IRC KeyNotes

STRATEGIC CONSTRUCTION MODELING AND DELIVERY
INDUSTRIAL RESEARCH CHAIR

ISSUE 6
July 2016

EVENTS

NOVEMBER 3, 2016
IRC Management Advisory Committee Meeting
University of Alberta, Edmonton

NOVEMBER 8 & 9, 2016
Innovation in Construction Forum 2016
University of Alberta, Edmonton

JANUARY 1, 2017
Official start of 2017–2021 IRC term

INDUSTRY PARTNERS

Aecon Industrial Western

Building Trades of Alberta

Capital Power Corporation

Christian Labour Association of Canada

Construction Owners Association of Alberta

Merit Contractors Association

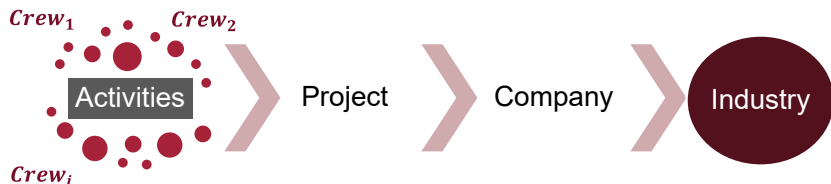Progressive Contractors Association of Canada

Suncor Energy Inc.

TransAlta Corporation

**NSERC
CRSNG**

Project Feature
Multilevel Productivity Analysis and Modeling

Examining challenges in improving construction productivity.

UNIVERSITY OF ALBERTA/ **DR. ABRAHAM TSEHAYAE**

by Cassandra Ommerli

Dr. Robinson Fayek and her research team have been working hard to kick off an extensive multilevel study on productivity analysis and modeling, which will serve to expand upon the scope of work carried out during the 2012–2016 term. Improving productivity is a key concern for construction groups, as it has a significant impact on project costs and thus drives investment decisions. Given the persistence of poor economic conditions in Alberta throughout 2015 and 2016, there is a great demand for knowledge and technologies that will allow construction industry practitioners to more accurately predict and optimize productivity and retain their competitive standing. However, effectively modeling construction productivity is a complex and challenging task, as productivity can be measured and tracked at many different levels within a project. Improving project-level productivity is a top priority for many organizations; however, evaluating project processes can be quite difficult given that human behaviour and decision-making practices must be accounted for.

IRC researcher and PhD candidate Nima Gerami Seresht is currently working to identify the critical factors influencing the productivity of Alberta construction projects at both the activity and project levels. The goal of this study is to develop a dynamic model of construction productivity with a hierarchal structure, which will allow for project-level productivity to be measured by aggregating the productivity values of activity-level models for equipment- and labour-intensive activities. The developed model will provide a comprehensive understanding of construction productivity by accounting for labour, material, and equipment costs as well as project indirect costs. In addition, it will assist in determining the most significant factors and practices affecting productivity at different levels of analysis, which will inform the development of strategies for improving construction productivity. Ultimately, the proposed model will be useful in applications related to project planning, supervision, and performance management.

In addition, IRC researcher and PhD candidate Mohammad Raoufi is exploring the impact of motivation on crew performance in Alberta construction projects. Labour is a critical resource in the construction domain, as many essential tasks are performed by construction workers.

Message From the Chair

Announcing 2017–2021 IRC Renewal

The IRC research team: **(Left, top–bottom)** Getaneh Tiruneh, PhD student; Ahmed Daoud, MSc student; Cassandra Ommerli, technical writer; Natalie Monzer, MSc student; Selam Ayele, PhD student; **(Middle, top–bottom)** Nima Gerami Seresht, PhD candidate; Dr. Aminah Robinson Fayek, professor; **(Right, top–bottom)** Mohammad Raoufi, PhD candidate; Dr. Abraham Tsehayae, postdoctoral fellow; Dr. Moataz Omar, (former) postdoctoral fellow; Nasir Siraj, PhD student; Yonas Halala, MSc student.

