STRATEGIC CONSTRUCTION MODELING AND DELIVERY

INDUSTRIAL RESEARCH CHAIR

Keynotes

Issue 11, October 2021

Message from the Chair

Moving Forward

This summer, it was my honour to accept an appointment as University of Alberta's Vice President (Research and Innovation) (VPRI), effective July 1, 2021. I look forward to serving the greater University of Alberta research community. I also look forward to future opportunities to expand outreach, networking, and knowledge sharing with my colleagues and partners in the construction industry, and the opportunities I will have to contribute significantly to the realm of research and innovation in my role as VPRI and beyond.

I continue to serve as Industrial Research Chair in Strategic Modeling and Delivery. We have some work and reporting yet to complete for the IRC in SCMD and to transition other projects to the CIC. Again, and as always, thank you for your support and involvement over the nearly 15 years of this NSERC-funded research program. Our industry partners, including individuals who have served on our Management Advisory Committee, have been absolutely vital to the research and tools we've been able to develop and contribute to the construction industry in Alberta and Canada. In addition, the IRC in SCMD provided some roots for the Construction Innovation Centre, which has a new director, Dr. Yasser Mohamed, who is a Professor of Construction Engineering in the University's Department of Civil and Environmental Engineering.

The construction industry has naturally been deeply affected since March 2020, when municipal, provincial, and federal governments responded to the COVID-19 pandemic with shutdowns and closures. As various sectors gradually move towards regular, pre-pandemic activity levels, the industry faces new challenges, such as ongoing development of safety and health protocols, short- and long-term effects on supply chains, and contractual/legal issues, in addition to ongoing issues, such as labour shortages. I am nonetheless very optimistic for the future of our industry, because every challenge presents a learning opportunity. Through industry partnerships with the IRC in SCMD and CIC, we have already demonstrated the problem-solving power of sharing knowledge and resources among individuals, researchers, construction owners and managers, and industry organizations and stakeholders. As we share what we've experienced and learned over the past year and a half, we have the unique opportunity to rebuild in ways that will make the construction industry more resilient, productive, and robust, both generally and in our capability to respond to major disruptions.

With deep gratitude, I say thanks again to all who have contributed to this group's efforts, and I look forward to our future collaborations.

– Dr. Aminah Robinson Fayek

Read the official announcement of Dr. Aminah Robinson Fayek new appointment by Dr. Bill Flanagan, University of Alberta's President and Vice Chancellor, here.

Note: The IRC in SCMD originally published this article September 28, 2021, on Medium.

IRC in SCMD

To Our Industry Partners

The NSERC Industrial Research Chair in Strategic Construction Modeling and Delivery at the University of Alberta is proud to count construction owners, owner associations, contractors, contractor associations, labour associations, and labour unions as our industry partners. To date, the chair's research program attracted the collaborations from a wide range of industry partners in Canada who are active in diverse fields such as oil and gas, power supply, pipeline, and institutional and commercial construction. The achievements of IRC in SCMD have been made possible thanks to the many partners we worked with over the years. Together, we have worked on many diverse research projects to make sure construction employees and organizations can have a better everyday working situation and a more successful future. As we complete the current and final IRC chair term, we would like to thank everyone who has been part of this journey so far. Thank you to our current partners:

Capital Power Corporation (CPC)

Christian Labour Association of Canada (CLAC)

Construction Owners Association of Alberta (COAA)

Electrical Contractors Associations of Alberta (ECAA)

Progressive Contractors Association of Canada (PCA)

Suncor Energy

Alberta Roadbuilders and Heavy Construction Association (ARHCA)

Merit Contractors Association

We wish to extend additional thanks to the representatives from our partner organizations who have provided insight and guidance via the Management and Technical Advisory Committees, which were chaired first by Ernie Tromposch (COAA), and then Paul de Jong (PCA). Thank you also to the current committee members for your perseverance as we switched to online meetings in response to the COVID-19 pandemic.

