You are cordially invited to the

Graduate Research Seminar

of the

Department of Industrial Engineering

Date: Wednesday March 27, 2024
Time: 12:30 to 15:30 Atlantic Time
Venue: Room 120, Sexton Campus

Schedule

1230-1245 Dr. John Blake
IENG7000 and IENG8000 seminar requirements and process

1245-1310 Kimia Mostaghimi
Assessing maximum expected arrival time of marine rescue vessels to incidents in the Canadian Arctic

1310-1335 Gizem Koca
Discrete event simulation model of an acute stroke treatment process at a comprehensive stroke center: Determining the ideal improvement strategies to reduce treatment times

1335-1400 Mostafa Mostafavi Sani
Evaluating an optimal integrated renewable energy supply chain with the incorporation of hydrogen storage for a small community

1400-1410 Break

1410-1435 Adam Forward
Stroke treatment process similarities and variations across Canada: A qualitative study

1435-1500 Qixuan Zhao
Defining surge level in emergency medical services

1500-1525 Mahsa Pahlevani
Analyzing ALC status and LOS predictability: Towards a decision tool for identifying ALC patients

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Abstracts

Assessing maximum expected arrival time of marine rescue vessels to incidents in the Canadian Arctic

Kimia Mostaghimi, MASc. student

In recent years, global warming in Canada and Arctic regions has received more attention, due to observed noticeable increases of 1.7 °C, and 2.3 °C in the mean annual temperature for Canada and its northern regions, respectively. The rise in temperature, especially noticeable in the Arctic has caused changes to the amount of sea ice, resulting in a surge of activities and denser traffic. This in turn raises concerns about heightened risks of incidents and accidents. Addressing this concern, our study focuses on the Maximum Expected Time to be Rescued (METR) in the Canadian Arctic. The Polar Code, the International Maritime Organization's main regulatory vehicle for shipping safety in the Arctic, mandates ships to carry at least 5 days' worth of survival equipment for all People on Board (POB). The objective of this work is to determine whether this 5-day timeframe is sufficient for rescue services in Canadian Arctic waters. To achieve this, a rescue operation is divided into different phases, of which this research aims to examine only selected phases, namely the preparation time and the transit time, denoted as METR-VT. To achieve this, a strategic planning model is developed to estimate the time until maritime rescue assets arrive at the incident scene under varying conditions, including ice coverage, different times of the year, different ice-going capability of responding vessels, etc. This study primarily concentrates on the transit time of marine responses, including government and nearby non-governmental vessels (vessels of opportunity). By utilizing a simulation model for ship routeing in ice, along with data from the Automatic Identification System to obtain insights in the spatio-temporal patterns of available rescue vessels, the maximum expected arrival time of marine rescue vessels is determined for Canadian Arctic marine areas.

Discrete event simulation model of an acute stroke treatment process at a comprehensive stroke center: Determining the ideal improvement strategies to reduce treatment times

Gizem Koca, PhD candidate

Stroke is a devastating disease and one of the leading causes of disability. Ischemic stroke is treatable with thrombolysis and/or endovascular thrombectomy (EVT). However, faster treatment increases the probability of good outcomes. This study develops a discrete event simulation model of the acute stroke treatment process at the Comprehensive Stroke Center in Nova Scotia, Canada. Several improvement strategies were trialed to determine reduction of treatment. The sub-tasks in the treatment process were modelled using a discrete-event simulation in Python. Nine scenarios were proposed based on different phases in the process, and the impact of each scenario was investigated. Scenarios were tested individually and in combinations. The results were compared using the Wilcoxon-Rank Sum Test. The primary outcomes of the model were DTCT (door-to-CT time), DNT (door-to-needle time), and DGPT (door-to-groin-puncture-time). The simulation model was run 30 times to simulate 500 patients. *Collecting patient history on the way to the CT scanner (rather than in ED)* and *transporting patient directly to CT and completing neurological evaluation & blood drawing in the imaging area* showed the highest impact on reduction for DTCT (14.2 vs 12.4 minutes, $p<0.001$; 14.2 vs 12.7 minutes, $p<0.001$, respectively), DNT times (39.3 vs 37.5 minutes, $p<0.001$; 39.3 vs 36.4 minutes, $p<0.001$, respectively), and DGPT times (68.2 vs 65.7 minutes, $p<0.001$; 68.2 vs 64.6 minutes, $p<0.001$, respectively). *Rapid treatment decision but if treatment decision time is 2 minutes or lower, no reduction needed* resulted in lower DNT (39.3 vs 36.2 minutes, $p<0.001$) and DGPT times (68.2 vs 63.7 minutes, $p<0.001$).

