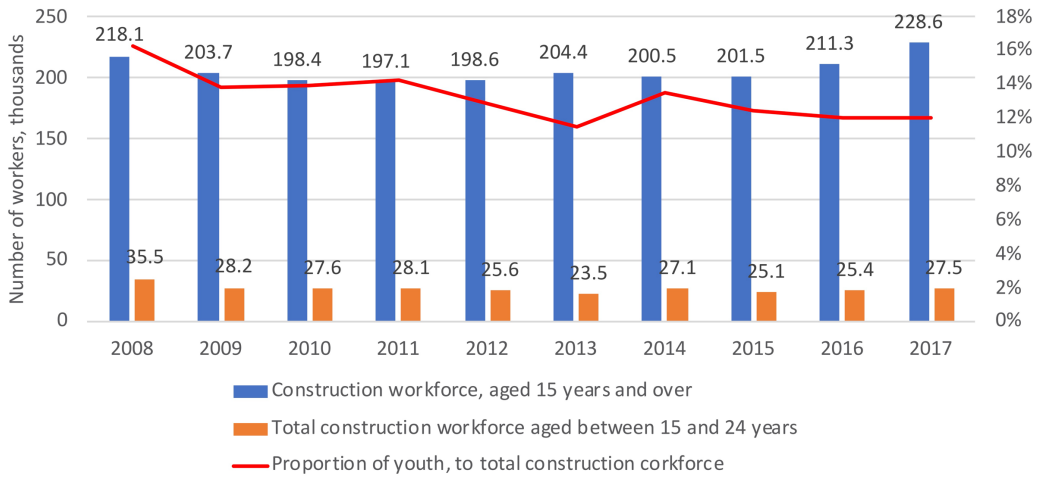
Data collection methodology: Statistics Canada

Implementation timeframe: Immediate – 2017 data is available.

Rationale: Attracting the next generation of workers is a top priority for many BC firms. Statistics Canada provides annual data on the number of young people working in the construction industry.

Despite efforts to attract more youth into construction, the proportion of the young people aged between 15 and 24 years old working in construction has declined from 16% in 2008 to 12% in 2016 at which point it levels off (Figure 12 next page).

Figure 12 Number of workers in BC's construction industry aged 15 - 24 years old, compared to BC's total construction workforce, thousands (source Statistics Canada)



Full versus part time employment

Data is available from Statistics Canada for full and part-time workers where part-time employees are defined as persons who usually work less than 30 hours per week at their main or only job. Part-time employment may become an important metric in the future but, for now, it represents less than 10 per cent of BC's total construction workforce (19,500 workers in 2017).

13. Wages

Metrics

- Average hourly wage of full-time union and non-union construction workers, current dollars.
- Average annual employment income for a selection of construction-related occupations broken out by gender, current dollars.

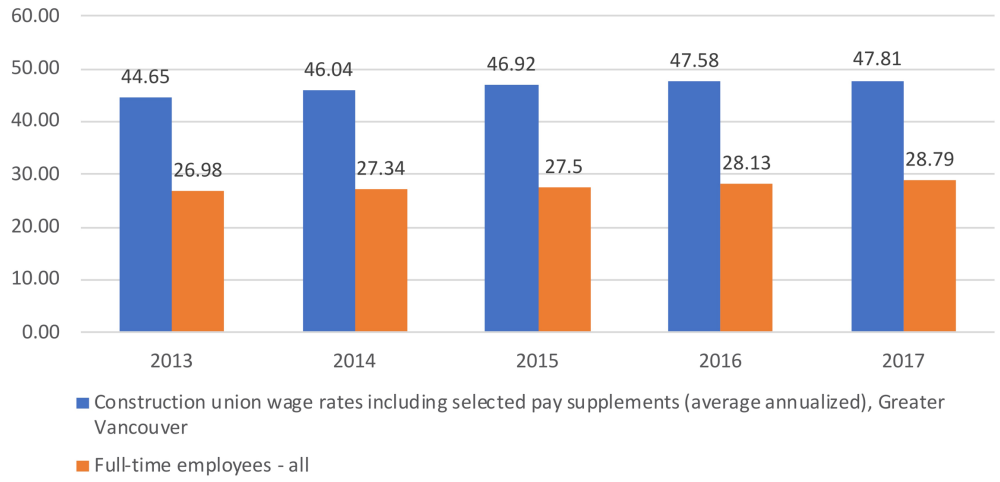
Data collection methodology: Statistics Canada.

Implementation timeframe: Immediate – 2017 data is available.

Rationale: Construction can offer a wide range of well-paying jobs, but this fact is not always understood by the wider population which may be a contributing factor to the current labour shortage. Metrics that track wages not only paint the picture about earnings potential but also provide a signal on labour costs. Statistics Canada tracks average hourly wages for construction workers to a fine degree of granularity. Data is broken out by dozens of different trades (by NAICS code), age, gender and full/part time workers.

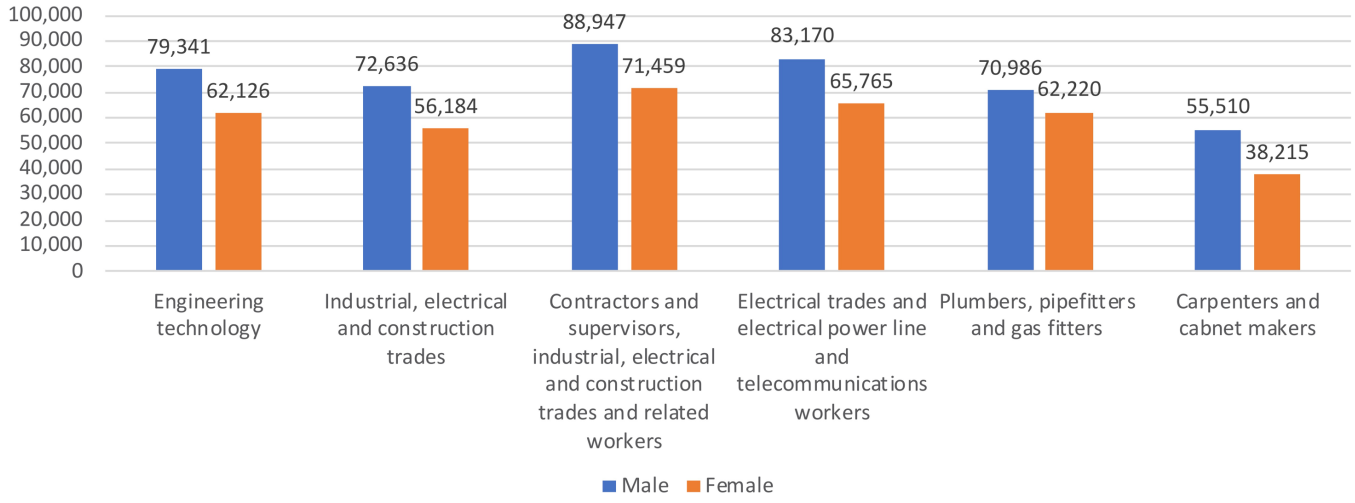
While there is information about average hourly wages for all workers, and for unionized workers by census metropolitan area (CMA), there is no discrete data on the non-unionized labour force (Figure 13 next page).

Figure 13 Average hourly wages for all full-time construction employees in BC and for unionized construction workers in metro Vancouver (source: Statistics Canada)



The range of occupations in construction is very large, however they can be rolled up into groups of key trades and technology areas (Figure 14). This metric can also address the income disparity based on gender, which is also key to improving the diversity of the industry.

Figure 14 Average annual employment income for male and female workers in a selection of construction trade and technology sectors (source Statistics Canada)



BuildForce labour market forecasts

While this data does not specifically delineate trade qualifications, BuildForce Canada's annual "Construction and Maintenance Looking Forward" publication forecasts a 10-year scenario of workforce supply and demand by trade, province, and region. These forecasts help industry, training providers and government decision makers manage workforce requirements.

www.buildforce.ca

14. Unionization

Metrics

- The number of workers who are union members and the proportion of the total workforce.
- The number of unionized workers by construction sector (residential, ICI, etc.).

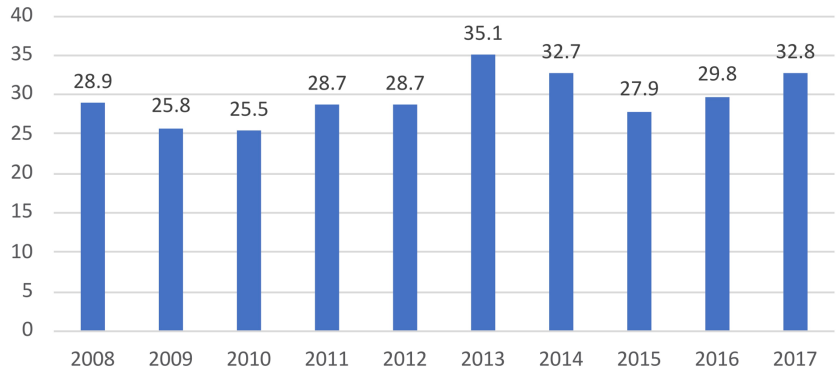
Data collection methodology: Statistics Canada

Implementation timeframe: Immediate – 2017 data is available.

Rationale: The proportion of BC's construction labour force that is unionized has become a hot topic in the light of the BC government's roll out of its Community Benefit Agreement.

Statistics Canada tracks unionization rates (Figure 15) but does not break out unionization rates by construction industry sector (e.g., residential, ICI, etc.) but, working with BuildForce, it may be possible to develop a greater degree of granularity. This would be important because, according to the BC government, unionization rates in the non-residential sector are much higher than for the residential building and home renovations sectors.[7] As 60% of BC's construction workforce is focussed on residential construction (new and renovations) then the union coverage metric needs to be able to properly reflect this.

Figure 15 Union coverage in BC's construction industry in BC, annual (x 1,000 workers) (source Statistics Canada)



15. Skilled trade satisfaction

Metric: index

Data collection methodology: BCCA

Implementation timeframe: After 2020.

Rationale: This metric is intended to provide an index score that reports on annual safety, health, and financial metrics. BCCA has identified that they will start tracking this metric in their 2017 – 2020 Strategic Plan.

E. Education

16. Qualifications

Metric: The number of certificates granted to registered apprentices and trade qualifiers in BC.

Data collection methodology: Statistics Canada, BuildForce

Implementation timeframe: Immediate – 2016 data is available.

Rationale: Readily available qualified workers are key to improving the quality and performance of construction projects. Unfortunately, for all key trades except for electricians, the number of workers completing apprenticeships and/or trade certifications has been going down.

Statistics Canada tracks the number of certificates granted to registered apprentices and trade qualifiers for dozens of different construction trades by age and gender. They also track the number of Red-Seal qualifications.

To start, it is sufficient to track a few key trades at a high level and then, based on industry feedback, start to break out the different aspects of the data over time (Figure 17, next page). Unfortunately, Statistics Canada data is only available up to 2016 (i.e., published 2 years behind current date).

Figure 17 Number of certificates granted to registered apprentices and trade qualifiers in BC (Red Seal and non-Red Seal). (Source Statistics Canada)

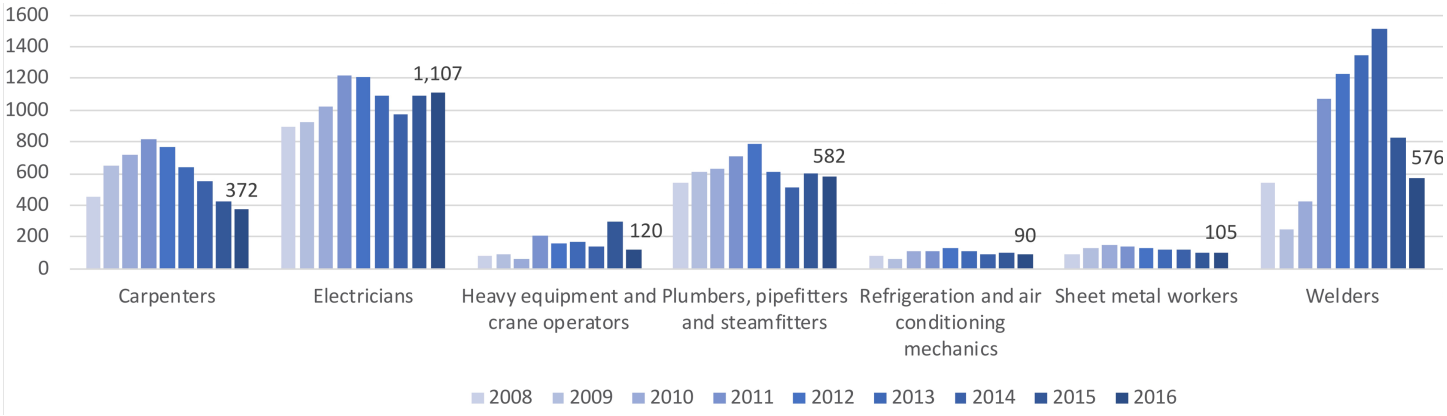
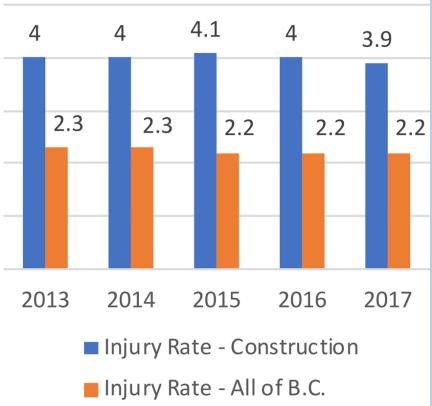


Figure 16 Injury rate for every 100 workers in BC, comparison between construction and provincial average of all industries (2017) Source WorkSafe BC



F. Safety

17. Incident reports

Metric the number of claims to WorkSafe BC for time-loss and serious injuries, both actual number and as a proportion of the total labour force (per hundred workers).

Data collection methodology: WorkSafe BC

Implementation timeframe: Immediate – 2017 data is available.

Rationale: WorkSafe BC reports the number of workplace injury claims and overall rate (injuries and serious injuries) for every 100 workers annually (Figure 19 next page). It is also possible to compare the injury rate in construction to the provincial average across all industries (Figure 16, left).

Workplace safety is a top priority for construction firms, however despite efforts, the injury rate has stayed fairly constant at around 4 per 100 workers for the past 5 years. This metric offers a way to track an important goal of bringing the construction industry's safety performance in line with all industries.