Photo by eskay lim on Unsplash

We also thank the industry partners who collaborated with us in previous terms of the IRC:

Aecon Industrial Western

Building Trades of Alberta

Enbridge Pipelines

Ledcor Group

Lockerbie & Hole

Petro-Canada

TransAlta Corporation

IRC in SCMD Research Portfolio

The NSERC IRC in SCMD has helped the Alberta construction industry develop research-based models to address current and upcoming industry problems. Under the IRC in SCMD, researchers from different countries gathered and completed a broad range of construction engineering and management research projects, using and advancing techniques such as fuzzy logic, artificial intelligence, and simulation to improve construction productivity and performance, assess organizational competencies, and mitigate construction risks. IRC researchers also started the planning for a project utilizing intelligent and resilient automation and technology (e.g., sensors and exoskeletons) to measure workers' health and safety, which will be carried out under the auspices of the Construction Innovation Centre (CIC). Other

research areas included workforce development and digitalization implementation in construction. Special research focus was given to leveraging the power of fuzzy logic in capturing and quantifying subjective uncertainties, vagueness, and imprecision that are inherent in construction problems. As a result, the research team developed many hybrid models that integrated fuzzy logic with other types of modeling and computing techniques, such as machine learning (e.g., artificial neural networks and clustering), optimization (e.g., evolutionary algorithms and particle swarm optimization), multicriteria decision-making (e.g., analytic hierarchy process and Technique for Ordering Preference by Similarity to Ideal Solution — TOPSIS), and simulation (e.g., agent-based modeling, Monte Carlo, and system dynamics) to capture subjective and random uncertainty and to develop more advanced analytical methods in construction.

Photo by Saad Salim on Unsplash

Tools

The IRC's collaboration with industry partners — including but not limited to construction owners, contractors, and labour associations — helps ensure that software tools developed through the IRC in SCMD serve industry needs and can be used in organizations' practices and decision-making processes. These tools incorporate practical applications of theoretical knowledge in software form, allowing smoother transfer of knowledge and technology to industry organizations. Tools developed over the three terms of the IRC under Dr. Robinson include tools to track and analyze construction organizational competencies impacting performance,

construction productivity, workforce skills development, project contingency, research and development in construction, contractor default prediction, absenteeism, and project status. More recently developed tools include:

- Fuzzy Risk Analyzer (FRA©), an advanced software tool for risk analysis in construction projects that determines construction project contingency based on the natural language assessment of risks and opportunities
- Digitalization Opportunities Road Mapping Tool (DORMT©), which provides construction organizations with a novel method of assessing investments pertinent to implementation of current and future digitalization opportunities
- Advanced Work Packaging Assessment Tool©, which automates calculation of the return on investment (ROI) of implementing AWP in construction projects
- Fuzzy Contingency Determinator© (FCD©), a risk analysis and management software tool

Technology Transfer and Value to the Industry

To further share knowledge and provide training to industry personnel, the IRC in SCMD hosted and participated in workshops addressing the above-mentioned tools as well as other topics, such as productivity improvement strategies, construction project and organizational performance, research partnership programs in Canada, industry practices and people skills, connecting real-world challenges with R&D solutions, using fuzzy logic to capture expertise in the construction industry, and effective integration of apprentices into the industrial construction sector.

IRC in SCMD has contributed to several venues for better transfer of knowledge to industry and allowing widespread adoption of the developed methods and tools. IRC in SCMD has regularly participated in the Construction Owners Association of Alberta Best Practices Conferences, an annual conference by owners, contractors and labour unions in Alberta. The technologies and tools developed by IRC in SCMD are designed to assist in creating safer and more productive workplaces and practices that can benefit not only Canadian construction workers, but also the Canadian economy and population at large by making Canada and Alberta more attractive for construction investment and improving an industry that continues to contribute significantly to Canada's GDP.

Again, thank you for fifteen great years of collaboration and innovation in construction. We look forward to working with you in future, whether through the Construction Innovation Centre or other collaboration spaces.

Sincerely,
Aminah Robinson Fayek and the IRC in SCMD team

Photo by Valeria Fursa on Unsplash

Note: The IRC in SCMD originally published this article September 28, 2021, on Medium.

IRC in SCMD

People: Changes

Goodbyes . . .

Please join the IRC in SCMD in congratulating **Dr. Getaneh Tiruneh**, who successfully defended his doctoral dissertation, "Hybrid Neuro-Fuzzy Model for Construction Organizational Competencies and Performance," in January.

Dr. Getaneh Tiruneh

Postdoctoral fellow **Dr. Sumati Vuppuluri** made numerous valuable contributions to IRC in SCMD projects, but unfortunately for us, she had to move on after a productive year with our research group. We all hope to be able to work with her again in the future.

Dr. Sumati Vuppulur

Two M.Sc. students recently completed research with the IRC in SCMD and successfully defended their theses.

As an M.Sc. student in the Department of Construction Engineering and Management, **Sara Ebrahimi** worked on data mining and analysis techniques. Sara's research focused on implementing and developing machine learning and artificial intelligence (AI) techniques in construction areas to predict, model, and optimize construction labour productivity.

