Joint CSCE Construction Specialty & CRC Conference 2025
Conférence conjointe spécialisée en construction de la SCGC et CRC-2025

Montreal, Quebec
July 28-31, 2025 / *28-31 juillet 2025*

A LITERATURE REVIEW ON GLOBAL CONSTRUCTION PRODUCTIVITY MEASUREMENT: A CROSS-SECTORAL APPROACH

A. Niaz[1], A. Mehdipoor,[1,*4], A. Kasundra,[1], M. Fawad,[2], Q. Chen[2], and A. Thompson[1,3*]

[1] Construction Research Centre, National Research Council of Canada, Ottawa, ON
[2] School of Engineering, The University of British Columbia, Kelowna, BC
[*3] alexandra.thompson@nrc-cnrc.gc.ca
[*4] amirhossein.mehdipoor@nrc-cnrc.gc.ca

ABSTRACT: Advanced construction practices such as Modern Methods of Construction (MMC) have gained significant traction across construction sectors globally with the US and Europe reporting $22 billion in annual cost savings and $1.6 billion in capital productivity gains by scaling MMC practices in 2019 as reported by McKinsey & Co. The Canadian construction sector in recent years has not achieved similar returns to scale on its productive capacity, with the last quarter of 2023 and the first quarter of 2024 marking record decade-lows in construction capacity utilization as reported by Statistics Canada. In the context of this shortfall, this study analyzes how these respective gains in productivity were recorded for construction projects completed outside Canada. To understand how advanced construction practices have enhanced the measurable value of construction projects globally, this paper undertook a literature review of academic and industry literature to analyze the constituent dimensions of productivity across 38 non-Canadian guidelines and frameworks documenting construction productivity practices using either traditional or MMC-based techniques. Reviewing this evidence yielded a final list of 12 empirical productivity frameworks used across real-world projects. Due to their standardized processes and metrics, the productivity measurement practices from these frameworks can be adapted to both conventional and MMC-based projects across sectors spanning building types dedicated for residential, commercial, and mixed-use cases. The subsequent findings identified opportunities to enhance current performance measurement practices for Canadian builders. These findings could potentially guide domestic operators in benchmarking their performance in line with global frameworks and identify areas for further standardization.

1. INTRODUCTION

The Canadian Construction Sector in recent years has stagnated in terms of achieving full returns to scale on its full industrial capacity, with the last quarter of 2023 and the first quarter of 2024 marking record decade-lows in terms of productive capacity utilization (clocking in at 82.6% and 82.7% respectively) (Statistics Canada, 2024). One proposed method to remedy this decrease in industrial productivity is to use Modern Methods of Construction (MMC) techniques which cover practices such as prefabrication, and panelisation constituting off-site construction.. Uptake for these techniques is expected to increase in North America, Europe, and Asia–Pacific while interest in adapting these practices continues to grow among economies in South America, Africa and the Middle East (Perera et al. 2022).

A key barrier to enhancing and sustaining comparable levels of productivity within the Canadian construction industry is the lack of a standardized approach to measuring the productivity value of specialized techniques. Traditional productivity measurement frameworks, such as those by Momaya and Selby (1998), have primarily focused on general industry metrics like direct costs and labour hours. However, with the growing adoption of MMC-based techniques (such as volumetric construction, twin wall technology, and thin joint masonry), these conventional measures are insufficient as MMC introduces additional considerations such as health and safety, environmental impact, and process efficiency. Therefore, refining earlier productivity assessment models to incorporate these broader factors is essential to fully capture the benefits and challenges associated with MMC adoption in Canada. Therefore, this review will identify global best practices for productivity measurement and potentially, normalize adopting advanced construction practices among cautious industry practitioners.

Examining three categories of building types (Residential, Commercial, and Mixed-Use) in terms of what productivity measurement practices have been used enables a like-for-like comparison between these categories. These categories were defined by Bello et al. (2024) in terms of their representation among commonly built environment structures for architectural, engineering, and construction (AEC) industries globally where MMC-based construction techniques have seen adoption. Reviewing these projects highlights the differences that exist in measurement indicators and processes across building types that may have adapted advanced techniques (such as MMC-derived practices) to various extents.