Figure 19 Number of construction workplace injury claims in BC (source WorkSafe BC)

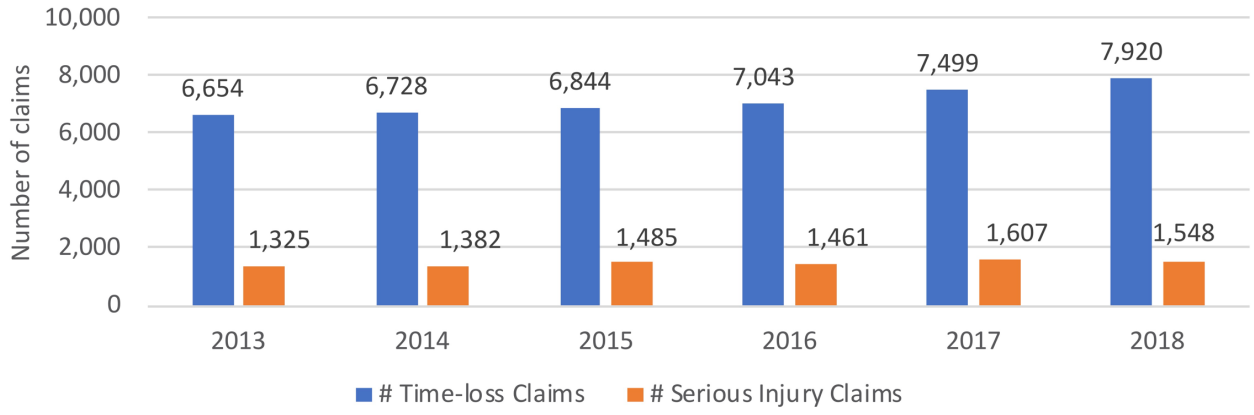
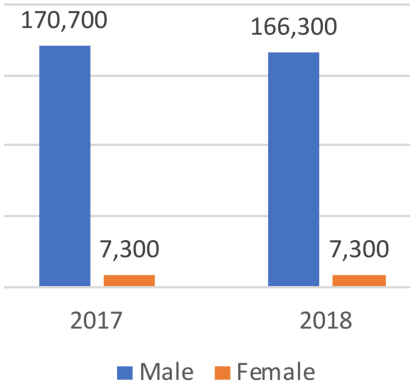


Figure 18 Construction workforce by gender in BC, 2017 and 2018 (source BuildForce)



G. Diversity

18. Women in the workforce

Metric:

- The number and proportion of women in construction trades
- The number of First Nation workers in BC's construction and manufacturing sectors.

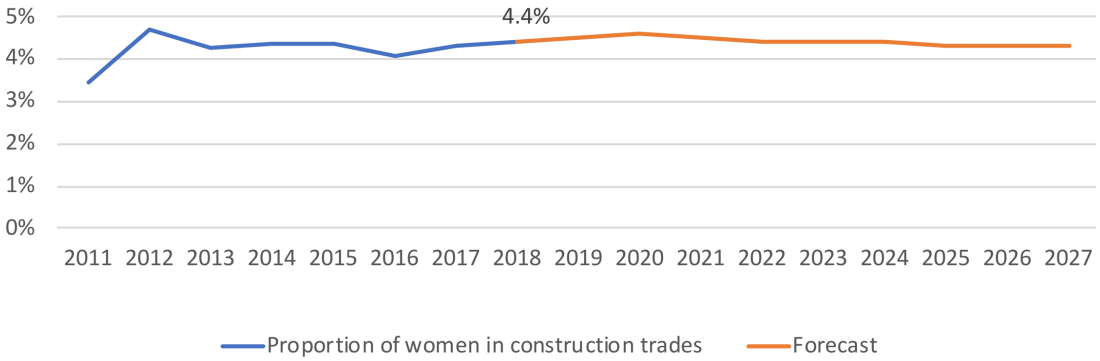
Data collection methodology: Statistics Canada, BuildForce

Implementation timeframe: Immediate – 2017 (Statistics Canada) and 2018 (BuildForce) data is available.

Rationale: Facing an acute shortage of workers, the construction industry needs to tap into new sources of labour. Attracting more women and aboriginal workers into the trades could offer a compelling solution. Currently there are only 7,300 women in BC's construction workforce (Figure 18), about 4% of the total workforce.

BuildForce tracks the number and proportion of women in BC's construction workforce and provides 10 year forecasts to help companies plan for the future (Figure 20). Note that the gender pay disparity is presented in the wages metric. Also, BuildForce data on workforce composition may differ from Statistics Canada.

Figure 20 Proportion of women in BC construction trades from 2011 to 2017 and 10 year forecast to 2027 (source BuildForce)



19. First Nations in the workforce

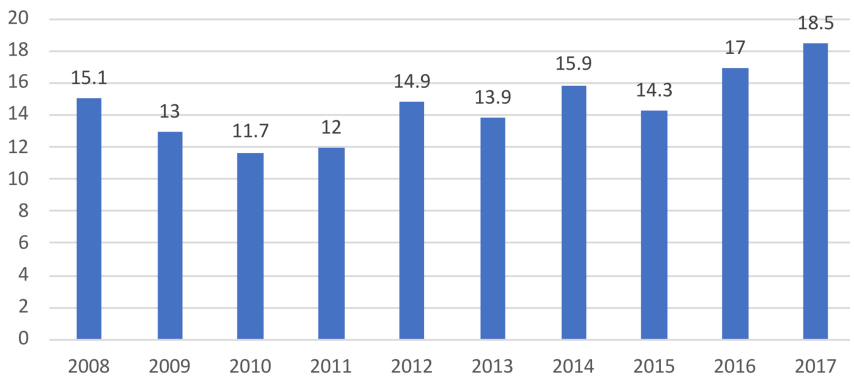
Metric: The number of First Nation workers in BC's construction and manufacturing sectors.

Data collection methodology: Statistics Canada

Implementation timeframe: Immediate – 2017 data is available.

Rationale: Supporting First Nation involvement in BC's construction workforce enables companies to engage with a fast growing, young and vibrant labour pool. However, it is challenging to get an accurate number of the number of First Nation workers involved in BC's construction industry. Statistics Canada combines construction and manufacturing data and also only publishes data for 1) Western Provinces and 2) the Prairies. Arriving at a metric for BC is therefore a matter of subtracting one from the other (Figure 21).

Figure 21 The number of aboriginal workers in construction and manufacturing in BC (thousands). (source Statistics Canada)



III. GROWTH AND RESILIENCY

H. Economic performance

20. Industry size

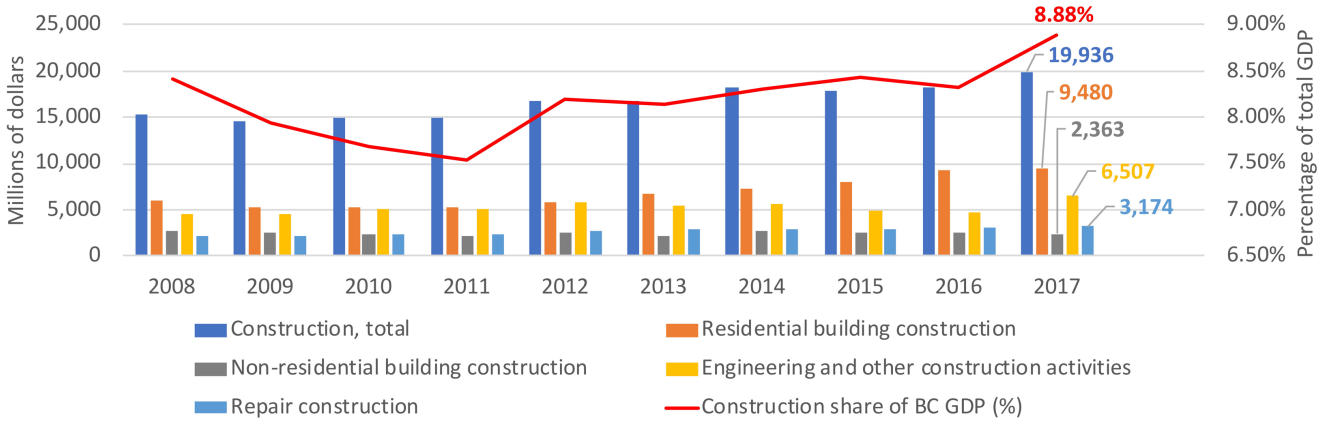
Metric: The value of Gross Value Added to BC's economy by construction and the proportion of BC's total annual GDP (chained 2012 dollars).

Data collection methodology: Statistics Canada

Implementation timeframe: Immediate – 2017 data is available.

Rationale: Construction is one of BC's largest industries and its prosperity is vital to BC's economy. It is important to track indicators that report on the industry's overall economic health. Currently, construction is at the highest value (almost $20bn) for more than ten years. Statistics Canada tracks data annually to the end of the previous year. Current data is broken out by construction sectors (residential, non-residential, etc.) and is chained to 2012 dollars (Figure 22).

Figure 22 Gross domestic product (GDP) at basic prices and share of total, BC (Chained



21. Productivity

Metric: Number of workers per unit of GDP.

Data collection methodology: Statistics Canada**.**

Implementation timeframe: Immediate – 2017 data is available.

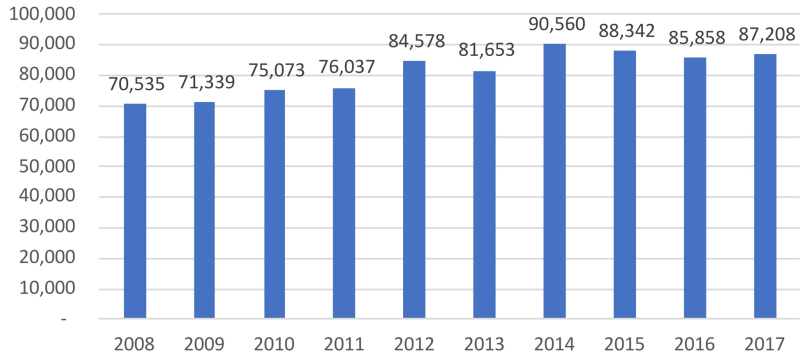
"For decades, the construction industry has been plagued by poor project productivity, particularly the craft disciplines, as well as an incapacity to reverse the trend. We compare ourselves to other industries (e.g., manufacturing) and lament our decline while others have substantially improved. The key differentiators are the metrics for benchmarking and the discipline to change."

Construction Owners Association of Alberta (COAA)

Rationale: Failure of businesses to optimize productivity can drag down profits. However, measuring productivity in the construction industry is an extremely challenging task because it comprises a complex mix of project-specific, manufacturing and service-based activities and because the most robust metrics are derived from project and company-specific data, then aggregated up to the industry level. Companies of all sizes therefore need to be fully engaged in the reporting process, which is unrealistic until the value of the reporting process is clear.

Until then, a rudimentary measure is simply to track the number of workers by unit of GDP. Data to do so is available from Statistics Canada (Figure 23). In time, "ASTM E2691 – 16 Standard Practice for Job Productivity Measurement" may be considered as an accepted standard for measuring production and productivity.[8] Given that productivity levels are of concern to industry leaders, it will be important for industry leaders to agree on an industry-specific methodology for tracking and reporting performance.

Figure 23 Productivity measured in terms of GDP contributed per worker (dollars)



22. Business size and formation

Metrics:

- Number of construction companies in BC
- Average annual revenues (in thousands of dollars) and proportion of SME businesses that are profitable (percentage).

Data collection methodology: Statistics Canada, Business in Vancouver.

Implementation timeframe: Immediate – 2017 data is available.

Tracking the performance of BC's largest firms

Monitoring the fortunes of BC's largest construction companies could offer an indicator of the confidence firms have in the BC market as well as the spin-off potential for work for smaller firms. According to the Business in Vancouver, the top three largest in 2018 are:

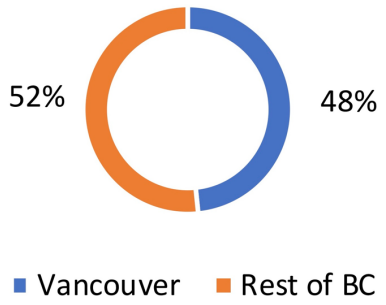
1. **The Ledcor Group of Companies** with 1,732 employees and $600m in billings in BC.

2. **Graham Construction** with 200 employees and $400m in billings in BC.

3. **Kiewit Canada Group** with 280 employees and $399m in billings in BC.

www.biv.ca

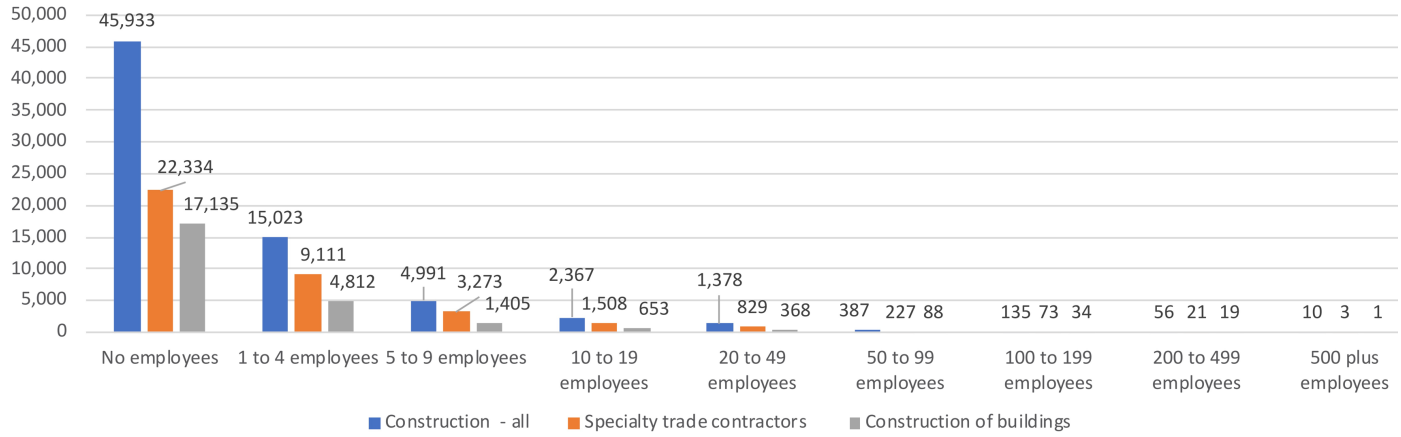
Figure 24 Location of businesses (with employees) in BC (source Statistics Canada)



Rationale: Indications of a prosperous industry would see companies grow their number of employees, the largest firms to grow the amount of business on their books and for the number companies grow as a whole. In BC, the vast majority of construction businesses (75%) are sole proprietorships (Figure 25) and only 14 companies have over 500 employees. Also, 48% of all businesses are located within Greater Vancouver (Figure 24, left). Statistics Canada offers a wide range of information about business formation and size that can be broken out by different trades (via NAICS codes).

Unfortunately, the data do not differentiate between residential and non-residential construction. Nevertheless, as a starting point for a KPI program, it is sufficient to start tracking data for the industry as a whole and break the data down to greater granularity based on future industry requirements. The BC government also tracks business formation and failures.[9]

Figure 25 Number of construction businesses by size (number of employees) in BC as of July 2017 (source, Statistics Canada)

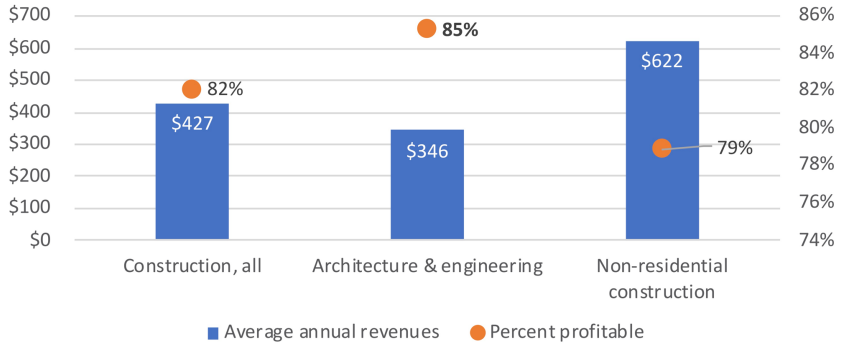


From time to time, Industry Canada reports at a national level on the performance of SMEs with up to 99 employees in terms of annual revenues and the proportion of businesses that are profitable. This data is gathered via survey (last update was in 2016). There is data for construction as a whole, for architecture and engineering and for non-residential construction (Figure 26).