Sara Ebrahimi

Matin Kazerooni started his research in January 2019 as an M.Sc. student in the department of Construction Engineering and Management. He focused on developing a decision-support system for identifying the most effective strategies for improving construction labour productivity. The findings of this research are expected to support construction practitioners in identifying effective improvement strategies to enhance the level of construction labour productivity in their construction projects according to their limited budget and resources.

Matin Kazerooni

Mackenzie Fix is a fourth-year student pursuing a B.Sc. in Civil Engineering Co-op from the University of Alberta. She spent the summer of 2021 researching how to improve labour productivity for industrial construction using artificial intelligence. Her research interests include artificial intelligence, optimization, and risk management.

MacKenzie Fix

Andrew Johnston has left his position as the group's computer programmer. He stayed involved with the group as our new programmer, Eric, came on board (see below). We all wish Andrew very well in his new work!

Andrew Johnton

. . . and Hello!

Eric Ren is the group's computer programmer. Eric says, "I see myself as a problem-solver, and I am always looking for new challenge." Eric earned a B.A. in Computer Science from the University of Saskatchewan, and he has worked as web developer for more than ten years, specializing in development of highly trafficked web applications with responsive design. He has created more than a dozen applications designed to help users.

Eric Ren

Note: The IRC in SCMD originally published this article September 28, 2021, on Medium.

IRC in SCMD

People: Continuing

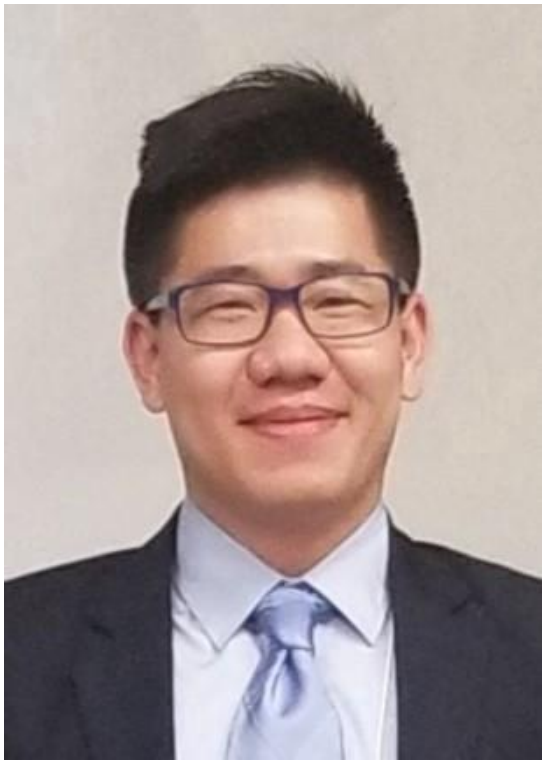
Note: The following content was intended for this article in the last IRC in SCMD newsletter, which contained an incorrect link. Minor edits were made to update/correct the article, and we sent a correct link in an Update to the IRC in SCMD mailing list in March 2022.

Our research group comprises postdoctoral fellows, doctoral students, and staff working with Dr. Aminah Robinson Fayek to wrap up the IRC in SCMD's research projects by the end of 2022.

During his doctoral program at the University of Alberta, Postdoctoral Fellow **Dr. Mohammad Raoufi** researched and developed best practices for planning and management of power plant turnaround projects that proved to be particularly valuable for our industry partners, who adopted our developed best practices for their projects. He also developed a novel fuzzy agent-based model of construction crew motivation and performance, which examined the diversity of crews, crew interactions, variations in crew motivation over time, and the situations in which crews perform. The resulting computerized model provided our industrial partner with an advanced simulation tools for project planning, execution, monitoring, and control that lead to improvement in project productivity. As a postdoctoral fellow at the University of Alberta, Dr. Raoufi has conducted research involving artificial intelligence, fuzzy logic, and simulation to improve labour motivation and productivity and other studies of advanced work packaging, workface planning, risk, productivity database development, and big data analytics.

Dr. Mohammad Raoufi

Dr. Phuong Nguyen joined the IRC as a Postdoctoral Fellow in October 2020. Dr. Nguyen holds a Bachelor's in Civil Engineering from Vietnam National University, Ho Chi Minh City University of Technology, his M.Sc. in Construction Management from California State University, East Bay, and his Ph.D. in Civil Engineering with a specialization in Construction Engineering and Management from the University of Kansas. Dr. Nguyen's research interests include project delivery and procurement methods, engineering decision-making under uncertainty, fuzzy logic, fuzzy cluster analysis, fuzzy pattern recognition, machine learning, and lean construction. Dr. Nguyen was selected as a scholar of the California State University Chancellor's Doctoral Incentive Program (CDIP).



