STRATEGIC CONSTRUCTION MODELING AND DELIVERY
INDUSTRIAL RESEARCH CHAIR

IMPROVING CONSTRUCTION LABOUR PRODUCTIVITY USING CONTEXT-SPECIFIC AND GENERALIZED MODELS

ABOUT THE CHAIR

Established in January 2012 under the leadership of Dr. Aminah Robinson Fayek, the Industrial Research Chair in Strategic Construction Modeling and Delivery operates within the Department of Civil and Environmental Engineering at the University of Alberta.

The Chair brings together construction industry owners, contractors, and labour groups working in Alberta and across Canada to develop comprehensive research-based solutions to key industry problems. Giving particular attention to Canada's oil and gas, utilities, industrial, and commercial construction sectors, the Chair focuses on strategic concerns related to construction management—such as construction industry productivity, project delivery, and performance. Research undertaken includes improvements to labour productivity, structuring projects and teams, assessing owner and contractor competencies, and reducing project execution risk.

The Chair's research program takes advantage of fuzzy logic's ability to capture and quantify the many subjective uncertainties that challenge construction projects. Researchers combine fuzzy logic with other forms of uncertainty modeling, artificial intelligence, and simulation techniques to develop advanced decision-support tools and approaches.

Dr. Abraham Assefa Tsehayae, Postdoctoral Fellow
Dr. Aminah Robinson Fayek, Supervisor

BACKGROUND

Construction labour productivity (CLP) significantly influences the success of projects, making it an ideal target for modeling. Such models allow us to imitate aspects of real construction environments and help to provide an improved understanding of CLP through the representation of influencing factors, practices, and work sampling proportions. However, there are a number of challenges in modeling CLP:

- The inherent requirement of dealing with numerous, complex, and continuous influencing input variables (productivity factors and practices);
- The need to address the objective and subjective nature of input variables in an integrated approach;
- The need for flexibility in adapting models to suit different project contexts; and
- Reliance on large data sets for model development, testing, and training.

RESEARCH OUTCOMES

- Developed a hierarchy of key CLP influencing factors, practices, and work sampling proportions, based on expert opinion and field data;
- Developed a reliable and efficient productivity data collection methodology using work study methods;
- Developed Productivity Tracker©, a CLP data collection and analysis tool; and
- Developed a series of context-specific and generalized models for predicting and analysing construction labour productivity of concreting activity under varying project contexts (industrial, warehouse, high-rise, and institutional) using granular fuzzy hybrid techniques.
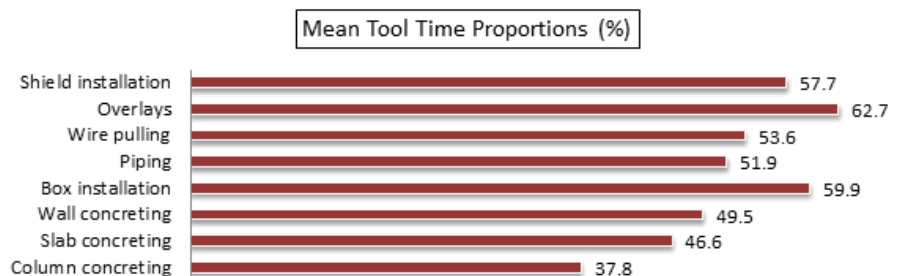
METHODOLOGY
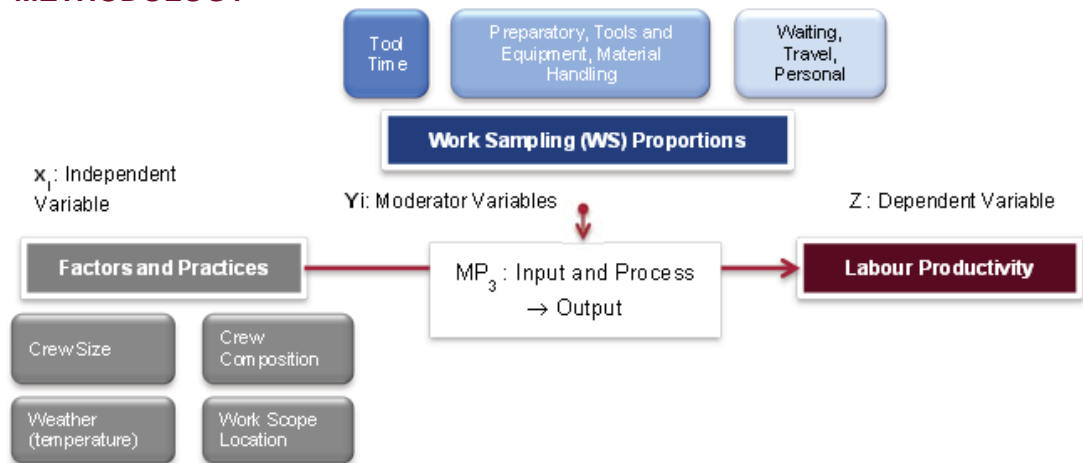
KEY RESULTS