To supplement the primary literature documenting productivity frameworks, guides devised by international construction accreditation bodies and regional industry associations were also referenced. This was done to understand how potential frameworks may have developed from an institutionalized lens which may have captured localized nuances not otherwise documented in scientific literature. Additionally, in order to standardize the process of comparing the extracted frameworks across building types, the CIRIA C792 (Jansen Van Vuuren and Middleton; 2020) and the Construction Productivity Taskforce (CPT) 7-Step (Construction Productivity Taskforce, 2022) frameworks were respectively used to compare process and indicator differences across the frameworks and building types covered as part of this review.

While past literature has detailed how MMC-based techniques (such as off-site construction) enhanced project productivity for various building types, external industry factors often complicate performing cross-sectional analyses for productivity measurement processes (Park et al., 2005). Instead, findings by McIntosh et al. (2021), a cross-sectoral analysis of the existing evidence critiquing advanced practices provided enhanced insights on adapting these practices effectively to a localized context. For this review, this entails adapting practices from off-site construction projects completed globally to a Canadian context.

Based on the various cases for off-site construction globally and how these contribute towards enhancing productivity measurement practices in Canada, the following research objectives were devised:

Research Question 1. What are the key differences in productivity measurement practices across residential, commercial, and mixed-use construction sectors globally?

Research Objective (RO) 1. Identify differences in productivity measurement processes across different building types part of construction sectors globally.

Research Question 2. How can the productivity Key Performance Indicators (KPIs) from global frameworks be categorized into performance areas specific to each sector?

Research Objective (RO) 2. Identify trends in KPIs present among different building types part of construction sectors globally.

Research Question 3. What insights can global frameworks provide to improve productivity measurement practices in the Canadian construction sector?

Research Objective (RO) 3. Outline research implications from the construction projects completed abroad that can be applicable to the Canadian construction sector.

2. METHODOLOGY

2.1. Research Design

As part of the initial literature review process, a multi-step approach (consisting of a broader literature scan and shortlisting as per recurring keywords) was adapted from Cheng et al. (2020) to source and select primary literature that was relevant to the main domains of research in SCOPUS. SCOPUS was used as the primary database for identifying relevant academic literature due to its greater coverage of non-North American scientific articles compared to its nearest competitor, Web of Science (Elsevier, 2023). This fits in with the geographic focus of this review.

Step 1: Identification: The search focused on looking into evidence of productivity in off-site construction projects across three sectors of construction projects (Residential, Commercial, and Mixed-Use) completed during the span of 2010 – 2024. Projects had to be non-Canadian international literature and conform to a selective list of targeted keywords.

Step 2: Literature screening: Articles were systematically screened for keywords that concerned the concept of productivity itself ("*Productivity*", "*Performance*", "*Frameworks*") and project characteristics ("*Modular*", "*Offsite*", "*Residential*", "*Commercial*"). This process of filtering is shown in Figure 1 *below*:

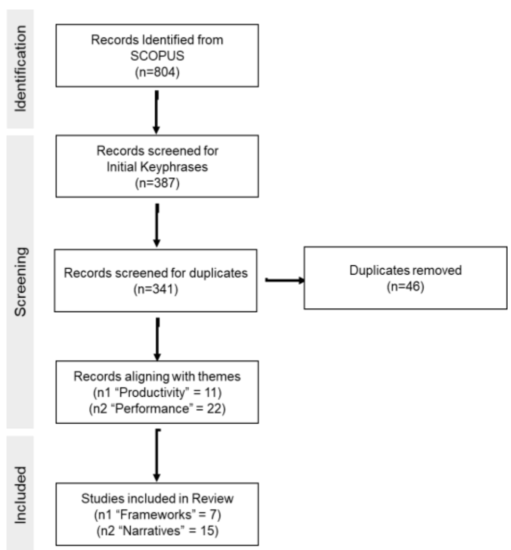

Figure 1: Keyword Search Funnel

The keywords chosen for the initial literature search yielded 341 articles (after factoring for duplication). In order to shortlist relevant articles to the core research questions, a frequency analysis was conducted using the Abstract and Author-defined keywords, to extract 22 articles that were semantically relevant to the research objectives and had covered productivity measures at the project-level, either directly as part of their experimental design or detailing a theoretical measurement framework based off a real-world case.