Given that 99 per cent of BC construction businesses have less than 100 employees, this could be an important metric against which firms can benchmark their own performance. To be useful, the metric would need to present more current data at a provincial scale and be able to compare to SMEs in other sectors, it does offer a starting point for further development in the future.

At the other end of the spectrum, large publicly traded firms are required to regularly publish information about their financial performance. A snapshot of the health of Canada's largest firms could be developed by creating a share index of publicly traded construction companies (Graham, Ellis Don, Bird Construction, Ledcor, etc.), construction equipment (e.g., Caterpillar, Finning, etc.) and engineering firms (Stantec, SNC-Lavalin, etc.).

Figure 26 Average annual revenues (in thousands of dollars) and proportion of businesses that are profitable (percentage) of SMEs with up to 99 employees across Canada, 2016 (source, Industry Canada)



I. Project pipeline

23. Proposed projects

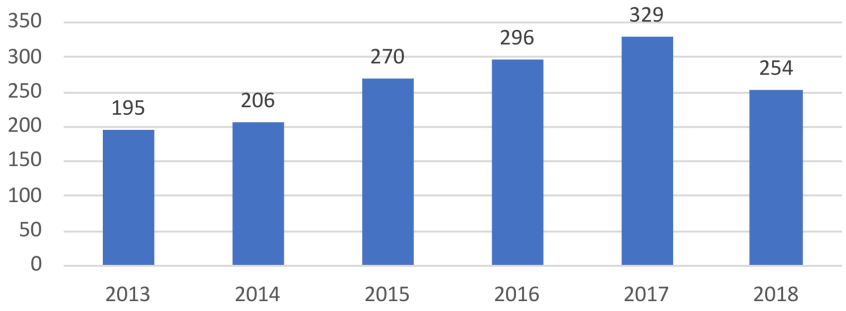
Metric: Value of proposed construction projects for residential and commercial building types.

Data collection methodology: BCCA

Implementation timeframe: Immediate – 2018 data is available.

Rationale: Construction companies of all sizes need certainty of future businesses to have the confidence to invest in labour, equipment, and other resources. At the same time, if there comes a point when the project pipeline becomes a backlog if companies are unable to handle the volume of work in a timely way. BCCA tracks the total value of proposed construction projects in BC (Figure 27). The BC government also maintains a major project inventory of private and public sector construction projects in B.C. with an estimated capital cost of $15 million (Can.) or greater which is published quarterly by region.

Figure 27 Total value (billions of dollars) of construction projects in BC (source, BCCA)



24. Building permits

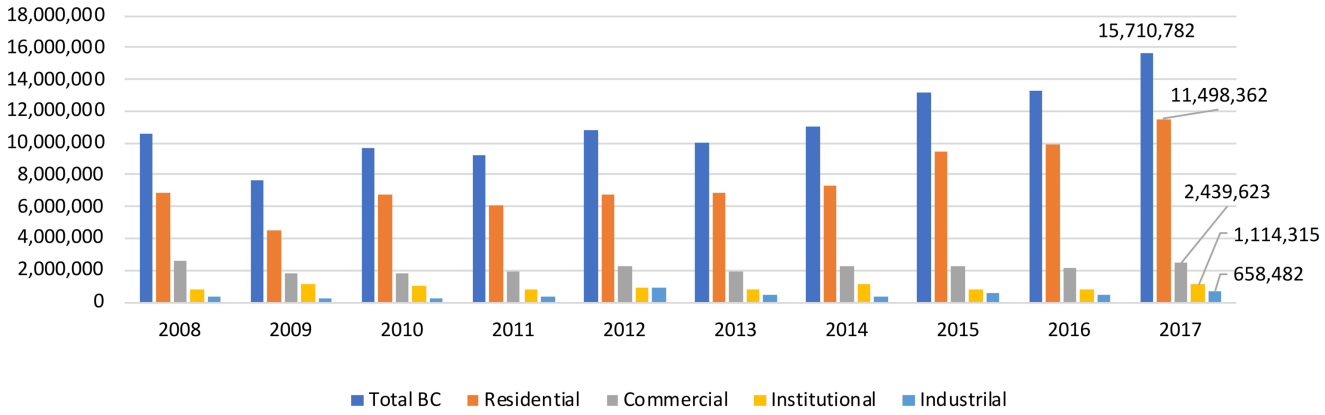
Metric: Total value of building permits issued in BC.

Data collection methodology: BC Stats

Implementation timeframe: Immediate – 2017 data is available.

Rationale: The value of building permits provides an indicator of potential construction projects and overall market health. The BC government tracks building permits at the provincial and local government level by building sector (residential, ICI, etc.) on a monthly basis (Figure 28, next page).

Figure 28 Building permit values (thousands of dollars) in BC by sector (source, BC Stats)



25. Capital expenditures

Metric:

- Monthly investment value in new housing construction in BC.
- Capital construction expenditures, non-residential tangible assets, by industry in BC.

Data collection methodology: Statistics Canada, CMHC.

Implementation timeframe: Immediate – 2018 data (CMHC) and 2017 data (Statistics Canada) is available.

Rationale: Tracking residential investment (Figure 29), and non-residential capital expenditures and repairs (Figure 30, next page) provides important trend data on how capital is being allocated across key construction sectors and investment categories. While Statistics Canada tracks both capital construction and repair expenditures, data for repairs is only available up to 2014.

Figure 29 Investment value in new housing construction in BC, (billions of dollars) source, CMHC.

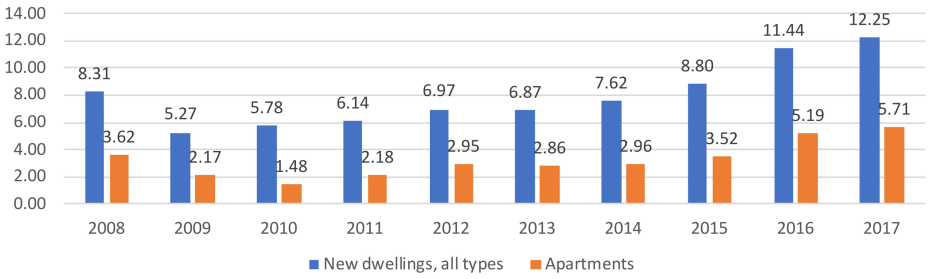
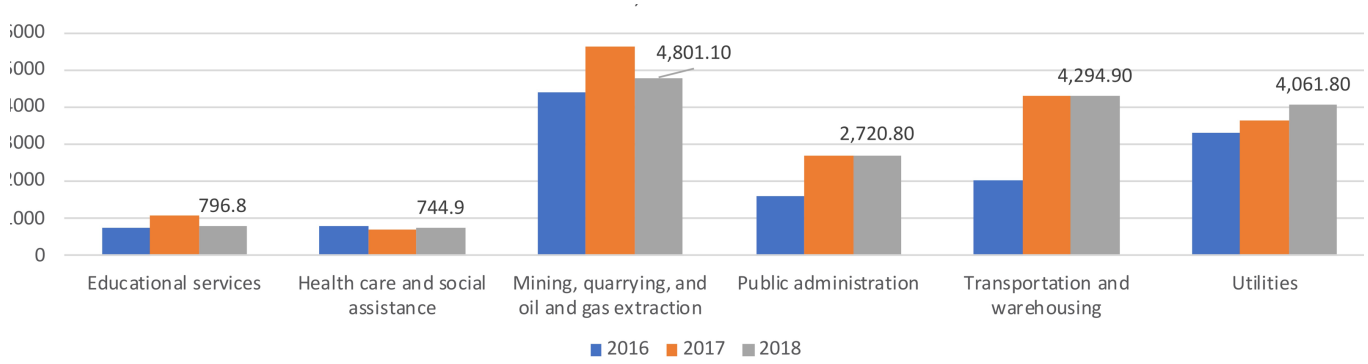


Figure 30 Top categories for capital construction expenditures, non-residential tangible assets, by industry in BC (millions of dollars) (source, Statistics Canada).



26. Costs to build

Metric: The square foot cost range for major building typologies, providing a market-based, rough estimate of the cost of construction.

Data collection methodology: Cost estimation / quantity surveying firms

Implementation timeframe: Immediate – 2017 data is available.

Rationale: While historical prices are not necessarily good indicators of future costs, data on what the market has been typically paying for completed building projects offers a useful snapshot of price trends. Several of the major cost estimation / quantity surveying firms publish annual construction cost schedules for typical building typologies in major Canadian cities (Figure 31). Ideally, the KPI would comprise an average taken across several sources.

Figure 31 Construction costs (dollars per square foot) for a selection of building types in Vancouver, 2016 - 2018 (source Altus Group)

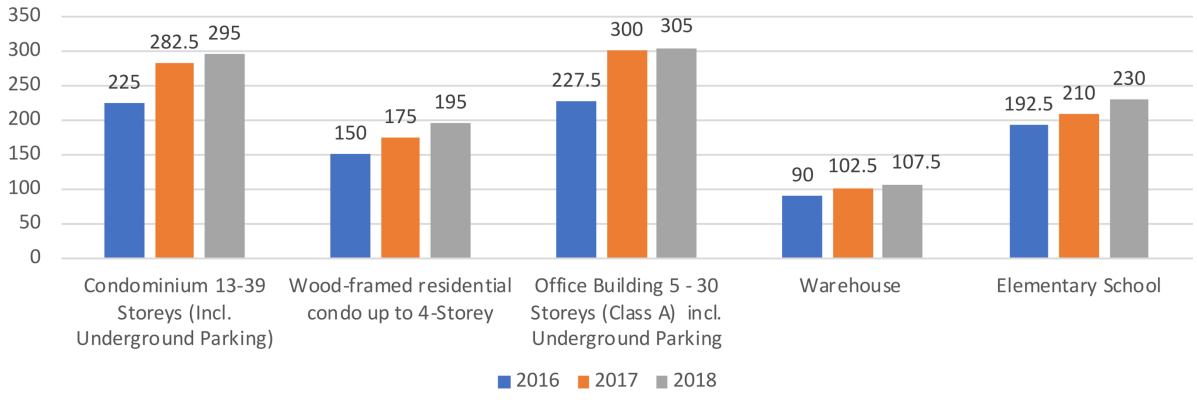
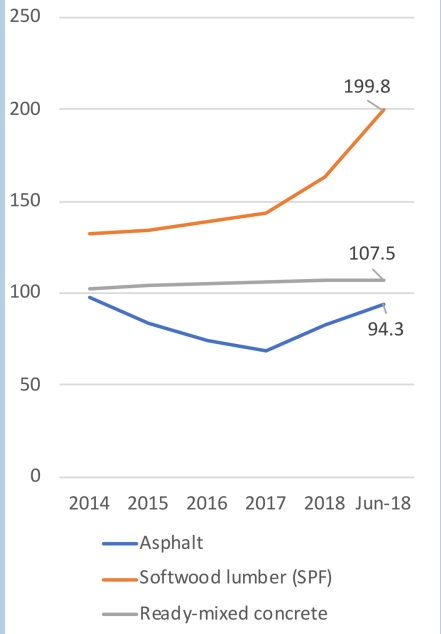


Figure 32 Industrial product price index for asphalt, softwood lumber and ready mix concrete in BC (2010 = 100) (source, Statistics Canada)



Bank of Canada benchmark interest rate and big four bank prime rates (December 2018)

Bank of Canada benchmark interest rate

1.75%

Bank prime rate

3.70 – 3.95%

J. Business costs

27. Materials prices

Metric: Industrial product price indices for key materials (asphalt softwood lumber and ready mix concrete).

Data collection methodology: Statistics Canada

Implementation timeframe: Immediate – 2018 data is available.

Rationale: Tracking the cost of construction materials is an important indicator of the external market forces that affect the overall cost of doing business in BC. Statistics Canada tracks the industrial product price index (IPPI) of a few major building materials (Figure 32) and the data only goes back to 2014. Until more key products and materials are included under the IPPI, tracking performance across the entire construction supply chain remains challenging.

28. Interest rates

Metrics: Bank of Canada benchmark interest rate

Data collection methodology: Bank of Canada

Implementation timeframe: Immediate – 2018 data is available.

Rationale: real estate and construction are highly leveraged industries and access to capital is key to driving market demand. Lending rates influence loans, mortgages as well as the investment potential of buildings that demand construction activity. The Bank of Canada sets the benchmark interest rate which the major banks then use to set their own prime rates.

K. Technology

29. R&D spending

Metric: Architecture, engineering and construction business expenditure on research and development in BC (x 1,000,000)

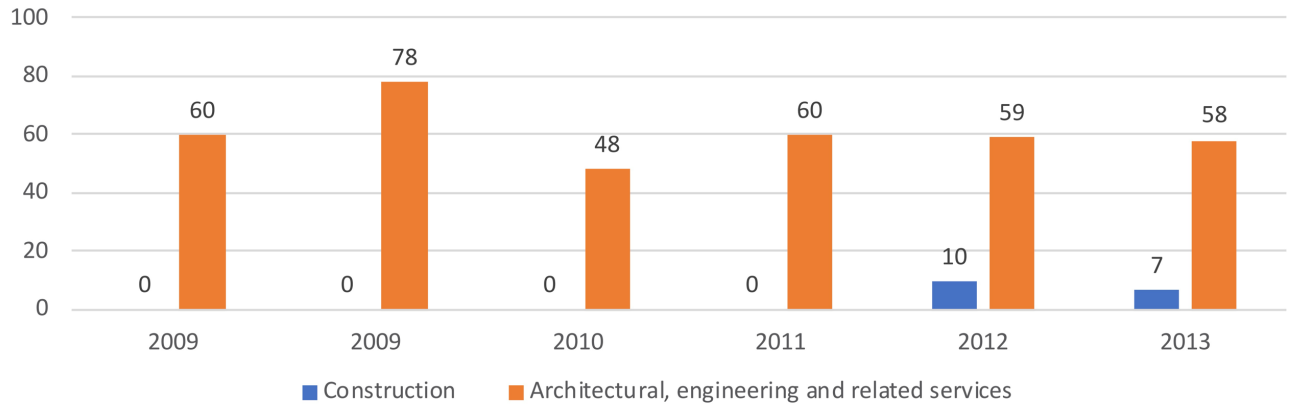
Data collection methodology: To be determined.

Implementation timeframe: After 2020.

Rationale: Today, technology and the practices that exploit them are becoming a greater factor in competitiveness and profitability. The degree to which businesses invest in R&D is an indicator of how ready they are to adopt new technologies and how resilient thy might be to unforeseen events.

Up until 2013, Statistics Canada tracked R&D spending by industry at the provincial scale (Figure 33). Although construction-specific spending data is only available for 2012 and 2013. More recently, the data has been gathered based on spending on by science type with two categories: 1) natural science and engineering and 2) humanities and arts. This data may be too high level for the construction industry and more work needs to be done to develop a data collection methodology to track research-related spending by construction firms at the provincial level.

Figure 33 Architecture, engineering and construction business expenditure on research and development in BC (x 1,000,000) (source, Statistics Canada)



30. Technology adoption

Metric: index

Data collection methodology: BCCA

Implementation timeframe: After 2020.