This study has entailed analysis of more than 10 projects across Alberta over a three-year period. The key findings are as follows:

A)   Tool time (direct work) proportions for several construction activities:

Mean Tool Time Proportions (%)

Activity	Proportion
Shield installation	57.7
Overlays	62.7
Wire pulling	53.6
Piping	51.9
Box installation	59.9
Wall concreting	49.5
Slab concreting	46.6
Column concreting	37.8

PROJECT PARTNERS

MERIT contractors association

NSERC CRSNG

Capital Power

PCA BUILDING CANADA TOGETHER

CLAC

TransAlta

STRATEGIC CONSTRUCTION MODELING AND DELIVERY
INDUSTRIAL RESEARCH CHAIR

Dr. Abraham Assefa Tsehayae, Postdoctoral Fellow
Dr. Aminah Robinson Fayek, Supervisor

ABOUT THE CHAIR

Established in January 2012 under the leadership of Dr. Aminah Robinson Fayek, the Industrial Research Chair in Strategic Construction Modeling and Delivery operates within the Department of Civil and Environmental Engineering at the University of Alberta.

The Chair brings together construction industry owners, contractors, and labour groups working in Alberta and across Canada to develop comprehensive research-based solutions to key industry problems. Giving particular attention to Canada's oil and gas, utilities, industrial, and commercial construction sectors, the Chair focuses on strategic concerns related to construction management—such as construction industry productivity, project delivery, and performance. Research undertaken includes improvements to labour productivity, structuring projects and teams, assessing owner and contractor competencies, and reducing project execution risk.