Additionally, this academic literature was augmented with 16 secondary sources. These secondary sources were derived from international standards such as those published by the International Organization for Standardization (ISO). Publicly available guides detailing regional frameworks from nations at a similar level of economic development (such as Singapore, New Zealand, and the United Kingdom) were extracted through general search engine-based queries, focusing on '*construction productivity' as* a search phrase.

The final list covered 22 academic articles which were then augmented with 16 secondary sources (derived from international standards and published by regional associations). This resulted in a total of 38 sources to be reviewed for structured frameworks and indicators.

Keyword frequency for this set of literature was plotted in VOSviewer (shown in Figure 2.) This was done to demonstrate trends in construction techniques cited among the sampled frameworks.

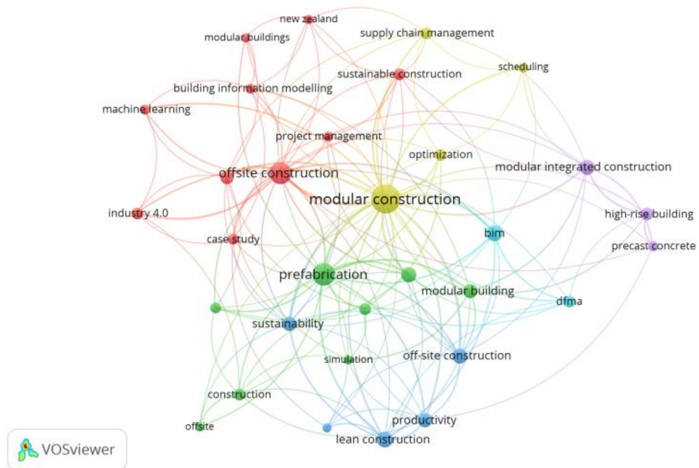

Figure 2. VOSviewer Keyword Co-occurrence Map (n > 5)

As per the Co-occurrence map in Figure 2., a trend among the sample list of productivity-focused literature was that MMC-based construction techniques (such as '*offsite construction*', '*prefabrication*', and '*modularity*' among others) were represented within the shortlisted literature. This implies that literature published after 2010 and covering productivity in an MMC context also documented a structured productivity measurement process and indicators. This correlation can also indicate that formal productivity measurement processes have been a relatively new domain in construction research.

2.2. Shortlisted Frameworks

In line with this review's focus on international frameworks, the shortlisted 38 sources cover frameworks in Australia, Asia, North America, and Europe. This geographic distribution is shown in Figure 3 below:

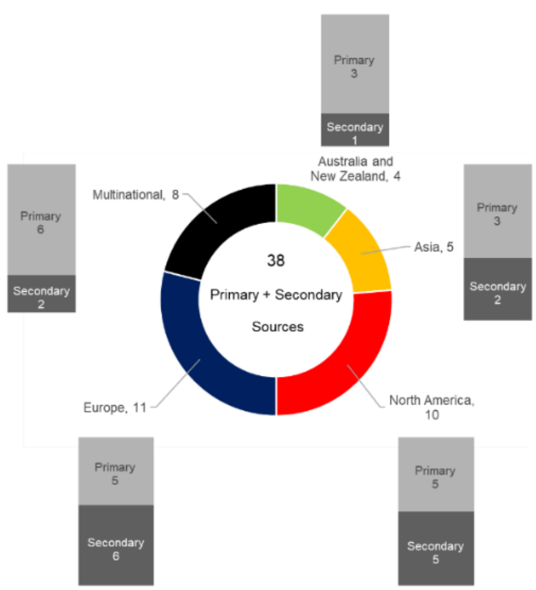

Figure 3. Geographic Distribution of Literature

Out of the shortlisted 38 sources, the following 12 productivity frameworks (in Table 4 below) were selected based on their geographical coverage, empirical application to a real-world project and level of detail in formally documenting measurement processes and underlying indicators:

Table 4: Selected Productivity Framework and overview description

Framework Source	Year	Description
Lawson and Ogden	2010	Cost-benefit analysis of building residential units in urban conglomerations to evaluate operational and sustainability impacts
Building and Construction Authority	2012	Activity analysis of the construction value stream and inputs.
Yu et al.	2013	Gap analysis of production value stream for housing units, focusing on materials and labour as being the primary determinants of productivity.
Pons	2014	Sustainability assessment to quantify productivity metrics using a survey-based multicriteria decision-making model.
Building Research Association of New Zealand	2014	Macroeconomic measurement of resource productivity and consumer-side demand being shaped by efficiencies in the construction process.
Singapore Contractors Association Limited	2016	Standardized assessment of site outputs based on labour and time inputs.
Construction Leadership Council	2018	Diagnostic rubric focusing on quantifying industry-wide levers of productivity (across cost, quality, time, and HSE impacts).
Ferdous et al.	2019	Operational review of production line operations focusing on unit output quantity (based on cost, design, technological, and labour overheads)
Glenigan	2021	Framework for quantifying economic and social impacts on an industry-level scale while tracking customer-side feedback.
Wrigley et al.	2021	Evaluation of proposed KPI template intended for power plants.
Geiger, Hock, and Nubel	2023	Value-stream analysis of how construction sites evaluated their performance on both the wider Project and focused Activity levels.
Pan and Zhang	2023	Evaluation of planning, design, and construction phases to factor for economic, social, and environmental aspects.

The relevance and limitations of these frameworks have been detailed in Table 5 below.

Table 5: Selection Rationale for Frameworks with Relevance to Canadian Industry Context

Framework Source	Year	Relevance	Potential Gaps
Lawson and Ogden	2010	Utilized operational factors (such as day-to-day time and unit productivity) as evaluative criteria which supports its use as a comparative benchmark.	Contextualized in terms of compliance with UK regulations which may limit its applicability to other jurisdictions.
Building and Construction Authority	2012	Analysed individual activities within the construction value stream which provides deeper insights into how productivity recorded across activities	Need additional representation of productivity gains that can be achieved by streamlining off-site activities in the construction process.
Yu et al.	2013	Provided both a current and desired state assessment of the construction value stream.	The indicators primarily cover unit and labour productivity which excludes factors such as environmental and lifecycle impacts.
Pons	2014	Analysis of weighted economic, environmental, and social indicators as part of a composite index to quantify construction performance.	Need a contextualized lens to assess how conventional projects would perform in comparison to MMC-based projects.
Building Research Association of New Zealand	2014	Utilized a composite measure to benchmark cost and time performance in a standardized manner.	The overt focus on optimizing cost efficiency excludes key non-economic and behavioural factors.
Singapore Contractors Association Ltd	2016	Extended the scope of construction site productivity beyond on-site activities by also including the impacts of site and supervisory guidelines	Measured rate of throughput to inputs (such as labour and time) which excluded other factors such as environmental, health, and safety.

Construction Leadership Council	2018	Accounted for the role of quality (and associated control measures) in impacting process productivity.	Focused on gauging performance at the industry-level without variations between types of construction projects
Ferdous et al.	2019	Identified productivity factors including cost, design, technological, and labour requirements.	Specific to situations covering installation and operational loads which may exclude the pre-construction phases and logistical requirements of construction projects.
Glenigan	2021	Covers feedback from end-users and construction site operators on satisfaction with the finished site and deviation from initial plans.	Based on a linear scale of 1 – 10, which limits capturing the underlying ambiguity within a respondent assign rating.
Wrigley et al.	2021	Provides a KPI template that can be adapted to benchmark unit productivity.	Specialized use case (nuclear energy) can limit the extent to which the identified practices can be adapted.
Geiger, Hock, and Nubel	2023	Focus on both value stream and activity-level productivity to derive a methodology for assessing construction sites.	An explicit focus on raw labour productivity limits how productivity can be augmented through capital and technological factors.
Pan and Zhang	2023	Broadly applicable performance indicators that can be used for measuring both modular and conventional construction projects.	The premise of the construction process is sequenced across three phases (Planning, Design, and Construction), which may differ between projects.

