Towards an Understanding of the Contemporary Engineering Profession

Occupational Outcomes of Engineering Graduates in Canada by Gender, Race, and Location of Study

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Executive Summary

Historically, engineering occupations have been narrowly defined as occurring in traditional engineering disciplines (civil, mechanical, chemical, etc.), which in Canada, typically require professional licensure. In the contemporary context however, we recognize that engineering graduates commonly enter a wide range of occupations, often not requiring professional licensure and often not within traditional engineering fields. Since research on engineering occupations conventionally focuses on licensed professional engineers, little is known about the occupations of engineering graduates who do not get licensed and who do not fill traditional engineering roles. Additionally, the proportion of engineering graduates holding engineering positions, both traditional and non-traditional, varies when considering demographics such as race, gender, and location of study. This work aims to understand the diverse occupational outcomes of engineering graduates within Canada, and how these outcomes differ for engineering graduates by demographic characteristics.

Our research objectives were to (1) develop an expanded typology of engineering occupations that is specific to the Canadian context; (2) determine if there is inter- or intra- occupational segregation among engineering graduates in Canada by race, gender, location of study, and their intersections, and (3) to determine the industry sectors of employment for engineering graduates residing in Canada, using the occupational typology developed, with attention to differences between demographic groups.

Using 2021 Census data and the National Occupational Classification (NOC) system, we developed a comprehensive typology to fully characterize the occupations of engineering graduates in Canada. This typology includes considerations of the level of expertise required and the engineering-relatedness of the occupation. The presented typology includes eight occupational categories, as follows: (1) Working in STEM Management; (2) Working in Other Management; (3) Working in an Engineering Profession; (4) Working in Science, Technology, and Math (STM) Occupations; (5) Working in Other Professions; (6) Working in Technical STEM; (7) Working in Other Occupations Not Typically Requiring a University Degree; and (8) Occupation Not Applicable.

Using this typology, we analysed the 2021 Census data and found that there are indications of inter- and intra- occupational segregation based on race, gender, location of study, and their intersections, on the occupational outcomes of engineering graduates in Canada. We have found that across all race and gender groups, those who obtained their degree inside of Canada had a significantly higher proportion of occupations in “Engineering Professions” and “Management Professions”, than those who trained outside of Canada. We see that those who studied outside of Canada are employed at a higher proportion in “Other Occupations Not Typically Requiring a University Degree”, and “Occupation Not Applicable”. Our findings align with previous work that suggests that white men have a higher proportion of graduates in management and engineering professions, while racialized women have the lowest proportion of graduates in management and engineering professions, for both domestically and internationally trained engineering graduates.

Our work also presents an investigation into the industry sectors of employment for engineering graduates. Unsurprisingly, we find that most engineering graduates are employed in “Professional, scientific and technical services”, followed by “Manufacturing”. However, the proportion of graduates within this category change when analysed by race, gender, and location

of study. We find that white men hold the largest proportion of occupations within these industry sectors, while racialized women and white women hold the lowest proportion.

The major implications of this work are two-fold. First, we have found that there are indications of inter- and intra-occupational segmentation along lines of gender, race, and location of study for engineering graduates within Canada. Second, we have found that engineering graduates from Canadian institutions are employed in diverse occupations and industries, which raises important questions of whether the current engineering curriculum within Canada is adequately preparing graduates for diverse career paths. Future work should further disaggregate by country of study to investigate if certain countries of study are preferrable for Canadian employment than other countries, and if certain engineering disciplines have more traditional or more diverse occupational outcomes.

Contents

1. Background

1.1 Introduction

In Canada, different stakeholder groups have a shared interest in the occupational outcomes of engineering graduates for wide-ranging reasons. Related to national interest, the government of Canada is concerned with growing and retaining STEM talent, including engineers, within its borders, to ensure there is continued necessary expertise to advance scientific innovation and economic growth (Invest in Canada, 2023). For engineering educators and regulators, a primary concern is whether the investments made in training engineering students have successfully contributed to growing the engineering workforce (Brunhaver et al., 2018; National Academy of Engineering, 2004, 2018). For equity advocates and researchers, the continued underrepresentation of certain groups and further professional attrition (e.g., from women and racialized individuals[1]) represent the ongoing need to increase equity, diversity, and inclusion within the profession.