Rationale: This metric is intended to provide an index score that represents the uptake of technology within BC construction firms. BCCA has identified that they will start tracking this metric within their 2017 – 2020 Strategic Plan.

PART 2

HOW THE KEY PERFORMANCE INDICATORS WERE SELECTED

4 KPI state of play

Although some countries and regions have been gathering information about their construction economies for decades, overall construction industry data collection and performance benchmarking is relatively new in Canada.

The KPI models currently in use for the construction industry around the world vary widely in terms of target audience, scale, and scope. Broadly, there are three main types: centralized industry statistics, industry "pulse checks" and aggregated project / business benchmarking. Examples of each of these models are presented in Chapter 6.

The purpose that each model serves is largely dictated by the quantity and quality of data generated. There is a three-way inter-relationship between the quality of data, the amount of effort required to gather and organize it and industry involvement, both in terms of degree of effort and the number of companies that need to participate in the process for the results to be useful. For example, project / business benchmarking tools generate high quality data, but they require significant investment in both time and money by businesses (because the data is primarily used for managing corporate performance). Participation rates in these programs tend to be low and skewed towards large companies. By comparison, a centralized dashboard can be maintained without any direct involvement from businesses. Many companies might refer to this dashboard, but the data is high level, may not be sufficiently granular and therefore may be less useful.

KPIs in other industries

KPIs are metrics selected to "track" the impact of periodic changes or deliberate interventions on the status quo. For example, the widely adopted "Bloomberg Terminals" have been used by multi-billion-dollar investment firms for decades to track economic and trade KPIs for "indicators" that provide evidence of changes that might impact investment strategies.

"Investment in modernizing the industry is made based on factual evidence of a return on investment. ROI cannot be demonstrated without robust industry KPIs."

Construction Scotland Innovation Centre

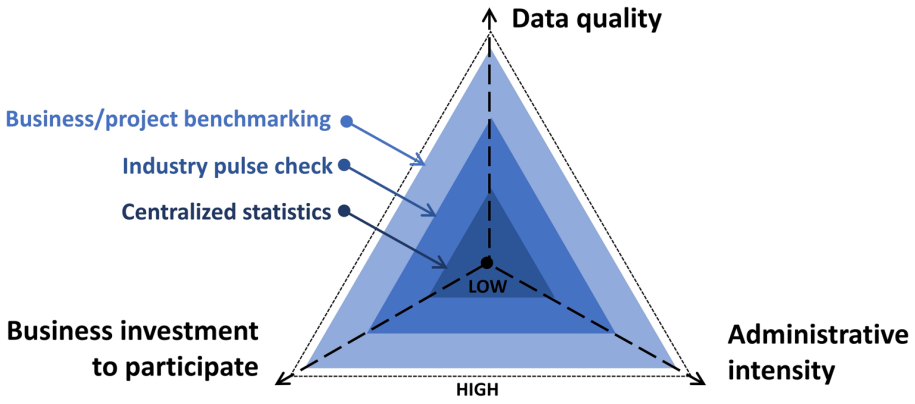


Figure 34: Inter-relationship between data quality, business investment to participate and administrative intensity of three types of KPI models

1. Centralized industry statistics

- A "dashboard" of relevant publicly available data such as employment and labour markets, building permits, industrial price indices, census data, etc. can offer a high-level snapshot of historical industry performance.

2. Industry pulse check

- A regular report on industry statistics supplemented by a survey of construction businesses, clients and, sometimes, other stakeholders that includes anonymized and aggregated data on indicators such as client satisfaction, reliability (% of projects on time / budget), sustainability (GHGs, tonnes of waste diverted), etc.

3. Project/business benchmarking

- Powerful proprietary tools are available to companies to track and optimize their corporate performance by benchmarking with similar companies and/or projects. Some of these programs aggregate, anonymize and report on the collective overall performance of participating companies.

5 KPI assessment framework

Key to the success of any KPI program is a clear understanding of the characteristics of the target audience and how they will use the information.

The three models of construction industry KPIs selected for review are in operation today in Canada and around the world. In some cases, there are several permutations or "spin-offs" from an initial format – for example, New Zealand adopted a model developed in the UK and the Construction Owners Association of Alberta (COAA}[10] has licensed elements of a scheme that initiated in the US. The methodology for evaluating the case study models is based on the following rubric consisting of two criteria: data quality and effort of collection.

5.1 Data quality

For each model, there is a qualitative assessment (based on low-medium-high) of the quality of data provided based on the following elements established by US-based data quality specialist, Blazent[11]:

1. **Accuracy and precision:** This characteristic refers to the exactness of the data. It cannot have any erroneous elements and must convey the correct message without being misleading. This accuracy and precision have a component that relates to its intended use. Without understanding how the data will be consumed, ensuring accuracy and precision could be off-target or more costly than necessary. For example, accuracy in healthcare might be more important than in another industry (which is to say, inaccurate data in healthcare could have more serious consequences) and, therefore, justifiably worth higher levels of investment.
2. **Legitimacy and validity:** Requirements governing data set the boundaries of this characteristic. For example, on surveys, items such as gender, ethnicity, and nationality are typically limited to a set of options and open answers are not permitted. Any answers other than these would not be considered valid or legitimate based on the survey's requirement.

This is the case for most data and must be carefully considered when determining its quality.

3. **Reliability and consistency:** Many systems in today's environments use and/or collect the same source data. Regardless of what source collected the data or where it resides, it cannot contradict a value residing in a different source or collected by a different system. There must be a stable and steady mechanism that collects and stores the data without contradiction or unwarranted variance.

4. **Timeliness and relevance:** There must be a valid reason to collect the data to justify the effort required, which also means it has to be collected at the right moment in time. Data collected too soon or too late could misrepresent a situation and drive inaccurate decisions.

5. **Completeness and comprehensiveness:** Incomplete data is as dangerous as inaccurate data. Gaps in data collection lead to a partial view of the overall picture to be displayed. It is important to understand the complete set of requirements that constitute a comprehensive set of data to determine whether or not the requirements are being fulfilled.

6. **Availability and accessibility:** This characteristic can be tricky at times due to legal and regulatory constraints. Regardless of the challenge, though, individuals need the right level of access to the data in order to perform their jobs. This presumes that the data exists and is available for access to be granted.

7. **Granularity and uniqueness:** The level of detail at which data is collected is important because confusion and inaccurate decisions can otherwise occur. Aggregated, summarized, and manipulated collections of data could offer a different meaning than the data implied at a lower level. An appropriate level of granularity must be defined to provide sufficient uniqueness and distinctive properties to become visible.

Lessons from Australia

In a 2010 review of international approaches to measuring KPIs in the Australian construction industry, a group of researchers[12] for the Australian Construction Industry Forum [ACIF] and Australian Procurement and Construction Council [APCC] found that to be effective, the measures and reporting mechanisms for performance management systems should be:

- Acceptable
- Meaningful to industry
- Easily understood (i.e., are simple, understandable and logical
- Repeatable
- Show a trend over time
- Suitable – they measure important things
- Feasible – they are easy and economical to collect
- Effective – they concentrate on encouraging the right behaviour
- Unambiguously defined
- Aligned – must link to national goals for the industry

"Anecdotal stories don't drive change. This is the era of big data and big data will drive decisions and change. How will we drive performance in an industry that doesn't really have performance metrics?"

Autodesk[13]

5.2 Effort of collection

In the Information Age, society is awash with data. However, the collection, organization and tracking of data, and the analysis necessary to convey relevant insights takes time and expertise on behalf of both the administrator and industry stakeholders. High quality KPIs therefore generally takes time and effort to establish and maintain. The lower the degree of effort to collect and present KPIs the more sustainable the program will likely be over the long term. Effort of collection is evaluated along three dimensions as follows:

1. Business involvement

- **Low:** requires little to no input from industry (e.g., construction businesses)
- **Medium:** relies on a representative number of businesses responding to short web-based or phone surveys, web polls, etc.
- **High:** a large number of businesses will be expected (though not required) to complete detailed surveys, undertake some amount of paperwork to source and keep track of data, and/or participate in focus groups.

2. Cost to businesses (both financial and in terms of staff time)

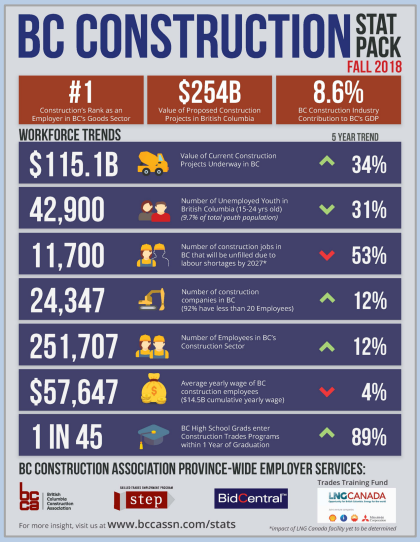
- **Free:** no cost or staff time necessary.
- **Low**: minimal costs in terms of staff time to complete a survey.
- **Medium:** could include subscription costs and/or staff time to source, organize and submit data, participate in focus groups.
- **High** subscription to some benchmarking tools can be over $20,000 per year and they require staff training to compile and manage the data as well as staff time to input and track data.

3. Administrative intensity

- **Low:** predominantly involves collecting data, organizing into charts and publishing on an annual basis.
- **Medium:** in addition to above, surveys are conducted and then the data is analyzed and converted into useful metrics.
- **High:** in addition to above, with large numbers of granular KPIs. Technical support may be provided to businesses participating.

Example

BCCA Construction Stat Pack



Since 2013, the BCCA has been collecting and publishing annual "Stat Packs" that centralizes a range of data (from Statistics Canada, BuildForce, etc. and an annual member survey) that paint a high-level and, generally, positive picture of BC's ICI construction industry. The one-page information sheets have, in the past, been oriented towards telling a topical story, such as labour shortages or unionization rates.

Statistics include labour and wage metrics, total construction value and the number of construction companies in BC – to provide a window into the BC economic environment for members to consider when considering important business decisions. However, the metrics tend to be selected to support political priorities and may not offer a fully objective view.

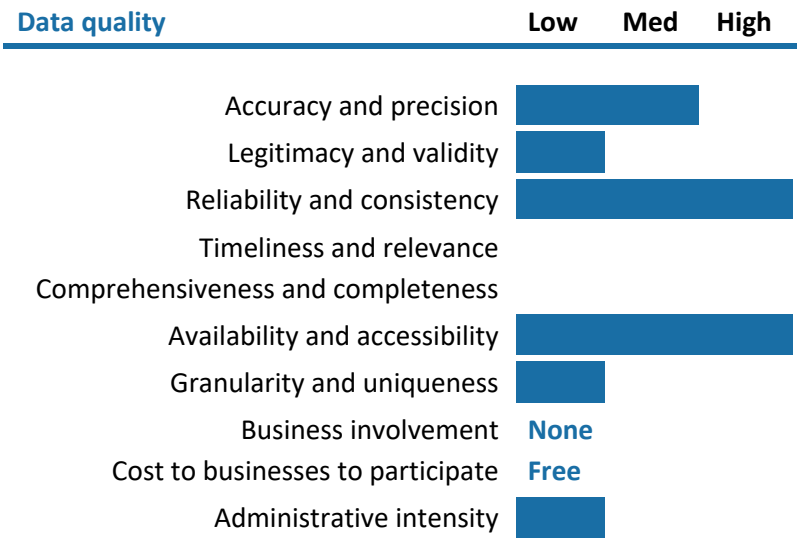
Available at www.bccassn.com

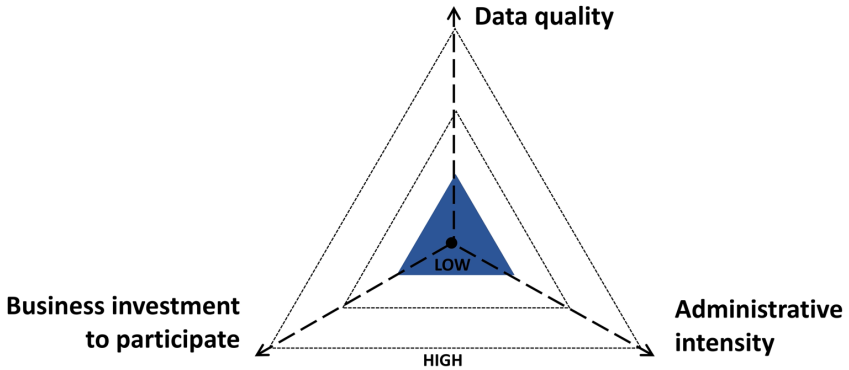
6 KPI models

6.1 Centralized existing statistics

By centralizing existing statistics, it is possible to convey a general picture of "what's going on" in the construction industry.

Objective quantitative metrics are publicly available from a range of reputable public and NGO sources (statistical agencies, safety organizations, etc.) both at the provincial and national level that can be assembled to track the broader context and market conditions (e.g. economy, regulations, commodity trade, etc.).Gathering data and organizing it into a format that is readily understandable by construction businesses (e.g., in charts) is the simplest and most cost effective process.





BCCA expansion of existing metrics

Building on its long-running annual Stat Pack publications, BCCA's Strategic plan (summarized in Chapter 7) proposes a series of important additional measures organized under four categories that will be developed from both publicly available and proprietary sources. The categories are:

1. **Construction projects**
2. **Skilled workforce**
3. **Technology**
4. **Community**

More details about BCCA's measures are provided in Appendix C.

The purpose of BCCA's metrics is to tell a particular story about the state of the industry while demonstrating the value that the organization provides to its members. Examples of how BCCA deploys key metrics in the face of industry issues include the level of unionization in the face of the BC Community Benefits Agreement requirements for public projects to be tendered to unionized contractors[14] and the rate of high school leavers entering trade training programs, given the current labour shortage. However, while these measures are important, for KPIs to ultimately drive industry-wide performance improvement, they need to tell the whole story, not just a good (or bad) story.

While leveraging statistical data minimizes the effort required of companies to provide data, the fact that construction businesses do not participate directly in the data collection process means that the resulting indicators will be generic. Statistics are, by their nature, lagging indicators and may be many months (sometimes years) behind. They may also not be very granular and may fail to pick up on important factors affecting local businesses and /or make it difficult to single out individual entities which may be contributing significantly to poor performance against a particular metric.

6.2 Industry wide pulse check

For stakeholders to see how well the industry is doing as a whole, an annual pulse check can provide an accessible, high level snapshot that combines both publicly accessible statistics and input from businesses.

Industry pulse checks can provide a happy medium between acceptable data quality and feasibility of data collection. Done well, they offer something for everyone – they are simple, understandable, and logical and they are easy and economical to collect. In most cases, the data is sourced from national statistics, and it is then complemented by a survey of companies, owners, and a random selection of projects.

In some schemes, businesses participate voluntarily and for free. In others, businesses are required to complete a survey that is administered by government.