3. FINDINGS AND ANALYSIS

3.1. Building Type Distribution

To answer the three research questions, the analyzed frameworks were grouped by building type (to represent the overarching construction sectors) as shown in Table 6 below:

Table 6: Identified Productivity Frameworks (Building Type-wise Distribution)

Residential	Commercial	Mixed Use
Lawson and Ogden (2010)	Yu et al. (2013)	Building Research Association of New Zealand (2014)
Building and Construction Authority (2012)	Pons (2014)	Singapore Contractors Association Ltd (2016)
Construction Leadership Council (2018)	Wrigley et al. (2021)	Glenigan (2021)
Ferdous et al. (2019)	Geiger, Hock, and Nubel (2023)	
Pan and Zhang (2023)		

Grouping the existing list of frameworks based on building type allowed for an in-depth understanding of what fundamental similarities and differences may exist among broader construction sectors. This categorization assisted in determining which particular productivity assessment practices can be appropriately adapted to the Canadian residential, commercial, and mixed-use Construction sectors.

3.2. Process Orientation within Frameworks

In order to facilitate a cross-sectoral analysis of construction practices across geographies, a key frame of comparison was the ability to assess the alignment of specific stages of the productivity measurement process within the overarching construction process (Pan, Gibb, and Dainty, 2012). In this regard, assessing whether the shortlisted frameworks followed a systematic path of KPI identification and prioritization, the associated projects within each of the identified sectors were mapped against the following phases within the CPT (Construction Productivity Taskforce) 7-Step framework (Construction Productivity Taskforce, 2022). To identify distinct processes between the project types under review, Mixed-use projects were excluded due to encompassing characteristics of both Residential and Commercial projects, which may distort inferences for any unique processes presented below in *Table 7*.

Table 7: Selected Productivity Framework Details

Phase	Residential	Commercial
Engage	Considered end users as the core group for highlighting areas for improvement.	Utilized feedback from staff to understand how human factors can shape productivity
Define	The definition of productivity centred around measuring raw construction throughput.	Utilized direct construction inputs to compare productivity among projects
Identify Data	Used on-site resource and utility consumption levels to identify areas for improvement.	Formulated the data collection strategy around the number of recorded defects and the number of units constructed
Identify Technology	Considered sources of operational losses for using technological tools to collect data.	Assessed technological readiness in terms of the time for labour to learn new technologies.
Collate Data	Focused on aggregating data for operational assets in order to plan contingencies	Established predictability measures to plan out operational activities and track deviation.
Measure and Analyse	Analysed the construction value chain on a sequential basis in order to identify lagging phases that may be hindering productivity	Delineated the construction process into phases to understand how design impacts the environment.
Improve and Feedback	Established baseline performance levels for individual activities to assess whether these are impacting the project timeframe.	Traced the level of wastage within the construction process to predict how design changes can shape productivity
Source of frameworks	Lawson and Ogden (2010), Building and Construction Authority (BCA, 2012), Construction Leadership Council (CLC, 2018), Ferdous et al. (2019), and Pan and Zhang (2023)	Yu et al. (2013), Pons (2014), Wrigley et al. (2021), and Geiger, Hock, and Nubel (2023)

The initial phases of productivity assessment were centered around requirements gathering while the later phases focused on the process of performance measurement and analysis. This indicates that while the process of diagnosing productivity gaps varies across projects and diverges at a certain point, the process of covering these gaps can be executed in a standardized manner based on their respective sectors.