Historically, only a fraction of engineering graduates practice as licensed engineers, and that fraction is even smaller among graduates educated outside of Canada. In most discussions, licensure is used as a proxy to account for engineering graduates who are deemed persistent in the profession. But this proxy measure presents an under-estimation of people engaged in engineering work. In this study, we take a broader approach to examine the professional outcomes of all engineering graduates, licensed or not.

We began by drawing on existing research to develop a typology of engineering occupations in the Canadian context that could be adopted for use with Canadian Census data. Employing our classification framework with 2021 Canadian Census estimates, we examined the occupational outcomes of all engineering graduates residing in Canada to better understand who among all engineering graduates are working in, (1) professional engineering occupations, (2) engineering-related occupations or STM occupations, and (3) occupations completely unrelated to engineering or STM. We further disaggregated these findings by industry sectors and intersectionally by race, gender, and location of study, to examine for disparity in occupational outcomes between demographic groups.

1.2 Occupational persistence in a changing profession

A major source of engineering licensure data is Engineers Canada, the national organization of the provincial and territorial regulators of professional engineers across Canada, which tracks the ‘graduation to licensure’ conversion rate of recent engineering graduates across the country. Engineers Canada data show that women continue to only make up 19 percent of newly licensed engineers in 2023, and an even smaller 15 percent of all practicing licensed Professional Engineers across Canada (Engineers Canada, 2024).

[1] The Ontario Human Rights Commission (2005) refers to racialization “as the process by which societies construct races as real, different and unequal in ways that matter to economic, political and social life.” Racialized persons include those who have been attributed with racialized characteristics, where White has historically been treated as the “norm”.

But there is a complexity to using licensure as a proxy for occupational persistence, and it relates to the diversity of engineering career paths that deviate from those most congruent with traditional engineering disciplines (e.g., in public administration, financial services) (Rottmann et al., 2019), including sub occupations within engineering such as educators and researchers, and engineering managers (Brunhaver et al., 2013), that often do not require licensure. Additionally, engineering practitioners in industries such as information technology are licensed overall in a very small proportion, as licensure is typically not required for this work. Designed mostly for the development of a somewhat 'homogenized' version of the engineering practitioner, engineering education continues to be hyper-intensive in math and science (Perlow & Bailyn, 2018), often to the exclusion of development in other areas. Given the increasing diversity of roles and career paths that engineering students can obtain upon graduation, the question becomes whether the model of engineering education is adequately equipping students for the diversity of career opportunities that are outside of traditional categories of engineering occupations (Brunhaver et al., 2013).

1.3 Research on occupational outcomes of engineering graduates

1.3.1. Redefining boundaries around engineering occupations

In the US, research using large national databases such as the ones from the **National Center for Education Statistics (NCES)** and the **Scientists and Engineers Statistical Data System (SESTAT)** has found that while only 36% of engineering graduates in the US are employed in "engineering occupations narrowly defined," an additional 46% are employed in what it termed "engineering approximate occupations" (National Academy of Engineering, 2018, p.2). In these adjacent occupations, knowledge and skills developed through engineering training are *heavily* relied upon. The report also reaffirmed the lack of diversity as a problem within engineering, calling for better communication about the pathways and opportunities within the profession as part of the outreach to underrepresented communities (National Academy of Engineering, 2018). Notwithstanding the other systemic inequities apart from awareness that perpetuates underrepresentation, promoting the profession as one with expanding boundaries may be a good engagement strategy, especially for members of underrepresented groups that do not identify with the occupation of engineering, narrowly defined. As the boundary of what constitutes engineering occupations comes to be redefined in the contemporary context, researchers have tried to systematically develop a new typology of engineering occupations based on the concept of "engineering relatedness" (Magarian & Seering, 2022).