Evaluating an optimal integrated renewable energy supply chain with the incorporation of hydrogen storage for a small community

Mostafa Mostafavi Sani, PhD student

The global effort to address climate change is causing an ever-growing enchantment with implementing clean energies as a viable substitute for fossil fuels. Uncertainties about renewable energies pose challenges, especially in small communities without reliable energy sources. Hydrogen is a promising solution due to its reliability and ability to store energy for long duration. However, there are still questions about if including hydrogen in renewable energy supply chains leads to an optimal configuration and balance between annual cost, environmental and societal impacts in order to meet the energy demands of a small community. Liverpool in Nova Scotia, Canada, was selected as a case study because it is susceptible to power outages and is appropriate for renewable energy development. After a tri-objective optimization, wind turbines (WT), Combined Heat and Power (CHP), Organic Rankine Cycles (ORC), and grid are identified as the most effective technologies. The best solution leads to a total annual cost of $6.14 million, an environmental impact of 0.2 species per year, and a social impact of 1256 utility. By incorporating the probability of power interruptions, the model shows a 2.2% decrease in social impact relative to having full grid access, which rises to 15.4% in an off-grid scenario. By 2030, it is projected that 22 MW of energy will be generated by hydrogen technologies as they gradually mature. Despite a 143% rise in total annual expenses, there is a significant 63% drop in environmental impact and a 4% increase in social impact in this situation. Hydrogen storage for the community has the ability to greatly enhance societal impacts and provide a more environmentally friendly option compared to traditional grid systems.

Stroke treatment process similarities and variations across Canada: A qualitative study

Adam Forward, MASc. student

Stroke is one of the leading causes of disability in Canada. There is a recognized disparity in the time to receive treatment between urban and rural hospitals. This qualitative study examines the variations and similarities in available resources, process workflow, adapted practices and data collection across Canadian hospitals through an overview of various perspectives on stroke treatment through healthcare experts. Semi-structured interviews were conducted with clinicians and care coordinators involved in stroke treatment. Clinicians with experience in acute stroke were recruited through snowball and purposive sampling for a breadth of perspectives. Thematic analysis was conducted to analyze recurring similarities and differences in acute stroke treatment across the sites. Fourteen participants were interviewed across seven different hospitals in five provinces. Analysis showed concerning resource variations, four participants in small hospitals lacked enough clinical staff and hospital beds for clinicians to go with the patient to imaging. In terms of adoption of best practices, participants in small centres found documenting treatment metrics was often delayed or unfinished. When it comes to process challenges, gathering accurate information early and communicating it throughout the process was a common challenge discussed. Considering data collection, most hospitals had a combination of paper and electronic data collection, resulting in re-entering data into their electronic system. As for workflow integration, most clinicians discussed integrating software applications to aid in stroke assessment calculations and the importance of telehealth consultations. There are noticeable variations in available resources and standardization of best practices in stroke treatment, primarily affecting rural centres.

Defining surge level in emergency medical services

Qixuan Zhao, PhD student

Surges in demand are a common challenge in emergency medical services (EMS). However, no research has developed a systematic way of defining surges levels in EMS. Inspired by the National Emergency Department Overcrowding Scale (NEDOCS), this study proposes a clustering algorithm based on genetic algorithms to define surge levels in EMS. Unlike NEDOCS which relies on subject assessments, this algorithm can objectively categorize surge levels with using EMS operational data. This adaptability also facilitates regional customization through hyperparameter adjustments, including features selection, and defining the number of surge levels.

Analyzing ALC status and LOS predictability: Towards a decision tool for identifying ALC patients

Mahsa Pahlevani, PhD candidate

The increasing demand for healthcare services presents challenges in managing patient flow within health systems. Among the critical issues in ensuring smooth operations with minimal inefficiencies are those related to Alternative Level of Care (ALC) patients. ALC patients, who no longer require acute care but face barriers to discharge, mainly due to lack of capacity in the next destinations, contribute to hospital overcrowding. This study proposes proactive approaches, using predictive analytics and Machine Learning (ML) models, to identify potential ALC patients and determine their ALC Length of Stay (LOS). In the first phase, the analysis includes binary classification tasks and regression models. The results showcase the efficacy of ML models, with the eXtreme Gradient Boosting model excelling in predicting ALC patients. Furthermore, the Random Forest regression model outperforms the other models in predicting the LOS for ALC patients. An analysis of the critical features involved in predicting these objectives identifies typical ranges for the features' values. Considering these feature combinations, two guidelines are provided for predicting ALC status and ALC LOS, offering valuable decision-making tools for healthcare management. In the next phase of the study, capacity planning of long-term care facilities is investigated, as it has a two-way correlation between ALC patients and the lack of capacity in long-term care facilities.