3.3. KPI Alignment within Frameworks

Beyond the process level view of how each of the identified frameworks had assessed productivity, this review assessed the key performance indicators (KPIs) being tracked by each of the frameworks under analysis. The categories used to group the identified KPIs were adapted from the Direct and Broad indicator categories defined within the CIRIA C792 Framework developed by Jansen Van Vuuren and Middleton (2020). The underlying patterns in KPI distribution for the three building types are shown in *Table 8*:

Table 8: Trends in Categorized Productivity Indicators

Indicators	Residential	Commercial	Mixed-Use
Cost	Focus on unit-level indicators (defined by either unit of production or labour inputs).	Focused on cost factors such as those occurring during the course of operations.	Focus on long-range indicators (such as financial solvency and return on assets)
Time	Concentrated on time duration required to maintain current throughput levels.	Compared elapsed timeframes and deviations from planned intervals.	Established estimates of individual activities (such as unit production and assembly).
Labour	Measured level of production per man-hour to compare process-level productivity.	Focused on labour-focused measures such as learning curves and overtime.	Used staffing metrics (such as retention and turnover)
Quality	Used the recorded number of homes produced and defects	Utilized completeness-based measures to track quality.	Utilized customer feedback measures such as satisfaction
Health and Safety	Tracked direct incident metrics against construction throughput	The sample frameworks did not track health and safety metrics	Leveraged quantified health and safety metrics
Environment	Volumetric measurement of wastage and resource consumption at intervals.	Quantified resource consumption and waste rates against construction progress	Incorporated qualitative measures for broader metrics (such as environmental).

Lifecycle	Emphasized on-site impacts such as tracking both active and ambient pollution levels.	Tracked end-of-life measures (such as waste deposits)	Compared how wastage and resource consumption levels against total project value
Local Disruption	Units-based approach to assessing externalities affecting project localities.	Tracked community impacts to measure on-site wastage	Focused on broader economic indicators (such as GDP).
Source of frameworks	Lawson and Ogden (2010), Building and Construction Authority (BCA, 2012), Construction Leadership Council (CLC, 2018), Ferdous et al. (2019), and Pan and Zhang (2023)	Yu et al. (2013), Pons (2014), Wrigley et al. (2021), and Geiger, Hock, and Nubel (2023)	Building Research Association of New Zealand (BRANZ, 2014), Singapore Contractors Association Ltd (SCAL, 2016), and Glenigan (2021)

While Residential and Commercial sector projects exhibited diverging trends in their processes for gauging productivity, they were largely unified in the indicators for measuring productivity. In this case, the processes to measure productivity differed more significantly than the indicators used to measure it, which aligns with the notion that construction productivity is a process-driven variable (Aniekwu and Okpala, 1988).

The total number of KPIs present within the shortlisted frameworks was 56. Among these frameworks, there was a noted focus on direct operational measures compared to indicators representing the project's broader impacts. The total number of KPIs were distributed category-wise as shown in Figure *9* below:

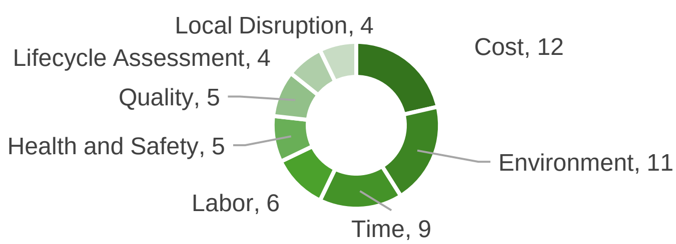

Figure 9. Indicator Distribution among Reviewed Frameworks (n=56)

Indicators related to Cost, Environmental Impacts, and Time accounted for more than half (~57%) of the total number of indicators identified. In line with the trend indicated by residential and commercial projects, indirect measures (such as Lifecycle Impacts and Local Disruption) were less represented among the sample set of indicators compared to direct measures (such as Costs, Environmental Impacts, and Time). This is thematically in line with the "direct" value proposition of MMC techniques in driving resource savings while positioning benefits beyond the worksite as 'indirect' as per Bassi et al. (2021).