UNIVERSITY OF ALBERTA/ **GRECIA PACHEO CASTRO**

It is with great pleasure that I announce the official renewal of the NSERC Industrial Research Chair in Strategic Construction Modeling and Delivery for the 2017–2021 term. I would like to take a moment to acknowledge the contributions of my current and former industry partners, graduate students, postdoctoral fellows, and staff members who have not only helped to secure the renewal of this dynamic and very valuable relationship, but that have also helped to ensure the ongoing success of the IRC since its inception in 2007. I would also like to thank NSERC for their support over the years. This past April, I was the proud recipient of APEGA Summit's 2016 Excellence in Education Award (see **page 5** for awards and announcements); I am grateful to my nominators, Dr. Roger Cheng, Dr. Mohamed Al-Hussein, and Dr. Abraham Tsehayae, and to APEGA for this honour and recognition of my work as an educator, which is truly my most important role. On **page 3** of IRC *KeyNotes*, we profile Dr. Tsehayae and Cassandra Ommerli, two key members of the IRC research team who play distinctive yet crucial roles in facilitating research and in helping the IRC to achieve its core objectives. I am also excited to welcome two new partner organizations to the IRC for the 2017-2021 term, the Electrical Contractors Association of Alberta (ECAA) and the Alberta Roadbuilders and Heavy Construction Association (ARHCA), who will be joining our six returning partners: Capital Power, Christian Labour Association

of Canada (CLAC), Construction Owners Association of Alberta (COAA), Progressive Contractors Association of Canada (PCA), Suncor Energy, and Merit Contractors Association.

As I mentioned briefly in our March 2016 edition of IRC *KeyNotes*, developing strategies to increase knowledge and technology transfer is a top priority for the IRC, as is it a crucial component in ensuring that the benefits of the program are shared broadly. After the successful debut of our presentation on *Practices & People Skills for Productivity and Performance: Owner & Contractor Perspectives* at the COAA Best Practices Conference in May, the IRC held its *Key Results and Recommendations Workshop* in early June (see our recap on **page 4**). The full-day event provided a comprehensive and highly interactive look at IRC projects on construction labour productivity and organizational competencies and project performance, which were covered in two back-to-back sessions led by myself and postdoctoral fellow Dr. Abraham Tsehayae. With a strong turnout and active participation from attendees, the *Key Results and Recommendations Workshop* proved to be a great opportunity to engage with our stakeholders and provided an effective format for communicating IRC research to industry practitioners in a way that is useful and accessible to them. Moreover, the workshop allowed us to gain direct feedback from individuals and groups both within and outside our partner base, which is an important step in developing methods and tools that truly move beyond the industry status quo.

One of the most significant challenges in producing innovation is in assessing the impact an innovation has had on performance. In order to effectively identify and implement innovations, it is critical that we improve our capacity to define and measure performance. In addition, we must enhance our ability to harness the large amounts of data collected through projects and offered by our partner organizations, while also ensuring that our practices effectively capture subjectivity, expert judgement, and the interaction of numerous factors that impact performance. In the context of construction, performance is assessed in terms of metrics such as cost, schedule, productivity, quality, and safety, all of which are core pillars in our research application areas. On **page 1**, we discuss two crucial components of an extensive multilevel study on construction productivity analysis and modeling currently being conducted by the IRC. We deliver innovation to our partners and the wider construction industry by developing resources that help them to better define, structure, and optimize their processes; to develop better methods of measuring their performance; and to identify underlying performance drivers so that organizations can focus on improving those project factors that have the highest value-added impact. Helping construction organizations improve their efficiency and performance will make them more profitable and competitive, in addition to creating safer and better work environments and generating new employment opportunities for Albertans. ∎

Aminah Robinson Fayek, PhD, PEng
NSERC Industrial Research Chair
in Strategic Construction Modeling and Delivery
Professor, University of Alberta
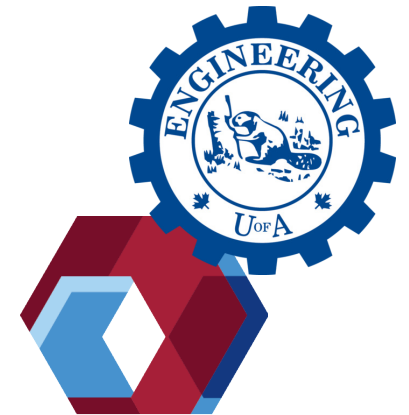
IRC Research Team Profile

Dr. Abraham Tsehayae and Cassandra Ommerli: Facilitating IRC research, connections, and vision

by Cassandra Ommerli & Dr. Abraham Tsehayae

Under the guidance of Dr. Robinson Fayek, the IRC research team is made up of a tight-knit group of student researchers, postdoctoral fellows, and staff members, all of whom play a vital role in bringing IRC projects to fruition. While partner organizations and other industry stakeholders routinely work alongside Dr. Robinson Fayek and her graduate students to plan and implement research, there are many more individuals who provide crucial strategic support to Dr. Robinson Fayek in a range of areas including student supervision, communications, and stakeholder engagement. In this article, we take a moment to profile two key IRC research team members, postdoctoral fellow Dr. Abraham Tsehayae and technical writer Cassandra Ommerli.