Dr. Phuong Nguyen

Hamed Fateminia is a Ph.D. Candidate in construction engineering and management at the University of Alberta, where he is pursuing further studies in project and portfolio risk management. He holds a B.Sc. in industrial engineering and an M.Sc. in project management. Hamed worked with IRC in SCMD programmer Andrew Johnston to develop and release the first version of Fuzzy Risk Analyzer© (FRA©), a software tool for determining construction project contingency using natural language, and he is currently incorporating simulation methods into artificial intelligence and optimization techniques to improve risk management at the project and portfolio levels by managing contingency reserve throughout the life cycle of projects that suffer from lack of numerical data in quantity or quality required for successful modelling.

Hamed Fateminia

Doctoral student **Nebiyu Kedir**'s research focuses on exploring the application of fuzzy hybrid techniques in the development of solutions to construction issues, primarily on productivity modeling and analysis. This work addresses the compound problem of human behaviour modelling (e.g., crew motivation and performance) using fuzzy agent-based modelling, dynamic interactions between inputs (e.g., multi factor productivity) using fuzzy system dynamics), and a decision-making platform that enables feedback mechanisms to improve productivity metrics in an environment of subjective and probabilistic uncertainties.

The focus of **Yisshak Gebretekle**'s grauduate studies work is fuzzy hybrid multilevel modeling of competency and performance in construction. His other areas of research interest include: fuzzy machine learning techniques for modeling interrelationships between construction competencies at different levels; integrating fuzzy system dynamics and fuzzy agent-based modeling to develop multi-level construction competency and performance assessment models; creating and linking multi-level competency models to performance measures; and linking performance measures at different levels.

Yisshak Gebretekle, Dr. Aminah Robinson Fayek, and Nebiyu Kedir

Our technical writer, **Renata Brunner Jass**, holds an M.Sc. in Quaternary Sciences, an interdisciplinary natural sciences discipline, for which she conducted paleoecology research. Before joining the IRC in SCMD in 2020, Renata worked for more than 20 years as a publishing professional specializing in academic, educational, professional development, and marketing content for STEM and English language learning materials in print, online, and multimedia formats.

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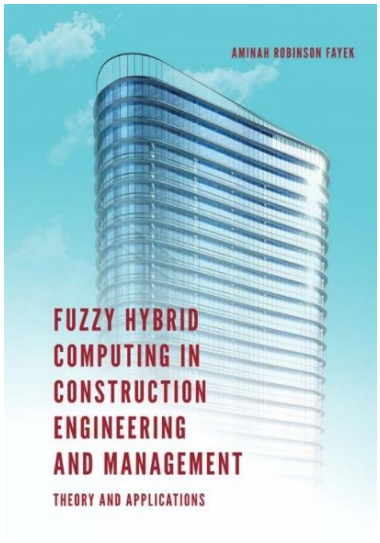
Construction Innovation Centre (CIC)

Some projects and research that started with the IRC in SCMD will continue under the auspices of the Construction Innovation Centre (CIC), founded in 2019 under the directorship of Dr. Aminah Robinson Fayek. As of July 1, 2021, Dr. Yasser Mohamed, a Professor of Construction Engineering in the University's Department of Civil and Environmental Engineering, became the new director of the CIC.

The Construction Innovation Centre brings together more than 30 engineering professors from multiple research programs and is supported by more than 50 partners in industry, professional associations, and funding bodies. Integrating this constellation of research and education into a single point of construction expertise provides unparalleled opportunities for construction innovation.

Click here for the CIC's webpage. You can also reach the Construction Innovation Centre via email at cic@ualberta.ca.

Note: We expect this to be the last IRC in SCMD newsletter. Thank you for reading! Please consider signing up for the Construction Innovation Centre mailing list, if you haven't already. You can contact the CIC via the above link or email address.



Fuzzy Hybrid Computing

Dr. Aminah Robinson Fayek edited *Fuzzy Hybrid Computing in Construction Engineering and Management: Theory and Applications*, published by Emerald Publishing in 2018. This book provides an introduction to fuzzy logic and a survey of emerging research trends in the area of fuzzy hybrid computing techniques in the field of construction engineering and management. Click here to learn more.

Produced by Dr. Aminah Robinson Fayek and Renata M. Brunner Jass,
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