4. DISCUSSION

In terms of representing how the Canadian landscape for productivity assessment can be augmented, the evidence within international literature corresponded with our initial research objectives in that:

RO.1. Productivity measurement practices for the early stages (such as for the initial engagement and requirements definition) were different across residential and commercial projects while steps covering the actual process of improving productivity metrics, converged in their focus areas. Therefore, RO.1 was Partially Met in there being a distinction in the measurement processes used across building sectors.

RO.2. For the respective productivity indicators**,** both residential and commercial projects tended to focus on raw throughput (such as quantity of units produced and active labour) while mixed-use projects utilized long-range targets (such as customer-side reviews). Therefore, RO.2 was Fully Met in indicators being categorized with a distinct trend among Cost, Time, Labour, Quality, and Environmental indicators.

RO.3. While International literature had documented indicators such as those pertaining to direct economic value in terms of cost, quality, and labour, there was a lack of indicators documenting broader impacts (such as lifecycle and community impacts). Therefore, RO.3 was Fully Met in highlighting gaps in global industry practices for productivity measurement which can be covered by future research efforts.

From the frameworks analysed during this review, the following trends were noted (in terms of the productivity measures and processes being tracked):

- Focus on marginal unit economics as a means to identify and drive productivity improvements;
- Utilized qualitative mechanisms in industry benchmarks to derive demand-side feedback from clients;

  Existing projects under evaluation had regional differences in the type of structures they had covered (i.e. high-rise structures in the case of Asia and detached-style dwellings in Europe and Oceania).

4.1. Research Significance

Considering the present lack of a standardized Canadian framework for construction productivity and through assessing how peer nations in the G7 and elsewhere have developed frameworks for their construction sectors, the findings of this review provided insights in terms of how operators within the Canadian construction sector can evaluate their productivity and performance on a competitive basis.

Evaluative elements from international projects can also be adapted to cover potential gaps in Canadian productivity measurement practices such as additional indicators representing construction activities impacts on local communities and enhancing unit-level productivity rather than focusing on the raw number of inputs within the construction process. This is supported by evidence that a universal gap in driving productivity within the construction process is of a lack of standardization in the units used to quantify it (Blismas, Pasquire, and Gibb, 2006). Therefore, future research efforts can be directed toward addressing this gap in order to ensure that both domestic and international construction sector operators have a baseline performance rubric they can leverage to quantify and benchmark their productivity.

5. CONCLUSION

The results of the review process were presented to understand how international frameworks and their indicators can assist in reforming productivity measurement practices in the context of Canada’s flagging productivity levels in its construction sector. In context of how direct ‘material’ indicators such as those tracking ‘Costs’, ‘Environment’, and ‘Time’ were largely represented among the set of global indicators, operators within the Canadian construction sector can utilize similar trends to identify levers that can shape their project productivity in a focused manner. These findings can be used in the course of future Canadian academic and industry research for inclusion as part of a hypothetical productivity measurement framework.

5.1. Limitations and future work

A key limitation among the reviewed frameworks was a noted lack of indicators to account for provisions to offset uncertainty in resource availability (in labour and input materials). Conceptualizing future-facing indicators for uncertainty can assist in developing KPIs responsive to supply and demand-side shocks.

Although this study had compared these differences across the three building sectors using a sample of frameworks sourced from global literature, narrowing the geographic scope to a continental level (such as North America or Europe) in future studies would allow for insights into what specific factors exist on a market-by-market basis that can contribute to the identification of measures for productivity assessment. It is likely that these factors would be pronounced when considering the differences in socioeconomic distribution and urban planning patterns on a continental, national, and regional level. Future research efforts can also potentially address whether (and how) public/private sector incentives used by other developed nations can contribute to standardized frameworks being adapted within the Canadian construction sector as well.

ACKNOWLEDGMENTS

This research is supported by the National Research Council of Canada (NRC) Collaborative Science, Technology and Innovation Program (Grant No. AWD-028080) and the University of British Columbia.