In October 2015, Dr. Abraham Tsehayae transitioned into his new role as postdoctoral fellow after successfully completing his PhD at the University of Alberta. Dr. Tsehayae first joined Dr. Robinson Fayek's team as a PhD student in January 2011, bringing with him a diverse background of both industry and academic experience. Prior to moving to Edmonton, Abraham worked for over six years as a lecturer at Addis Ababa University in Ethiopia and as a consultant in planning and contract administration for several building, real estate development, and international hotel construction projects. "Given the international esteem of the construction engineering program at the University of Alberta and the number of high-profile projects being undertaken in the province, I was quite excited about the prospect of moving to Edmonton," remarks Dr. Tsehayae.

DR. ABRAHAM TSEHAYAE
UNIVERSITY OF ALBERTA/ **GRECIA PACHEO CASTRO**

Now, five years later, Dr. Tsehayae has built an extensive portfolio of research during his time studying under Dr. Robinson Fayek, including having worked as the primary student researcher on one of the IRC's longest-running and most successful projects on construction labour productivity, which examined the factors and practices influencing labour productivity on several Alberta construction projects. This past June, Dr. Tsehayae led a session on this study at the IRC *Key Results and Recommendations Workshop* (see **page 4**). He notes that, "The IRC offers an exceptional research opportunity for students that would not be accessible without the contributions of participating organizations." Throughout the course of his PhD, Dr. Tsehayae has produced numerous academic articles and more than 20 industrial reports; in addition, many of the methodologies and findings developed through his work with the IRC are currently being implemented by partner organizations. Dr. Tsehayae has been recognized for his research and academic excellence with a number of honours and awards including the 2015 Canadian Society for Civil Engineering Stephen G. Revay Award for best journal paper published in the Canadian Journal of Civil Engineering in areas of construction engineering, construction management, or project management; the Queen Elizabeth II Graduate Scholarship; the Ledcor Scholarship in Construction Engineering and Management; and the Robert Stollery/ USF and G Insurance Company of Canada Award in Construction Engineering and Management.

With the 2017–2021 IRC renewal term secured, Dr. Tsehayae has been hard at work with Dr. Robinson Fayek and PhD students Nima Gerami Seresht, Mohammad Raoufi, and Selam Ayele to help develop a new multilevel study on productivity (see **page 1**) that will expand upon the scope of the IRC's existing work on labour productivity. As a postdoctoral fellow, Dr. Tsehayae has the opportunity to take on a more advanced role in facilitating connections with members of industry and in ensuring that the IRC's research objectives are being met: "While my work as a PhD student afforded me an in-depth look at key challenges in modeling and improving labour productivity, the postdoctoral position is providing me with a broader view of construction research in areas such as the evaluation of construction R&D programs, capital project productivity, and individual and crew motivation."

Moreover, Dr. Tsehayae works in supporting Dr. Robinson Fayek with the supervision and mentorship of graduate students, where he is able to share his expertise in framing construction research problems, developing data collection metrics, working with advanced hybrid artificial intelligence-based techniques, and effectively presenting research findings. For Dr. Tsehayae, a continuous investment in knowledge and a receptiveness to learning new methods and concepts is essential for success as both a researcher and instructor. Dr. Tsehayae brings creativity and pragmatism to his work, challenging graduate students to push themselves further to investigate new techniques and helping them to develop strategies to work effectively within the practical limitations of their projects. Having been involved with the IRC since the beginning of the 2012–2016 term and having worked closely with so many individuals on both the industry and academic sides of the partnership, Dr. Tsehayae possesses a unique insight that will enrich the work done by the IRC research team.

CASSANDRA OMMERLI
UNIVERSITY OF ALBERTA/ **GRECIA PACHEO CASTRO**

Over the past year, IRC technical writer, Cassandra Ommerli, has played an integral role in helping to create a competitive renewal application for the 2017–2021 term. Shortly after joining the IRC research team in June 2015, Cassandra began working closely with Dr. Robinson Fayek to edit proposal content and coordinate efforts with industry partners and university administration to complete the program application, all of which culminated in the renewal of the IRC this past June. More recently, Cassandra made major contributions in planning and administering the June 2016 *Key Results and Recommendations Workshop*.

As a member of the IRC team, Cassandra wears many hats, supporting the scholarly work of Dr. Robinson Fayek and her students through contributing her expertise as a writer and editor, and acting as an industry liaison and program manager on initiatives related to IRC communications, public relations, and knowledge and technology transfer. Cassandra is also the lead writer, editor, and designer for IRC *KeyNotes*. With a diverse academic background in areas including sociology, philosophy, technical writing, and web development, Cassandra is committed to building a multidisciplinary knowledge base that allows her to work with content that is technically complex and translate it into forms that are accessible to a wide range of audience types.