1.3.2. Typologies of engineering occupations and career paths: Past & Present

There have been various approaches in the literature for defining what constitutes an "engineering" occupation. Rohde et al., (2020) defined an engineering occupation based on the presence of the word "engineer(ing)" in the job title, while engineering-related occupations were those that did not have "engineering" in the job title, but whose occupation was located in an engineering-related sector. All other occupations were classified as "non-engineering". While this allows a systematic evaluation of occupations, this typology does not specifically account for differences within engineering occupations. Brunhaver et al. (2013) further disaggregated

"engineering occupations" into sub-occupations including engineering managers, engineering consultants, and engineering practitioners, and found differences in the feelings of engineering relatedness and skills most used between these groups.

Others have focused on the duties performed within certain occupations to designate "engineering occupations". Frehill (2007) utilized participant's self-described primary work activities (administrative/related, engineering, sales/purchasing/marketing, teaching, other) to categorize occupations of engineering graduates. For others, design has been used as a unifying element across engineering work. Magarian and Seering (2020) categorized engineering occupations as those with a "design instantiating or governing" role where there are direct design "determinate" responsibilities (e.g., individual contributors, engineering managers, and directors), and "engineer-Conpar" occupations as those with a design moderating role, where contribution towards design is resultant of collaboration and other forms of influence (e.g., analysts, cross-disciplinary managers).

In addition to "engineering-relatedness", occupations broadly have also been classified based on the appropriateness of the occupation for the education and skill level of the employee. Education-Occupation match and mismatch are terms referring to whether an occupation is below, equal, or above the skill level of the worker (Chiswick & Miller, 2009; 2012). Typically, worker skill level has been assessed using the highest degree achieved by the worker and the typical educational and experience requirements of an occupation (Hartog, 2000). Konnikov (2019) identified three skill "levels" within engineering occupations from highest to lowest: managerial, professional, and technical. Previous research indicates inequities of occupational outcomes across managerial, professional, and technical-level positions for underrepresented groups (Konnikov, 2023), therefore skill-level is included in our occupational typology.

As discussed, two major characteristics can be useful in defining occupations for engineering degree holders, the "engineering-relatedness" of the occupation, and the expertise level generally required for the occupation. This follows the framework for occupational (mis)match presented by Salas-Velasco (2021) and allows us to not only investigate if the occupation is appropriate for the worker's area of study (i.e. engineering relatedness) but also the level of expertise required for the occupation (i.e. undergraduate versus high school education requirements). A review of the literature shows that most typologies focus on only one of these characteristics, and a more comprehensive typology is required to understand the diversity of contemporary occupations held by engineering graduates.

No matter how engineering occupations are categorized, evidence suggests not all occupations or career pathways are equally accessible to all engineering graduates or conversely, similar pathways may lead to different professional outcomes for different demographic groups.

1.3.3 Intra-occupational stratification and career path streaming of engineering graduates

Researchers have examined the disparity in occupational outcomes of underrepresented groups in professions such as medicine (Crompton, Le Feuvre, and Birkelund 1999; Pickel and Sivachandran 2024), law (Bolton and Muzio 2008), and engineering (Gilmartin et al. 2024). Intra-occupational segregation is a phenomenon where members within a profession are segmented into higher/lower positional status, income categories, organizational authority, and/or other forms

of stratification, often along race and gender lines (Campero 2021). The causes have been attributed to bias and discrimination.

Specific to engineering, Campero (2021) found that women in software engineering were disproportionately hired into quality assurance (QA) positions (considered lower status and lower paid), compared to developer jobs. Although women with stronger educational credentials were less likely to apply to QA jobs, men, regardless of educational credentials, were even less likely to apply to QA jobs compared to women.

Researching engineers across industry sectors, Cardador (2017) revealed several inadvertently negative consequences for women who have risen into management roles; they included the reinforcement of gender stereotyping in the workplace where women were seen as less technical if they were considered managerial, and weakened engineering professional identity of women who saw themselves as moving away from engineering into management – an unexpected identity development for women not seen in men. Although the logical assumption is that advancing into management would be a desired career path for women in engineering, the resultant threat to professional identity along with diminishing work/life balance threatens to undermine women's capacity to persist within the engineering profession (Cardador, 2017).