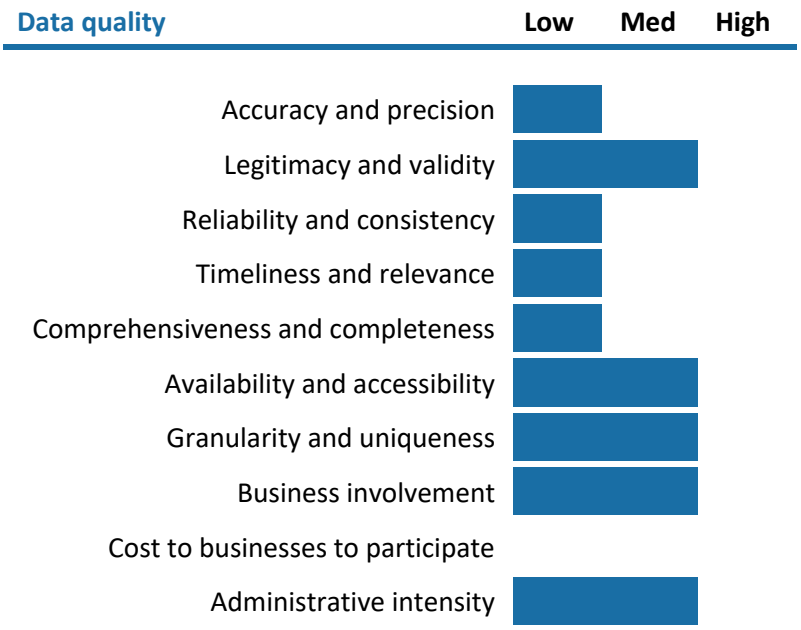
Example

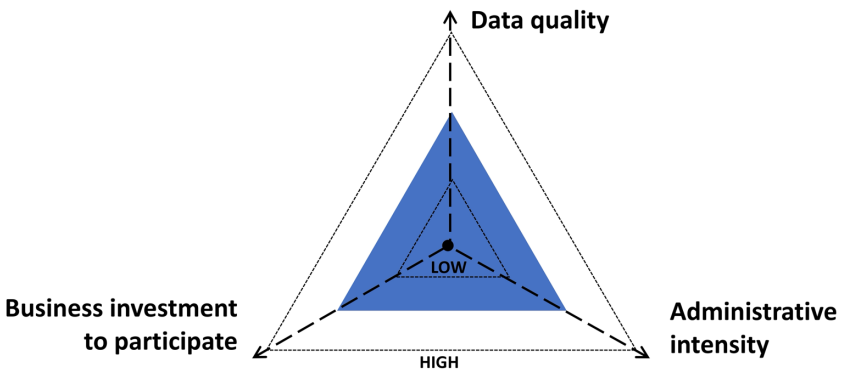
UK Industry Performance Report

Glenigan (a UK-based market research firm that provides construction project sales leads, market analysis, forecasting, and company intelligence) publishes the annual "UK Industry Performance Report".

The report is based on the UK Construction Industry Key Performance Indicators which are produced by a partnership of the Department for Business, Innovation & Skills[15] and Constructing Excellence using data from the Office for National Statistics, Building Cost Information Service, Health and Safety Executive, Dun & Bradstreet, and other third-party financial analysts.

Information is also drawn from surveys of construction businesses, owners and consultants, and a random sample of construction projects across the UK.



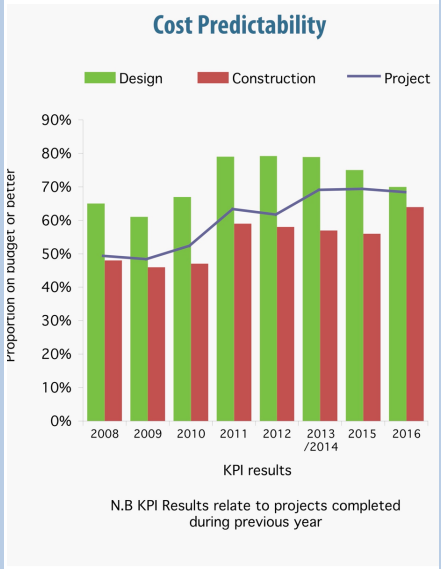


UK Construction Industry KPI program

As the most widely imitated, and critiqued, the Glenigan / Constructing Excellence model from the UK is the one that may yet prove to have the widest impact.

The UK Construction Industry KPI program emerged from Sir John Egan's (1998) "Rethinking Construction" report.[16] The British construction industry as a whole was in a poor state, with projects consistently failing to meet client expectations, being delivered late and over-budget. Egan identified a number of drivers for change, including better client leadership, supply chain integration and investment in the workforce. He set a number of ambitious targets against which this improvement should be measured, which are still recognized today as 'headline' performance indicators, such as time and cost predictability (Figure 36).

Figure 35 UK Industry KPIs, cost and time predictability performance (2017)



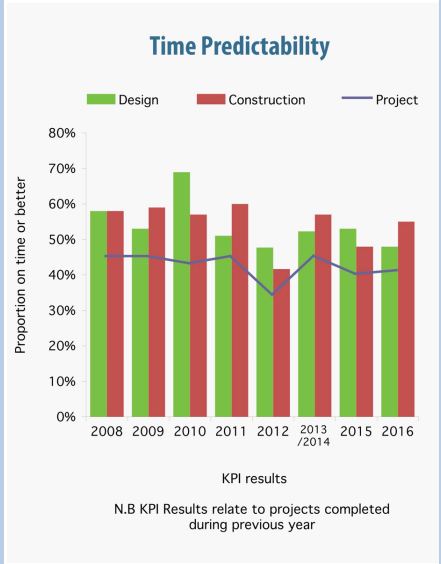
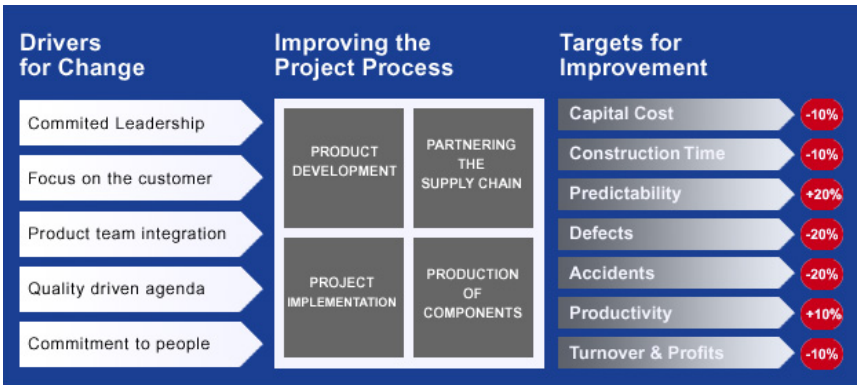


Figure 36 Sir John Egan's "5:4:7 Mantra for Change", from "Rethinking Construction"



The UK industry KPI program was developed to help contractors measure their performance in a consistent way, to demonstrate their improvements in time, cost and quality and to understand how their performance compared to their peers.

The value of an industry-wide snapshot relies on access to sufficient data that is of a suitable quality to be statistically representative of industry issues as a whole. It has taken Glenigan, in partnership the UK's Constructing Excellence (now part of BRE), over two decades to:

1. Develop industry understanding of the quality of its information and what it should be used for, and
2. Build its reputation as an impartial, trustworthy organization.

Details of the UK's Industry Performance Program along with the target KPIs are presented in Appendix D.

Qualitative ratings

The UK Industry Permeance Report references qualitative data for metrics such as client satisfaction (for product and service) are collected using a rating system where respondents provide scores out of 10 where:

10 = Totally satisfied

8 = Mostly satisfied

5/6 = Neither satisfied nor dissatisfied

3 = Mostly dissatisfied

1 = Totally dissatisfied

For defects, respondents are asked to rate the condition of the product/facility with respect to defects at the time of handover, using a 1 to 10 scale, where:

10 = Defect Free

8 = Some defects with no significant impact on client

5/6 = Some defects with some impact on client

3 = Major defects with major impact on client

1 = Totally defective

Qualitative, self-reported ratings are highly subjective. They can adversely impact data quality and make it difficult to compare construction to other industries.

Constructing Excellence started with a relatively small set of KPIs, but the number of data sources grew quickly. Indeed, the pace of expansion was a cause for criticism as some felt it had led to industry frustration and data overload.[17] Nevertheless, by 2017, the UK Industry Performance Report published a total of 69 KPIs which are presented on the following pages and are organized in the following categories:

- Economic indicators
    - All construction
    - All housing
    - All non-housing
- Respect for people
- Environment
- Construction consultants

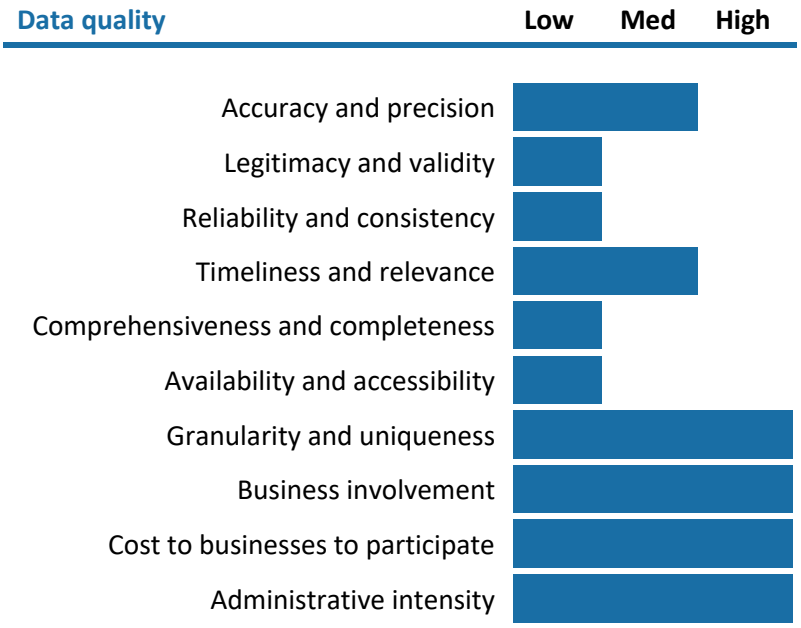
While this can increase the rigour of the results, it also increases the resources required to measure. Because the UK system has been going the longest, it has been subject to the greatest amount of criticism. In their assessment of the UK system, the Australian research team offer the following issues and recommendations:

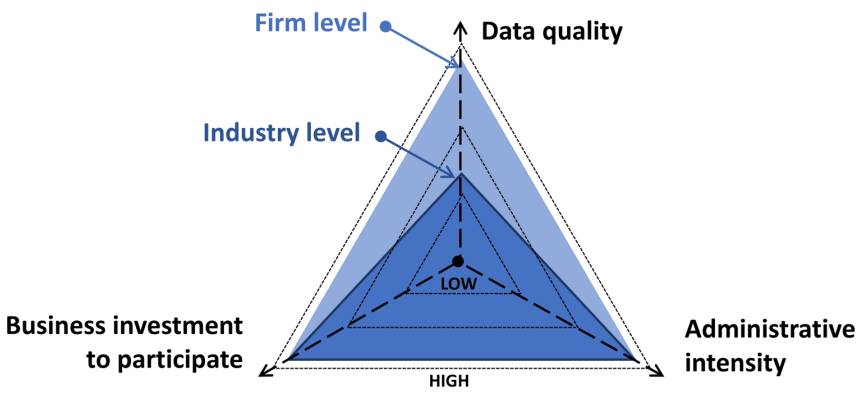
Criticism	Recommendation
Subjective assessment of some of the key measures (particularly satisfaction and some approaches to the assessment of quality)	Rely on objective measures collected by independent organisations / sources
Some of the measures are crude and open to interpretation or lag behind activity so far as to not be very useful	Use measures which are agreed to by all stakeholders, and are valid
While raising the profile of benchmarking in the industry - attempts to improve industry performance have largely failed due to lack of involvement with top level coordinating agencies or failure to engage significant numbers from industry	Engagement of “peak” (i.e., national) bodies
Large number of KPI schemes under way at the same time leading to fragmentation, frustration in the industry	Engagement of “peak” (i.e., national) bodies
Data overload	Report results simply (perhaps with indexes of multiple KPIs)
Large investment (cash and in-kind) required to implement, measure and report on the data	Where possible, use data which is already collected to reduce costs

6.3 Business / project benchmarking

Data from business and/or project performance benchmarking programs can be rolled up to provide metrics that track the quantitative and qualitative performance of a project or business and tracks the performance changes over time.

'Benchmarking' is a process of making structured comparisons of the performance of firms or other bodies, either with their peers or with externally defined reference criteria. Research to support the adoption of KPIs in Australia found that most current approaches to Construction KPIs around the world are conducted at the firm or project level via business management optimization tools. [19] Benchmarking programs are therefore only of interest to this study insofar as they aggregate, anonymize, and publish the data at an industry level. A detailed review of the relative merits of benchmarking programs for the purpose of business improvement is outside the scope of this study.





Example

CII/COAA Major Project Benchmarking

The Construction Owners Association of Alberta (COAA) serves the heavy industrial construction and industrial maintenance industries that operate in Alberta's oil and gas sector.

COAA has been running the "Major Project Benchmarking" in partnership with CII of University of Texas since 2005, publishing summary reports in 2009 and 2014 for a set of major projects. Recently, COAA also released the "High-Level Productivity Calculator",[18] developed in partnership with three US-based organizations: CII, the Construction Labor Market Analyzer® (CLMA) and the Construction Users Roundtable (CURT).

COAA members are in the Oil and Gas field, primarily dealing with large construction projects valued in the billions of dollars, spanning many years. COAA members participating in the benchmarking program regularly submit detailed data on project cost, productivity and workforce metrics, as well data relating to rework, engineer design efficiency and best practices.

This attention to detail has paid off: statistically significant data has helped subscribers gain 10% improvement in performance (data is available only to paying subscribers). The surveys and data is accessible through an on-line web portal.

COAA's KPIs

The COAA/CII model tracks an extensive set of KPIs focuses on project performance and productivity.

- Project Performance:
  - Cost
  - Schedule
  - Safety
  - Changes
  - Rework
- Project Productivity:
  - Engineering
  - Construction

COAA's web based KPI system "ranks" the subscriber's project performance within the performance range of their peers:

- **Median performance:** Provides the median value of all peer's projects under the KPI being considered.
- **Quartile performance:** Breaks down the dataset into quarters of performance, to allow subscribers to see the distribution of all peer's projects.
- **Sample Size:** Provides the number of projects that have entered values for the selected KPI.
- **Comparison Data:** Allows subscribers to compare the Alberta Data set to CII's US data set. In addition, different project types can be compared (Oil Sands SAGD vs. Pipeline projects).

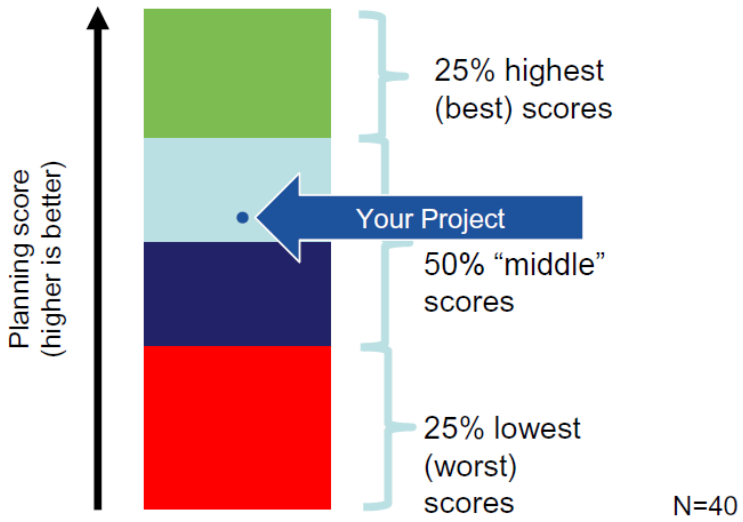
Alberta's industry benchmarking programs

COAA's benchmarking database focuses on recording project productivity on oil and gas related capital projects. The intention was two-fold: initially, to allow COAA members to benchmark their projects with that of their peers and determine improvements they may need to make; and second, as the database matured, to allow COAA to track productivity and report to all members important improvements at the industry level, to proactively improve productivity.