Event recap

Key Results and Recommendations Workshop

by Cassandra Ommerli & Dr. Abraham Tsehayae

In June 2016, the IRC hosted its *Key Results and Recommendations Workshop* at the University of Alberta. The event consisted of two interactive sessions led by Dr. Abraham Tsehayae and Dr. Aminah Robinson Fayek, which explored critical findings from two province-wide studies conducted by the IRC on (1) construction labour productivity and (2) organizational competencies and project performance. Well attended by a diverse group of construction owners, engineers, contractors, labour unions, construction associations, government, and university researchers, the *Key Results and Recommendations Workshop* is part of an ongoing initiative by the IRC to promote the transfer of knowledge and technology between industry and academia. Given overwhelmingly positive feedback from attendees, the IRC will explore the possibility of hosting future workshops to showcase progress on some of its other project application areas. For those unable to attend the workshop, a brief summary of each session is provided in the sections below.

SESSION I: IMPROVING CONSTRUCTION LABOUR PRODUCTIVITY ON ALBERTA CONSTRUCTION PROJECTS
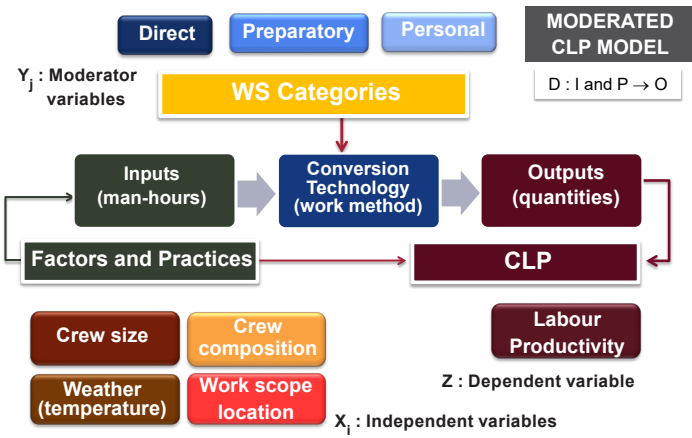

Construction labour productivity system model forumalation.

UNIVERSITY OF ALBERTA/ **DR. ABRAHAM TSEHAYAE**

Session I covered findings from an extensive multiyear study on construction labour productivity. Over the course of the 2012–2016 term, IRC researchers collected job site data from several Alberta projects in order to provide construction practitioners with methods for improving project outcomes by identifying the most significant factors and practices impacting construction labour productivity. Most notably, findings from this study suggest a significant discord in the way that project management personnel and trade workers perceive the influence of many factors affecting productivity, particularly those related to crew experience, training, and cooperation, such as fairness of work assignments and treatment by foremen; frequency of accidents; stringency of safety rules; availability of drawings and specifications; availability of required hand tools; availability and quality of materials; and frequency of rework. Collected data on tool time, which refers to the amount of time spent by trade workers doing work directly leading to project outputs, showed mean values ranging from 45% to 60%. The basic assumption that productivity improves with increased tool time was tested for several activities, and results show that tool time alone is not a strong predictor of labour productivity. In contrast, the study found that improving tool time while simultaneously improving factors and practices impacting productivity can yield improvements of up to 1.5 times

better productivity. This knowledge will help practitioners to better predict and optimize construction labour productivity in different project scenarios and in turn improve project performance and working conditions for all levels of project personnel.

SESSION II: IMPROVING ORGANIZATIONAL COMPETENCIES & CONSTRUCTION PROEJCT PERFORMANCE
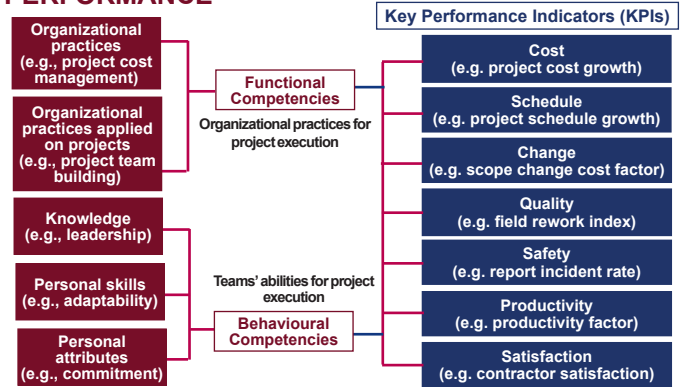
Construction organizational competencies and project performance.