REFERENCES

Aniekwu, A.N., and Okpala, D.C. 1988. Contractual arrangements and the performance of the Nigerian construction industry (the structural component). *Construction Management and Economics*, *6*3(1): 3-11.

Bassi, R., Dunster, A., Miller, J., Noonan, K., and Quarry, R., 2021. *Benefits of Modern Methods of Construction in Housing*. Constructing Excellence. United Kingdom

Bello, A. O., Khan, A. A., Idris, A., and Awwal, H. M. 2024. Barriers to modular construction systems implementation in developing countries' architecture, engineering and construction industry*. Engineering, Construction and Architectural Management, 31*(8): 3148-3164.

Blismas, N., Pasquire, C., and Gibb, A. 2006. Benefit evaluation for off-site production in construction. *Construction Management and Economics*, *24*(2): 121–130.

McIntosh, O.B., Burnett, A., Feldman, I., Lamphere, J., Reuter, T., and Vital, E. 2021. Can Sustainability Knowledge-Action Platforms Advance Multi-Level Sustainability Transitions? *Conference Proceedings at the 5th International Conference on Public Policy*, Barcelona.

Building Construction Authority (BCA), 2016. *Construction Productivity R&D Roadmap.* Singapore.

Building Research Association of New Zealand (BRANZ). 2014. *Study Report SR310: Measuring construction industry productivity and performance.* New Zealand

Construction Leadership Council (CLC). 2018. *Innovation In Buildings Workstream Housing Industry Metrics.* United Kingdom

Construction Productivity Taskforce (CPT). 2022. *Measuring Construction Site Productivity: A Seven-step Framework for Success.* United Kingdom

Elsevier. 2023*. Content Coverage Guide - SCOPUS.*

Ferdous, W., Bai, Y., Ngo, T.D., Manalo, A., and Mendis, P. 2019. New advancements, challenges and opportunities of multi-story modular buildings . *Engineering Structures*. 183: 883-893

Geiger, M., Hock, D. and Nübel, K. 2023*.* Development of a Novel Production Model for Labour Productivity: Modular Construction Toolkit Design. *Buildings*, 13(11): 2887

Glenigan. 2021. *Construction KPIs Annual Report: UK Industry Performance Report,* United Kingdom

Jansen Van Vuuren, T., and Middleton, C. 2020. *Methodology for quantifying the benefits of offsite construction*. CIRIA. United Kingdom

Lawson, R.M. and Ogden, R.G. 2010. Sustainability and Process Benefits of Modular Construction *Proceedings of the 18th CIB World Building Congress,* Salford, United Kingdom.

Momaya, K., and Selby, K. 1998. International competitiveness of the Canadian construction industry: a comparison with Japan and the United States. *Canadian Journal of Civil Engineering*, *25*(4): 640-652

Pan, W., and Zhang, Z. 2023. Benchmarking the sustainability of concrete and steel modular construction for buildings in urban development. *Sustainable Cities and Society*, 90: 104400.

Pan, W., Gibb, A. G., and Dainty, A. R. 2012. Strategies for integrating the use of off-site production technologies in house building*. Journal of Construction Engineering and Management*, 138(11): 1331-1340.

Park, H.S., Thomas, S.R., and Tucker, R.L. 2005. Benchmarking of Construction Productivity. *Journal of construction engineering and management*, 131(7): 772–778

Pons, O. 2014. Assessing the Sustainability of Prefabricated Buildings. *Eco-efficient Construction and Building Materials*. 434-456. Woodhead Publishing

Singapore Contractors Association Ltd (SCAL). 2016. Construction Productivity in Singapore: Effective Measurement to Facilitate Improvement. Singapore

Statistics Canada. 2024. The construction sector is not operating at full capacity - Here are some data that could explain why. *Government of Canada.*

Wrigley, P. A., Wood, P., O'Neill, S., Hall, R., and Robertson, D. 2021. Off-site modular constructionand design in nuclear power: A systematic literature review. *Progress in Nuclear Energy*. 134: 103664