This ambitious program relied on detailed project-level KPI tracking under a number of over-arching metrics. An important aspect of COAA's database was a phased approach that demonstrated the value of KPIs to COAA members, while also building a large and detailed enough database for their improvement goals, a process that took several years.

The data is built up from project level surveys distributed to participating members, consisting of "owners" and "contractors". The surveys are over 100 pages long and very detailed. Subscribers access the data via a web-based dashboard, where they can select one of their projects for comparison to all projects currently being tracked in the database. All projects are categorized by "Quartile" ranking of performance to allow comparison without divulging individual project's performance, although the sample size tends to be small (Figure 37). Because the data is at the project level, only the subscriber has access to their respective data to protect subscriber's identities. More details about COAA's Project Performance Assessment, Project Productivity Assessment and its phased KPI deployment processes can be found in Appendix E.

Figure 37 COAA benchmarking output illustrating the quartile performance scoring system.



Benchmarking programs can provide highly granular, complete data that is built for the construction industry. KPIs are included under a range of categories including cost, schedule, safety, change and re-work, productivity (hr / unit rate, quantity installed in the field (e.g. concrete, steel, etc.) and so on. A list of metrics from the COAA HLPC is provided in Appendix E.

Certainly, in theory, if a large data set of accurate metrics is collected over time, this system can even provide a means for statistical trend analysis. However, few (if any) schemes have been able to prove this out in practice and this is primarily because the dataset is too small.

The data collection methodology employed by benchmarking programs requires an extensive use of surveys of firms and the data needs to be gathered over a long time to be useful. Such an approach certainly allows for fine grained analysis of data at the project or firm level and allows for firms to compare their performance against national averages. Further, benchmarking programs can help to normalise and habituate the practice of collecting and recording KPIs regarding productivity – something that is good business practice irrespective of the size of the firm.

However, given the effort involved, project- and firm-level benchmarking programs remain the purview of a few large companies on account of the resources and expertise required to engage with them effectively. There are only 58 contractor members of the CII benchmarking program of which only a few are active in Canada. Those that do participate are among the largest construction firms in the country – the likes of SNC-Lavalin, PCL, AECOM, Hatch, Kiewit, Turner, Jacobs, Fluor, Victaulic, Worley Parsons, etc.[20] In a similar vein, COAA's database now includes approximately 60 Alberta megaprojects. The datasets are small, comprising very large firms only and very, very large projects.

Further, these programs rely on companies self-reporting their data so analysis at the industry level is reliant upon aggregating up from the specific voluntary responses of individual firms and is therefore fraught with sampling issues.

In summary, corporate benchmarking for growth optimization can be valuable but, given the small datasets, the degree of administrative intensity, business involvement in providing the data and cost to participate, these programs are currently ill-suited to providing industry-level indicators.

"Benchmarking has been recognized as a core component of continuous improvement programs in the capital projects industry. Implementing specific benchmarking approaches on Alberta-based projects will provide the participating companies with a systematic process to measure project performance, enable external comparisons with peers' projects, and establish project objectives. Moreover, a comprehensive benchmarking system can identify areas for work process improvement."

COAA 2009 Summary Report

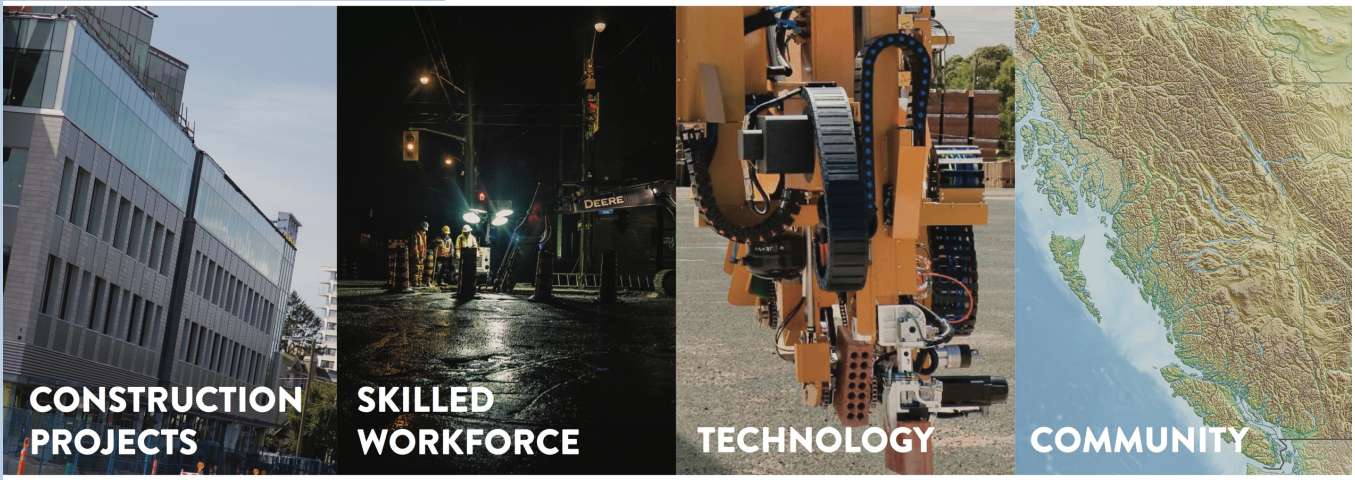
Because oil and gas projects can be very large, complex, and diverse, COAA has developed a hierarchical structure to ensure different COAA member's projects are compared to similar projects.

"Our vision is that British Columbia is home to a world-class construction sector that demonstrates exceptional productivity and resilience."

BCCA 2017-2020 Strategic Plan

7 Data strategy

To determine what data to collect and how best to organize it, it is important to align with the vision and priorities of leading firms as expressed by industry associations such as the VRCA and the BCCA.



BC's most trusted source of procurement expertise and project opportunities.	*Developing BC's construction workforce through demand-side expertise and input.*	*Fostering construction innovation and entrepreneurship.*	*Connecting our geographic, cultural, and business networks.*

BCCA's 2017 - 2020 strategic priorities

"We believe that excellence, underpinned by a culture of learning and innovation, is a critical factor for the survival and prosperity of VRCA's members and BC's construction industry as a whole.

Our Big Hairy Audacious Goal (BHAG) is to be Canada's premier construction centre of excellence by 2027. We believe that as a construction centre of excellence we will bring about the transformational change required by our members, the industry and society to navigate the future successfully, by catalyzing the adoption of best-in-class, innovative construction processes, technologies, materials, and business strategies."

VRCA 2017-2020 Strategic Plan

EDUCATE	ADVOCATE	FACILITATE
1. Foster a culture of continuous learning across the industry by providing world class technical and non-technical education and training.	2. Foster an environment that encourages collaboration, innovation, and adoption of standard practices in order to promote fair, open and transparent business practices across the industry.	3. Enable connections and opportunities across the industry by providing a range of business-oriented programs, services and support that include first- class networking opportunities.

4. Optimize the use of VRCA's building as an important educational and promotional tool for construction best practices.

5. Achieve full brand recognition as the premier Construction Centre of Excellence in Canada through VRCA's programs, services and advocacy work.

6. Lead by example through adoption of best practice board governance and operational processes and procedures that support delivery of VRCA's vision and mission.

7. Achieve long-term financial viability through exceptional leadership.

VRCA's 2017 – 2020 Strategic goals

It is proposed that, to start, the KPIs should be drawn from government statistics where possible supplemented by short surveys. Over time and on the strength of positive uptake by industry, greater reliance may be placed on surveys.

Figure 38 Recommended data collection strategy for BC.

Unit of analysis for data collection	Industry
Reporting levels	Industry
Data collection process	Longitudinal
Data collection source	Primarily external Some internal
Data collection methodology	National statistics, supplemented with surveys.

There are numerous options available to KPI measurement, many of which are onerous and do not return a meaningful view of the industry given the subjective nature of the collection methodology. Each has strengths and weaknesses and therefore the final selection will incur some trade-offs (Figure 39).

Figure 39 Strengths and weaknesses of potential KPI data sources

Data source	Strengths	Weaknesses
National or provincial statistics	• Trustworthy • Long-range • Free to access	• May not be up to date • May not be sector specific
Voluntary surveys	• Industry specific • Current data	• Low response rate may lead to sampling errors • Administrative burden

Generally, the findings from this review of KPI models align with research in Australia, which determined that using and reporting data collected at the industry level[21]:

- is efficient – the majority of data is already collected and is publicly available.
- can be sustained over the long haul, as significant high-level funding is not required for this specific activity.
- is less suspect to respondent error, and controls are in place to ensure quality of data collection in the various agencies.
- lends itself readily to time series analysis– which are critical to establishing trend data.
- enables the performance of the construction industry to be compared to the performance of other industries.

For BC, the proposed KPI data collection and reporting strategy would focus on the industry level to start (Figure 38, left). However, there may be discrete opportunities to extend to the firm level in the future, particularly when engaging with public owners, industry leaders on specific issues (e.g., adoption of BIM, zero emission buildings, etc.) and/or partnership with BCCA.

When developing a KPI program for BC it is important to start small and make the data meaningful to BC's construction businesses.

For BC, the proposed KPI data collection and reporting strategy would focus on the industry level to start. However, there may be discrete opportunities to extend to the firm level in the future, particularly when engaging with public owners, industry leaders on specific issues (e.g., adoption of BIM, zero emission buildings, etc.) and/or partnership with BCCA.

7.1.1 Start small

Measuring, reporting, and tracking KPIs can be a complex endeavour. KPIs need to be introduced deliberately and in small steps. It is strongly recommended to start with a simple set of KPIs in order to minimize the direct involvement of industry and the administrative burden.

KPIs generated by national and provincial statistics bodies complemented by a voluntary client satisfaction survey and a few KPI-related questions added to established survey processes will make participation easy. Longitudinal data collection processes (in which data is gathered for the same subjects repeatedly over a period of time) is key to establishing trends.

7.1.2 Make the data meaningful to businesses

Ensure the set of KPIs provide tangible data that can help construction businesses understand their industry and the market better. While action not data drives improvement, KPIs cannot tell businesses what the "right" thing to do might be but they can help illuminate and uncover new or poorly understood factors that can help inform decisions.

In the short term, this helps companies get used to reading and utilizing KPIs, prove their value and encourage others to participate. Long term, normalizing the use of KPIs means the administrator, industry and stakeholders can refine, add, and push the limits of what KPIs to track, making them progressively more valuable each year.

PART 3

NEXT STEPS

8 Addressing data gaps

Establishing an impartial, accurate picture of the health of BC's construction industry is the first step towards engaging stakeholders and "sets the table" for strategic and political decision-making.

This project undertook an initial exportation into the quality and availability of publicly available data relevant to construction. Several key data gaps emerged that require further research.

1. **Business performance**: many companies publish information on their websites and (large companies) through SEC filings that could offer an important understanding of financial performance, investment in R&D, sustainability, and CSR practices, philanthropic, and more. An annual review of websites and annual reports would be a substantial piece of work but would be very beneficial. Establishing a share index of publicly traded AEC firms might also be useful.
2. **Data broken down by industry sub-sector:** BC's construction industry is large and diverse, yet much of the data does not discriminate between the various key sectors – industrial, commercial, institutional, residential (large and small), civil infrastructure, road building, new construction, renovations and retrofits, operations, and maintenance etc. Business dynamics vary widely for businesses that operate in these different areas. More work needs to be done to create an accurate picture on a sub-sector basis related to workforce make-up and skills, unionization rates, sustainability, profitability, productivity and more.
3. **Owner satisfaction:** pilot survey questions for public owners were developed as part of this project. However, given that the concept of KPIs is new, it will be necessary to engage directly each organization to find the right person, introduce them to the program and then work through the data collection process, one-on-one.
4. **Technology adoption and R&D investment:** construction industries around the world are bracing for an unprecedented level of adoption of new and potentially disruptive technology. However, Statistics Canada stopped publishing data on investment in R&D by industry in 2013. A new methodology for collecting this data needs to be established.

Thirty KPIs are presented in this report of which twenty metrics are derived from publicly available data and can be published right away.

I. PERFORMANCE

Environment

- Building energy use (GJ/m^2) in BC
- GHGs from buildings and from construction activity in BC.
- Construction waste diverted (tonnes)

II. PEOPLE

Workforce

- Composition
- Youth in construction
- Wages
- Unionization

Education

- Qualifications (BC)

Safety

- Incident reports (BC)

Diversity

- Women in the workforce (BC)
- First Nations in the workforce (BC)

III. GROWTH AND RESILIENCE

Economic performance

- Industry size (BC)
- Productivity
- Business size & formation

Project pipeline

- Proposed projects
- Building permits
- Capital expenditures

Business costs

- Industrial product price indices in Vancouver
- Cost to build (median square foot) in Vancouver
- Interest rates

9 Moving forward

There is no question that the quality and relevance of the data improves with the degree of engagement by construction businesses. The more they are willing to share, the more accurate are the insights.

The following steps are suggested for the VRCA to consider as it moves forward with implementing a KPI program.

9.1 Publish an annual KPI report and build an online "dashboard"

Industry-level KPIs should be easy to access for both businesses and industry stakeholders.

- Once the final suite of KPIs has been selected for tracking, the easiest way to getting the KPI data to companies would be to publish an annual KPI report (PDF format).
- In time and on the strength of a positive response from industry, consider building an easy-to-navigate KPI dashboard and posting on the VRCA's website, so the data is easy to access.
- Explore the potential to secure funding to retain a consultant to design and build a KPI dashboard and easily updatable database.

9.2 Establish consistent KPI definitions and standards

There are several situations where data quality is poor (see Chapter 7) or where there are multiple sources for the same data, but the collection methodology differs.

- Encourage industry leaders across the country to work together to establish common definitions and standards for key metrics.
- Advocate to data providers (such as Statistics Canada) to develop and track information in a format and level of granularity that is useful to the construction industry.
- Initiate a client satisfaction survey to gauge predictability of project delivery (assist with survey completion if necessary).

9.3 Ensure the data is handled properly

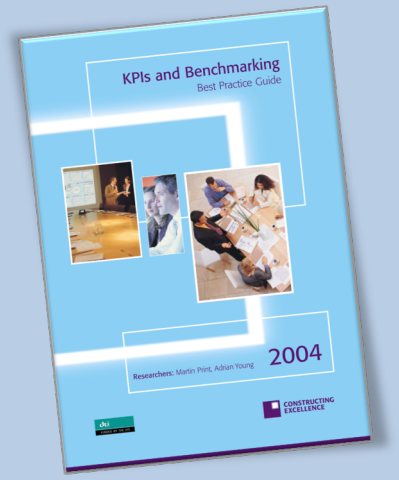
It is imperative that businesses trust the data and trust that the data they provide is properly protected. While KPIs may reveal that BC's construction industry is doing better than might be expected in certain areas, it is also possible that, to start, the data may point to disappointing performance or may uncover significant gaps. Bad news, in particular, is more easily believed and acted upon if it comes from a reputable source.