UNIVERSITY OF ALBERTA/ **DR. AMINAH ROBINSON FAYEK**

Session II covered findings from a study conducted with several Alberta-based construction organizations to identify and compare critical functional competencies (organizational and project practices) and behavioural competencies (people skills) for owners and contractors. These functional and behavioural competencies were then assessed for their impact on project key performance indicators (KPIs), which measure project success against planned values related to cost, schedule, safety, quality, productivity, and satisfaction. Although owners and contractors evaluated the importance of certain competencies differently, they agreed on the relative importance of functional competencies related to safety, engineering and procurement, cost, risk, integration, quality, communication, and human resources, as well as behavioural competencies related to training, consultation, motivation, negotiation and crisis resolution, self-control, reliability, and commitment. Owners showed a higher maturity level in some functional competencies, such as safety, environmental management, contract administration, and commissioning and startup, while contractors showed a higher maturity level in other functional competencies, such as scope management, cost management, time management, and resource management. In terms of behavioural competencies, owners agreed more strongly than contractors that their teams possessed certain competencies.

By modeling the relationship between behavioural and functional competencies and performance (KPIs), the study found that significant improvements in project KPIs could be realized by increasing the level of maturity of functional competencies or by increasing the level of agreement of behavioural competencies. Moreover, it was found that when simultaneous improvements in multiple competencies were made, the improvements in project KPIs were even more significant. The results of this study are intended to provide practitioners with a method for evaluating their projects and teams and for benchmarking their competencies against other owners and contractors. In addition, these results will help organizations to quantify the relationship between project competencies and project performance in order to identify areas for improvement, which will lead to improved project practices and the development of more targeted and effective training programs for a greater return on investments in training.

For more information on the *Key Results and Recommendations workshop* or either of the IRC studies on construction labour productivity and organizational competencies and project performance, contact **Dr. Aminah Robinson Fayek** at *aminah.robinson@ualberta.ca*. ∎

Project Feature
Continued from page 1

The ability to predict worker performance is vital to any construction project performance model, yet research in the construction domain is lacking in methods for assessing the impact of worker motivation on performance and productivity. The goal of this study is to identify critical motivational factors at both the individual and crew levels and to determine the impact of motivational and situational/contextual factors on performance. Using this information, researchers will develop a model that describes the relationship between motivational factors, crew motivation, and performance metrics. In the long term, construction practitioners will be able to use this model to develop more accurate crew performance metrics. In addition, this knowledge will be useful in helping organizations to design policies and procedures targeted at improving crew motivation for better overall project performance.

For more information on the research projects discussed in this article and to explore the opportunity to get involved, contact **Dr. Aminah Robinson Fayek** at *aminah.robinson@ualberta.ca*. ■

IRC Research Team Profile
Continued from page 3

This sentiment rings true in the context of Dr. Robinson Fayek's research, which combines concepts from a number of disciplines including mathematics, business, and social sciences. As a writer and editor, Cassandra uses her skills to help Dr. Robinson Fayek and the IRC academic team achieve a consistent voice and vision in their work both individually and as a group. "I see myself as something of a content strategist," explains Cassandra, "I help to develop and optimize content, be it material for our website, awards and grant applications, presentations, and posters, in order to maximize its impact and help the IRC achieve its objectives." Cassandra notes that she is grateful to have been brought on board with the IRC during such a critical period and to have had the opportunity to be involved in the renewal application, "This whole experience has really allowed me to gain a more comprehensive understanding of IRC research as well as a new appreciation for its short- and long-term goals." Looking ahead, Cassandra will be working with Dr. Robinson Fayek and Dr. Abraham Tsehayae to develop new strategies to make findings from IRC research more accessible to industry stakeholders. ■

Dr. Aminah Robinson Fayek receiving the Excellence in Education Award at the 2016 APEGA Summit awards.

2016 APEGA SUMMIT AWARDS/ **APEGA**

CONGRATULATIONS

- In April 2016, Dr. Aminah Robinson Fayek was recognized with **APEGA Summit's 2016 Excellence in Education Award**. This award is issued to members of APEGA who have made exemplary contributions to teaching and learning at a recognized post-secondary teaching establishment in Alberta.

- Congratulations also to IRC PhD candidate Nima Gerami Seresht and Dr. Robinson Fayek for receiving an honorable mention by the **Canadian Society for Civil Engineering (CSCE)** Selection Committee for the **2016 Steven G. Revay Award** on their paper entitled "Career paths of tradespeople in the construction industry". ■