The Chair's research program takes advantage of fuzzy logic's ability to capture and quantify the many subjective uncertainties that challenge construction projects. Researchers combine fuzzy logic with other forms of uncertainty modeling, artificial intelligence, and simulation techniques to develop advanced decision-support tools and approaches.
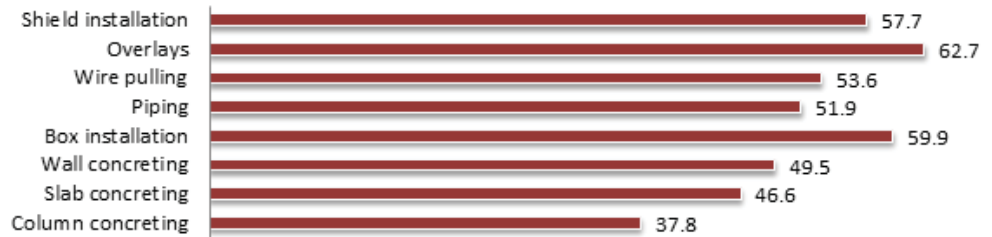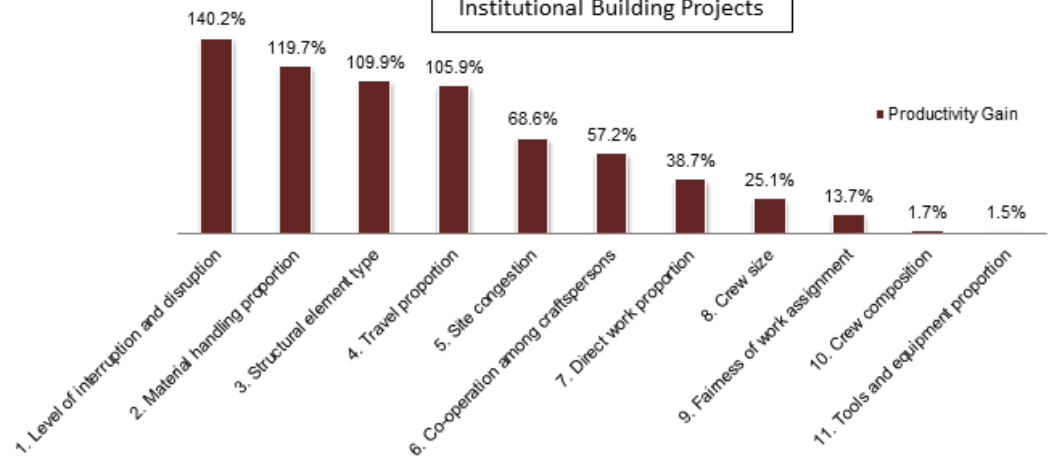
PROJECT PARTNERS

MERIT contractors association | NSERC CRSNG | Capital Power | PCA BUILDING CANADA TOGETHER! | CLAC | TransAlta

Mean Tool Time Proportions (%)

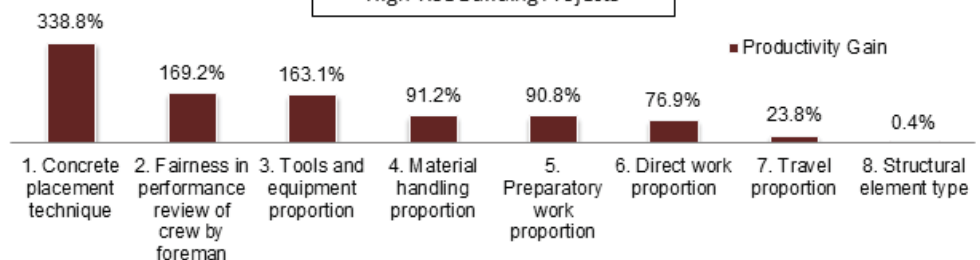| Activity	Proportion
Shield installation	57.7
Overlays	62.7
Wire pulling	53.6
Piping	51.9
Box installation	59.9
Wall concreting	49.5
Slab concreting	46.6
Column concreting	37.8

B)   Improvement of CLP in concreting activity can be achieved by focusing on the following influencing factors:

Institutional Building Projects — Productivity Gain

Factor	Productivity Gain
1. Level of interruption and disruption	140.2%
2. Material handling proportion	119.7%
3. Structural element type	109.9%
4. Travel proportion	105.9%
5. Site congestion	68.6%
6. Co-operation among craftspersons	57.2%
7. Direct work proportion	38.7%
8. Crew size	25.1%
9. Fairness of work assignment	13.7%
10. Crew composition	1.7%
11. Tools and equipment proportion	1.5%

High-rise Building Projects — Productivity Gain

Factor	Productivity Gain
1. Concrete placement technique	338.8%
2. Fairness in performance review of crew by foreman	169.2%
3. Tools and equipment proportion	163.1%
4. Material handling proportion	91.2%
5. Preparatory work proportion	90.8%
6. Direct work proportion	76.9%
7. Travel proportion	23.8%
8. Structural element type	0.4%

INDUSTRY APPLICATIONS

- Critical context-specific factors and practices leading to better labour productivity through improved construction planning and execution.

- A comprehensive data collection and analysis tool (Productivity Tracker©) for use in productivity improvement studies by researchers and industry practitioners.