- To ensure the KPI program is without political bias, it is advisable for it to be administered by an independent third party, similar to CII's relationship with COAA or Glenigan for the Constructing Excellence scheme in the UK. A knowledgeable 3rd party partner helps alleviate client or public concern regarding the data's trustworthiness.
- Ensure the data collection process must comply with all relevant national and provincial privacy and cyber security regulations.
- Beyond compliance, data collection and management needs to respond to industry sensitivities about potential exposure of proprietary information.

9.4 Minimize administrative intensity

Behind the scenes, the KPI program should not be a burden to the VRCA's administration in terms of either cost or time.

- Publish the KPI report only once a year. Once a template has been established, the process to update can be quite simple.
- Once a digital dashboard design has been built, annual updates can be largely automated.
- Share program administration across leading construction associations (starting, for example, with a pilot in Western Canada) to reduce the burden while building a community of practice among leading companies and stakeholders.
- Leverage the leading-edge work currently underway within organizations such as NAIT's Productivity and Innovation Centre[22] and Alberta-based GO Productivity[23] wherever possible.



Tips for businesses starting their own performance measurement systems

In 2004, Constructing Excellence noted 9 "best practices" for KPIs.[24]

- Believe in measurement
- Start simple.
- Measure what's important
- Communicate effectively – let the data speak
- Have clear responsibility, not bureaucracy
- Use appropriate technology
- Become a data-based decision maker
- Action, not data, drives improvement
- KPIs and partnering go together

This practical "How-to" guide could form an important educational resource to BC construction businesses.

9.5 Be patient

Program growth will be slow and conditional upon regular communication with businesses. A challenge for some programs has been that they were administered by academic / research establishments that were remote from industry making it difficult to provide feedback.

- Plan for the fact that it is going to take time for the KPIs to achieve the requisite data quality and provide useful insights.
- While it important for a KPI program to be impartial, it is also necessary for it to engage fully and regularly with construction businesses and industry stakeholders.

9.6 Celebrate leadership

For a KPI program to be successful, industry needs to be invested in the process and believe in the benefits -whether it is for a company to compare its own performance to improve its competitive edge or s to lift industry performance overall.

- There are owners and managers that are leading the way on performance measurement. It is already integral to their role: it helps them set goals, measure achievement, and unify the direction of the organization. Engage these individuals to become KPI "ambassadors" to build participation and protect the program from being seen as a "flavour of the month".
- Establish a "best practice club" to share ideas and lessons learnt.
- Provide business management education for those firms that have no fundamental confidence in performance measurement.

APPENDICES AND REFERENCES

Appendix A: Research methodology

Primary KPI contacts

The research for this report included contact with the model providers from BCCA, Glenigan and COAA. Some of these representatives provided answers to our questions or gave their insight from their experiences. During the next steps, representatives from these organizations will be valuable resource for setting up the VRCA's own KPI Model.

This report was initiated as a framework document for construction associations like the VRCA to setup and operate their own KPI metrics system. Objectively, KPI tracking can achieve a range of value propositions and fulfill different objectives; but all achieve this by providing a means for data and evidence-based decision-making. What the decisions are being made for is up to the adopting associations.

Therefore, the research needs to understand what other models were trying to achieve, and what "pieces" (metrics, data sources and collection systems, participation expectations, etc.) were used to build the KPI system to support the objective. From this, BC/Alberta based construction associations can understand the requirements for building and operating a successful KPI system for their specific objectives. This was achieved through 4 tasks:

Task 1: Secondary research of existing models

Drawing on national and international best practices, the first task involved collecting information on potential industry KPIs applicable to the Canadian context. The KPIs reviewed needed to be in operation for several years and have reported KPI data back to industry audiences more than once.

- Identify available data sources in Canada and assess for reliability and rigour.
- Determine what KPIs others have collected and why, and consider its use by local construction associations.
- Determine the characteristics that make KPIs useful and simple to understand.
- Identify gaps / important information that is not currently collected, that may be useful for local construction associations.
- Analyse KPIs in the context of delivering sufficient and useful information in a reasonably timely manner.
- Develop a summary of secondary research findings to support the recommendations of the final report (Task 3).

Task: Industry consultation

Originally intended to be completed after information collection from Task 1, to gather feedback and commentary from VRCA members and experts regarding the secondary research findings. However, the VRCA leadership decided to forgo this task, focusing on finishing the final report, and receiving feedback for report's final findings and recommendations.

Task 2: Draft the KPI framework and collection methodology

Based on analyses of secondary research findings, and considering the originating BCCA survey from 2015, develop a draft KPI framework, describing the metric, the provenance, and the value proposition.

- Articulate the collection criteria and the burden of effort that may be imposed on construction companies.
- Demonstrate how KPIs might be used in BC's industry setting.
- Address issues of privacy (e.g., data anonymity).
- Develop information delivery model that meet the needs of industry stakeholders (published data, reports, mock-ups, etc.)
- Examine the pros and cons of different roll-out strategies.
- Create and issue a data collection pilot (i.e., client satisfaction survey) to demonstrate the proposed KPI model's operation, while collecting useful, relevant data.

Task 3: KPI program business plan / pricing strategy

Based on acceptance of the draft KPI framework, prepare a draft budget and business plan to administer the program. The intent is to help construction associations with assessing the need and seek funding, and to eventually create stand-alone, self-sustaining KPI models.

Task 4: Final report

Summarise all tasks in this report, describing the considerations, trade-offs and logistics of creating a long-term, value-driven KPI tracking system.

The following survey was developed for future use by the VRCA to gauge the satisfaction of public owners with their recent construction projects and experiences.

Appendix B: Client satisfaction survey

STEP A – Data Calculator

Please fill in all white data boxes with your project data to quickly calculate the values you will need for the survey.

Tell us about the building projects that your organization have/had in progress during 2018. These are projects that either started construction, were in the midst of the construction process or were substantially completed:

Enter data for all projects completed in 2018:

Examples provided in blue - please delete and replace.

Projects	**Tender Price**	**Completion Price**	Price Delta	**on time**
1	$1,000,000	$1,111,000	***11.1%***	x
2	$1,000,000	$988,000	-1.2%	
3	add more projects		#VALUE!	
4			#DIV/0!	
5			#DIV/0!	
6			#DIV/0!	
7			#DIV/0!	
8			#DIV/0!	
9			#DIV/0!	
10			#DIV/0!	
11			#DIV/0!	
12			#DIV/0!	
13			#DIV/0!	
14			#DIV/0!	
15			#DIV/0!	

Total Tender Price	Total number of completed projects	Total Completion Price at substantial completion
$2,000,000	2	$2,099,000

STEP B - Survey Answers

The Excel workbook will automatically calculate some of the answers from the project calculator in Step A.

Q1 Tell us about the building projects that your organization has in progress during 2018, that either started construction, were in the midst of the construction process or were substantially completed (answers calculated from Project Data sheet):

Total number of active projects **2**

Total value of active projects **$2,000,000**

Q2 Of the projects completed in 2018, what proportion were "on budget"(answers calculated from Project Data sheet)?

Total number of projects where the final price at substantial completion was within +/- 5% of the tender price: **1**

Total value of projects where the final price at substantial completion was within +/- 5% of the tender price: **$0**

The % difference between tender price and the price at substantial completion for all of your projects cumulatively (S all tender prices / (S all completion prices – S all tender prices) **4.95%**

Q3 If there were price differences between tender and substantial completion, what were the causes?

Comment Please complete

Q4 Of the projects that your organization completed in 2018, what proportion were "on schedule" (answers calculated from Project Data sheet)?

Total number of projects that were completed on or before the predicted date **1**

Total value of projects that were completed on or before the predicted date **$1,111,000**

Q6 Please describe the metrics your organization uses to track the predictability, reliability and performance of your projects.

Comment Please complete

Q7 Considering all of your projects that achieved substantial completion in 2018, the number of defects and call backs were (select ONE answer that best represents your experience):

- Much more than expected
- More than expected
- As expected
- Less than expected
- Much less than expected

Q8 The most common causes of defects and call backs were (select ALL that apply):

- Incomplete Construction Documents
- Poor workmanship
- Compressed construction schedule
- Compressed design schedule
- Poor communication between owner & consultants
- Poor communication between consultants & contractor
- Other (please specify)

Q9 Using a 10-point scale; with 1 being "very unsatisfied" and 10 being "very satisfied"), please rate your overall satisfaction with the projects that you have been involved with over the past 12 months:

- Consultant design services
- Contractor construction services
- Consultant-contractor construction coordination
- The quality and performance of the building at substantial completion
- The quality and performance of the building at the end of the 1-year warranty

Q10 Where are the majority of your projects located?

Please complete

Appendix C: BCCA strategic metrics

The BCCA's 2017 – 2020 Strategic Plan proposes the following measures as a means to benchmark the value it provides to members. However, most of the metrics offer a means to monitor industry performance as a whole.

1. Construction projects

- Annual procurement assessment measuring the quality of the tendering process for major public projects via the introduction of a **Public Procurement Quality Index** NEW
- Access to information and training for government procurement professionals
- Number of professional, compliant, in-budget bids received on infrastructure projects
- Number of public projects operating within industry guidelines for fair and transparent processes
- BC's largest directory of trade contractors, facilitating wider access to project opportunities across the province
- Number of public projects in BidCentral
- Number of private projects in BidCentral
- Number of Prebid projects in BidCentral
- Number of contractors accessing online project opportunities

2. Skilled workforce

- Number of young British Columbians entering the trades
- Size of the projected skills gap
- Proportion of women, New Canadians, First Nations, and those with disabilities in the construction workforce, and particularly in apprenticeship programs
- Data tracking in regard to the demographic composition of BC's skilled construction workforce
- Annual safety, health, and financial metrics via the introduction of the **BCCA Skilled Tradesperson Satisfaction Index** NEW
- Number of construction workers holding up-to-date safety credentials
- Number of construction employers offering robust benefits plans

3. Technology

- Annual construction technology adoption and awareness metrics via the introduction of the **BCCA Construction Technology Index** NEW
- Number of BC construction companies adopt new technologies that improve processes and project outcomes
- Number of Made-in-BC construction technologies introduced and developed
- Direct collaboration between BC's construction and technology sectors

4. Community

- BCCA "Stat Pack" spotlighting key indicators and trends that measure the activity and requirements of our industry
- Level of collaboration and networking in the industry measured via the introduction of a **Construction Partnership Index** NEW

Appendix D: UK Industry Performance Report

The UK Industry Performance Report is laid out in the form of a summary of insights and then a series of tables and charts. The economic indicators are the most extensive (Figure 40).

Figure 40 UK Industry Performance Report: Economic KPI summary - all construction

KPI	Measure	Performance																	Trend	
		1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013/14	2015	2016	Last Year	All Years
Client Satisfaction - Product	% scoring 8/10 or better	72%	73%	72%	73%	78%	80%	83%	84%	82%	83%	86%	87%	87%	83%	82%	81%	85%	▲	▲
Client Satisfaction - Service	% scoring 8/10 or better	58%	63%	63%	65%	71%	74%	77%	79%	75%	77%	84%	82%	80%	75%	75%	73%	77%	▲	▲
Client Satisfaction - Value for Money[1]	% scoring 8/10 or better	-	-	67%	69%	73%	74%	79%	80%	75%	75%	82%	77%	81%	78%	75%	74%	76%	▲	▲
Contractor Satisfaction - Performance - Overall[1]	% scoring 8/10 or better	-	-	-	-	64%	65%	63%	62%	62%	62%	64%	69%	69%	75%	74%	69%	74%	▲	▲
Contractor Satisfaction - Provision of Information - Overall[1]	% scoring 8/10 or better	-	-	-	-	57%	59%	58%	56%	56%	56%	59%	63%	64%	73%	69%	69%	73%	▲	▲
Contractor Satisfaction - Payment - Overall[1]	% scoring 8/10 or better	-	-	-	-	67%	66%	65%	65%	63%	63%	67%	71%	77%	80%	79%	81%	79%	▼	▲
Defects - Impact at Handover[1]	% scoring 8/10 or better	-	65%	53%	58%	68%	68%	72%	77%	73%	73%	77%	75%	68%	74%	71%	73%	73%	▶	▲
Predictability Cost - Project[1]	% on cost or better	-	50%	46%	48%	52%	50%	48%	45%	46%	49%	48%	52%	63%	61%	69%	69%	68%	▼	▲
Predictability Cost - Design	% on cost or better	65%	64%	63%	63%	65%	62%	63%	66%	64%	65%	61%	67%	79%	79%	79%	75%	70%	▼	▲
Predictability Cost - Construction	% on cost or better	37%	45%	48%	50%	52%	49%	48%	44%	49%	48%	46%	47%	59%	58%	57%	56%	64%	▲	▲
Predictability Time - Project[1]	% on time or better	-	28%	36%	42%	44%	44%	46%	44%	58%	45%	45%	43%	45%	34%	45%	40%	41%	▲	▲
Predictability Time - Design	% on time or better	27%	37%	41%	46%	53%	55%	52%	57%	58%	58%	53%	69%	51%	48%	52%	53%	48%	▼	▲
Predictability Time - Construction	% on time or better	34%	62%	59%	61%	59%	60%	62%	60%	65%	58%	59%	57%	60%	42%	57%	48%	55%	▲	▼
Profitability[1]	Median % profit before interest & tax	-	4.4%	5.1%	5.2%	5.4%	7.0%	8.1%	7.9%	8.2%	9.6%	9.9%	7.7%	5.0%	2.7%	2.1%	2.8%	2.5%	▼	▼
Productivity (VAPE Current Values)[1]	Median value added/ FTE employee (£000)	-	27	28	28	31.1	32.6	34.2	38.2	42	45.5	46.2	49.5	58.5	60	63.8	66	69	▲	▲
Productivity (VAPE Constant 2012 Values)[1]	Median value added/ FTE employee (£000)	-	43.9	43.2	41.1	43.1	42.4	42.7	44.5	46.5	47.9	46.8	50.4	61.2	61.9	62.8	62.1	63.7	▲	▲

The UK Industry Performance Report uses the following definitions for its key economic KPIs[25]:

- **Profitability:** Company profit before tax and interest as a percentage of sales.
- **Productivity**: Company value added per employee (£). Value added is turnover less all costs subcontracted to, or supplied by, other parties.
- **Construction cost:** The normalised construction cost of a project in the current year, less the construction cost of a similar project one year earlier, expressed as a percentage of the construction cost of a similar project one year earlier.

Normalisation is a statistical method for removing the effects of specification, location, function, size and inflation.

- **Construction time:** The normalised time to construct a project in the current year, less the time to construct a similar project one year earlier, expressed as a percentage of the time to construct a similar project one year earlier.

Construction consultants KPIs

The UK Industry Performance Report tracks the following KPIs for consulting services. They are all measured based on the percentage scoring 8/10 or better:

- Client Satisfaction-Overall
- Client Satisfaction-Value for Money
- Client Satisfaction-Quality of Service
- Client Satisfaction-Timely Delivery

The UK Industry Performance Report pulls out the following economic indicators for housing, and non-housing:

KPI	Measure
Client Satisfaction - Product	% scoring 8/10 or better
Client Satisfaction - Service	% scoring 8/10 or better
Defects - Impact at Handover	% scoring 8/10 or better
Predictability Cost - Project	% on cost or better
Predictability Cost - Design	% on cost or better
Predictability Cost - Construction	% on cost or better
Predictability Time - Project	% on time or better
Predictability Time - Design	% on time or better
Predictability Time - Construction	% on time or better

Respect for People KPIs - all construction

KPI	Measure
Staff Turnover - All Companies	Median % staff turnover
Sickness Absence - All Companies	Median number of days lost
Safety – Industry	Mean accident incidence rate
Working Hours	Median usual hours worked per week
Qualifications & Skills	Median usual hours worked per week
Training	Median annual training days per full-time equivalent employee
Investors in People	Mean % of direct employees covered by IiP commitment & recognition
Staff Loss	Median % direct employees who left employment
Construction Skills Certification Card (CSCC)[26]	Median % direct employees that hold a CSCC
Make-up of Staff – Women	Median % women employed Mean % women employed
Make-up of Staff - People from BME	Median % people from black or minority ethnic backgrounds
	Mean % people from black or minority ethnic backgrounds
Make-up of Staff - Aged under 24	Median % people employed aged under 24
	Mean % people employed aged under 24
Make-up of Staff - Aged over 55	Median % people employed aged over 55
	Mean % people employed aged over 55
Make-up of Staff - Disabled People	Median % people employed who are disabled
	Mean % people employed who are disabled

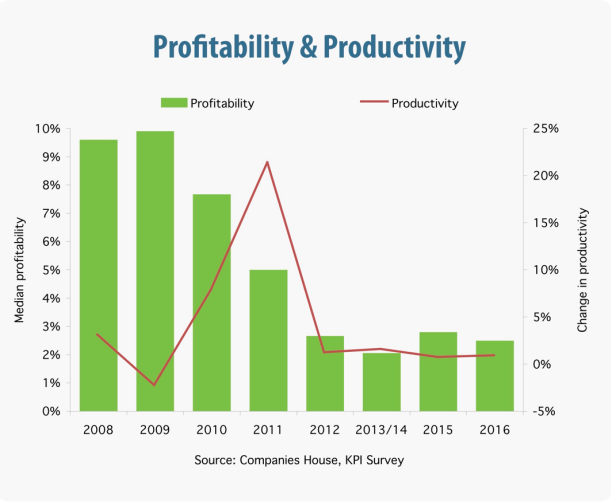
Environment – all construction

KPI	Measure
Product Performance	
Energy use (Designed)	Median energy use kg CO2 / 100m2 gross floor area
Energy use (Designed) - Housing SAP Rating	Median SAP2001 rating
Energy use (Designed) - Housing SAP Rating	Median SAP2005 rating
Mains water use (Designed)	Median water use m3 / 100m2 gross floor area
Construction Process Performance	
Energy Use (Current Values)	Median energy use kg CO2 / £100k project value
Energy Use (Constant 2012 Values)	Median energy use kg CO2 / £100k project value
Mains Water Use (Current Values)	Median water use m3 / £100k project value
Mains Water Use (Constant 2012 Values)	Median waste removed from site m3 / £100k project value
Waste (Current Values)	Median movements onto site / £100k project value
Waste (Constant 2012 Values)	Median movements onto site / £100k project value
Commercial vehicle movements (Current Values)	Median energy use kg CO2 / £100k project value
Commercial vehicle movements (Constant 2012 Values)	Median energy use kg CO2 / £100k project value

Productivity and profitability

Collecting data from firms on productivity and profitability is rife with challenges. The most effective method is to aggregate and anonymize benchmarking data from firms that participate in proprietary programs such as the KPI Engine which feeds into the UK Industry Performance report, or the CII benchmarking tool that underpins the COAA model discussed in Section 6.3. The key issues are that these programs are only used by a few large firms and the data is self-reported.

Figure 41 UK Industry KPIs: profitability and productivity performance (2017)



Source: 2017 Industry Performance Report, Glenigan

Predictability

The UK Industry Performance Report relies on a large number of quantitative metrics that attempt to capture how effective the UK construction industry is at bringing projects in on time and on budget. Industry stakeholders such as owners, policy makers and researchers find this data very useful for capital planning, developing and pacing the adoption of new codes and standards, targeting investments in R&D, and more. However, collecting the data can be challenging as it requires businesses to report at the project scale and for the data from all participating companies to be rolled up into an industry-level aggregate.

Predictability of cost

There are three indicators- one for design cost, one for construction cost and one for project cost.

1. **Design Cost** - actual cost of the design process at "Available for Use" stage less the anticipated cost of the design process at "Commit to Invest" stage, expressed as a percentage of the anticipated cost of the design process at Commit to Invest.
2. **Construction Cost** - actual cost of the construction process at Available for Use less the anticipated cost of the construction process at "Commit to Construct" stage, expressed as a percentage of the anticipated cost of the construction process at Commit to Construct.
3. **Project Cost** - actual cost of the combined design and construction process at Available for Use less the anticipated cost of the combined design and construction process at Commit to Invest, expressed as a percentage of the anticipated cost of the combined design and construction process at Commit to Invest.

Predictability – time

There are three indicators- one for the design phase, one for the construction phase and one for the whole project.

Design Time - actual design duration of the design process at "Commit to Construct" stage less the anticipated duration of the design process at Commit to Invest, expressed as a percentage of the anticipated duration of the design process at Commit to Invest.

Construction Time - actual duration of the construction process at Available for Use less the anticipated duration of the construction process at Commit to Construct, expressed as a percentage of the anticipated duration of the construction process at Commit to Construct.

Project Time - actual duration of the combined design and construction process at Available for Use less the anticipated duration of the combined design and construction process at Commit to Invest, expressed as a percentage of the anticipated duration of the combined design and construction process at Commit to Invest.

Appendix E: COAA KPI assessment

Project Performance Assessment allows COAA subscribers to compare their performance at the project level, inclusive of different firm's potential differences (e.g. strengths and weaknesses). While CII's proprietary set of KPIs are large and wide ranging, COAA subscribers decide for themselves which KPIs they wish to track, that would give them the most value. Given this range of KPIs available from CII, the KPIs reported in 2015 can be very detailed (e.g. concrete slabs broken down to on-grade, elevated slabs, area paving). Safety was not reported in 2015, but is an on-going priority and an important part of Phase 3's objectives.

COAA Project Performance Assessment

Eighty categories of Project Performance KPIs are organized hierarchically and are tracked and reported by COAA in the Phase 2 Report, which was issued 2015 (Figure 43 and Figure 42).

Figure 42 COAA/CII Project KPI categories and measures

KPI	Measure
Project Cost Growth	Actual Project Cost – Initial Predicted Project Cost / Initial Predicted Project Cost
Project Schedule Growth	Actual Project Duration – Initial Predicted Project Duration / Initial Predicted Project Cost
Construction Cost Growth	Actual Construction Cost – Initial Predicted Construction Cost / Initial Predicted Construction Cost
Construction Cost Factor	Actual Construction Phase Cost / Actual Total Project Cost
Engineering Design	% Design completion at the start of construction
Construction Schedule Growth	Actual Construction Duration – Initial Predicted Construction Duration / Initial Predicted Construction Duration
Contingency/Budget (%)	% size of the project's contingency compared to the project's sanction budget
Modularization	Degree of modularization

Figure 43 COAA/CII Project Hierarchical Structure

Level 1	Level 2	Level 3
Upstream (Oil Exploration/ Production)	Oil Sands SAGD	Cogeneration
		Central Plant Processing Facilities
		Pad and Gathering
	Oil Sands Mining/ Extraction	Oil Sands Mining
		Central Plant Processing Facilities
Downstream	Oil Sands Upgrading	Naptha Hydrotreater Unit
		Hydrogen Plant
	Oil Refining	Utilities and Offsite
Natural Gas	Natural Gas Processing	
Pipelines		
Well Sites / Well Pads		

COAA Project Productivity Assessment

Project Productivity KPIs are broken down into 2 categories of metrics, Engineering and Construction, quantified with the simple formula of hours of work to quantity. In other words, how many hours of labour are expended for a given quantity of work.

This simple formula for productivity is simple and easy to understand, and generally align with estimating and common practice in the industry.

Engineering Productivity

Engineering design is broken down into 4 divisions of work:

KPI	Measure
Structural Steel	Actual Direct Design Work Hours / Issued for Construction Quantity
Piping	
Wire and Cable	
Equipment	

Construction Productivity

Construction is broken down further into 11 divisions of work:

KPI	Measure
Structural Steel	Actual Installed Direct Work Hours / Installed Quantity
Piping	
Concrete	
Insulation (Piping)	
Electrical Equipment	
Instrumentation Devices	
Cable Tray	
Wire and Cable	
Electrical Heat Tracing	
Scaffolding	

An additional metric included with the Construction Productivity attempts to capture indirect work as a result of the direct work hours. COAA strictly defines what is direct or indirect, to ensure comparability between projects.

KPI	Measure
Construction Indirect and Direct Work Hours	Indirect Work Hours / Direct Work Hours

Definitions

Lagging indicators: KPIs that quantify something that has already happened, "how much of the project was completed as a result of that work."

Leading indicators: KPIs that provide indication of positive outcomes for lagging indicators; in COAA's case, members answer surveys that rank the top leading indicators.

Best practice: CII has created 10 "best practice" categories that bridge COAA member's leading indicators with related KPIs. This allows analysis of whether the leading indicator is indeed, leading to better outcomes.

COAA phased KPI deployment: lagging to leading

COAA phased the introduction because of their initial goal of developing an Alberta-specific dataset for benchmarking (using the CII KPI model). KPI benchmarking started with the normalization of the practices required to utilize KPIs, and the long-term commitment to collect Alberta specific data.

The KPI program has now been running for 10 years, with a sizable dataset collected and reasonable number of firms participating in the program. This facilitates the primary goal: described as "lagging to Leading".

Phase 3 utilizes CII's "10-10 Program", which takes the KPI dataset to set a "benchmark performance" for the industry. Then, a survey of COAA members who have submitted projects to the KPI system determined what they believe were "leading indicators" of better outcomes (i.e., lagging indicators show better performance than benchmark).

CII's 10-10 classifies the 10 leading indicators under 10 categories, and determines which KPI relate to them via 10 best practice categories:

Leading indicators	Best practices
Planning	Front End Planning
Organizing	Constructability
Leading	Project Risk Assessment
Controlling	Planning for Start-up
Human Resources	Alignment
Quality	Team Building
Sustainability	Change Management
Supply Chain	Quality Management
Safety/EHS	Material Management
Design Efficiency	Zero Accident Techniques

This provides the basis for analysis: for example, COAA members who felt they did poorly on leading indicators related to front-end planning for constructability, tended to have worst cost growth for contractors during construction.

The aim is to track what activities improves productivity and was does not, and disseminating that information to COAA members. This type of analysis is only available to COAA KPI participants: Phase 3 seeks to demonstrate the value of this analysis to increase participation and grow the dataset further, making the KPI analysis even more useful.

COAA's High Level Productivity Calculator (HLPC) is designed to enable a project and its craft disciplines to be benchmarked against a validated project index (Figure 44).

Figure 44 COAA HLPC input sheet

Data Description	Data Guidance
Company Name	*Text*
First Name	*Text*
Last Name	*Text*
Email	*Email Format*
Project Name	*Text*
Country	*U.S. or Canada*
State or Province	*Text*
City	*Text*
Zip Code	*U.S. or Canada Format*
Total Installed Cost	*Whole Number*
Project Class ID	*Picklist*
Project Type ID	*Picklist*
Industry Type ID	*Picklist*
Project Status ID	*Picklist*
Start Date	*mm/dd/yyyy*
End Date	*mm/dd/yyyy*
Project Total Recordable Incident Rate (TRIR)	*Up to 2 Decimal Places*
Direct Work Hours	*Whole Number*
Indirect Work Hours	*Whole Number*
Measurement System	*Picklist: Metric or Imperial*
Onsite Total Concrete	*Whole Number (Yd^3 / M^3)*
Onsite Total Concrete Work Hours	*Whole Number*
Onsite Total Structural Steel	*Whole Number (Tons / MT)*
Onsite Total Structural Steel Work Hours	*Whole Number*
Onsite Electrical Wire	*Whole Number (LF / LM)*
Onsite Electrical Wire Work Hours	*Whole Number*
Onsite Total Piping	*Whole Number (LF / LM)*
Onsite Total Piping Work Hours	*Whole Number*
Onsite Instrument Devices	*Whole Number (EA)*
Onsite Instrument Devices Work Hours	*Whole Number*
Onsite Insulation Piping	*Whole Number (ELF / MLF)*
Onsite Insulation Piping Work Hours	*Whole Number*
Onsite Total Equipment	*Whole Number (EA)*
Onsite Total Equipment Work Hours	*Whole Number*
Onsite Modules Skids	*Whole Number (EA)*
Onsite Modules Skids Work Hours	*Whole Number*
Onsite Total Scaffolding Work Hours	*Whole Number*
Offsite Modules Skids	*Whole Number (EA)*
Offsite Modules Skids Direct Work Hours	*Whole Number*
Offsite Modules Skids Indirect Work Hours	*Whole Number*
Full-time Equivalents (FTEs)	*Up to 2 Decimal Places*
Engineering deliverables were released in a timely manner to support construction operation?	*Satisfaction Scale Picklist*
Engineering deliverables were complete and accurate (minimal errors and omission)?	*Satisfaction Scale Picklist*

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3 Print, M., Young A.,"KPIs and Benchmarking Best Practice Guide", for Constructing Excellence and the DTi, 2004 www.constructingexcellence.org.uk

4 www2.gov.bc.ca/gov/content/environment/climate-change

5 https://data.vancouver.ca/datacatalogue

6 Certified B Corporations are a new kind of business that balances purpose and profit. They are legally required to consider the impact of their decisions on their workers, customers, suppliers, community, and the environment. This is a community of leaders, driving a global movement of people using business as a force for good. More information is available at https://bcorporation.net

7 https://news.gov.bc.ca/factsheets/community-benefits-agreement

8 www.astm.org/Standards/E2691.htm

9 www2.gov.bc.ca/gov/content/data/statistics/economy/business-formations-failures

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20 CII member companies are listed at www.construction-institute.org/membership/member-list

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25 The UK Construction Industry Key Performance Indicators are produced by a partnership of the Department for Business, Innovation & Skills and Constructing Excellence using data from the Office for National Statistics, Building Cost Information Service, Health and Safety Executive, Dun & Bradstreet and other third-party financial analysts. Definitions are cited from Chapter 16 of "Construction Statistics - Chapter 16 - Key Performance Indicators and Benchmarking, No. 11, 2010 Edition", published by the Office of National Statistics, UK.
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26 The UK Construction Skills Certification Scheme (CSCS) is the leading skills certification scheme within the UK construction industry. CSCS cards provide proof that individuals working on construction sites have the required training and qualifications for the type of work they carry out. The scheme keeps a database of people working in construction who have achieved or are committed to achieving a recognised construction related qualification. Holding a CSCS card is not a legislative requirement. It is entirely up to the principal contractor or client whether workers are required to hold a card before they are allowed on site. However, most principal contractors and major house builders require construction workers on their sites to hold a valid CSCS card.
www.cscs.uk.com