Qualitative research documenting the executive track to C-Suite in traditional engineering firms (e.g., chemical processing, manufacturing) have been drawn primarily from experiences of engineering leaders who are white and male given the historic homogeneity of this group, while career paths not conventionally associated with engineering are often represented by women and other underrepresented minority groups (Rottmann et al., 2019). More recent quantitative research did not find race or gender to be associated with the executive track as a career path, although racialized women were found disproportionately overrepresented on the non-traditional career path (Chan et al, 2024).

Using 2021 Canadian Census data, the **Ontario Society of Professional Engineers (OSPE)** reported that of all engineering graduates in Ontario, only 22% of women graduates were working in engineering, compared with 31% of men (Weissling, 2023). The intersectional dimensions of this disparity become starkly evident when data were disaggregated further by location of study. Canadian degree holders, both men (41%) and women (35%) were employed as engineering professionals in much greater proportion compared with international engineering graduates (IEGs); only 20% of men and 13% of women with engineering degrees from outside of Canada were employed in engineering and engineering management. These findings echo previous research that also examined census and national household survey data, but those studies were limited in how they attended to intersectional identities. Boyd and Thomas (2001) examined only male engineering graduates and found that those who migrated as adults had poorer labour market outcomes and were less likely to be employed in management, engineering, or technical occupations, compared with those who were Canadian-born or had migrated as children. Looking at STEM graduates more broadly, Boyd and Tian (2017) found immigrants were less likely to be employed in STEM occupations compared to Canadian-born, and the income disparity was starkest between immigrant non-STEM workers, compared with Canadian-born STEM workers, among all who were STEM-educated. In this study, although gender was accounted for and was consistently a negative predictor of outcomes for women, it was treated as a control variable as a gender analysis was not the intent of the study (Boyd & Tian, 2017).

There is limited research that explicitly focuses on race as part of its central analysis, and there is no data from Engineers Canada on the proportion of racialized professional engineers in the country. There is research that addresses race in its examination of discrimination and exclusion within the profession, but it does not focus on occupation or industry sector segmentation by race and gender (e.g., Adams & Flores, 2022), or is focused narrowly on IEGs (e.g., Chaze & George, 2013).

2. Research Objectives

This study was built on two existing areas of research related to engineering occupational outcomes: (1) The expanding occupational boundaries of the engineering profession; and (2) Equity concerns around the differential occupational outcomes of engineering graduates based on intersectional identities and location of study.

Our research objectives were:

1. To develop an expanded typology of engineering occupations that is specific to the Canadian context, guided by emergent research and relying on the existing framework of the National Occupational Classification (NOC) system;
2. To determine if there is inter- or intra-occupational segregation among engineering graduates in Canada, by race, gender, location of study, and their intersections; and
3. To determine the most prevalent industry sectors of employment for engineering graduates residing in Canada, using the occupational typology developed and with attention to differences between demographic groups.

Drawing from the literature on new typologies of engineering occupations (Magarian & Seering, 2022; National Academy of Engineering, 2018; Arjaujo & Salerno, 2021; Konnikov, 2023; Salas-Velasco, 2021), we first developed an expanded typology of engineering occupational categories that would be applicable across Canada and better aligned with the emergent understanding of engineering and engineering-adjacent occupations.

Using our new classification scheme, we explored occupational patterns between intersectional identities, and then between industry sectors to ensure we were not conflating occupation with sector of employment. For example, an engineering graduate can work in financial services, an industry sector not traditionally associated with engineering; and within financial services, the graduate can work in a professional engineering occupation (e.g., computer engineer), an "engineer-conpar" as Magarian and Seering (2022) defined (e.g., Environmental/Social/Governance - ESG analyst), or in a non-engineering-related occupation (e.g. financial manager).

Based on previous research, we expect to find a greater proportion of White Men in the more narrowly defined engineering occupations, more senior roles, and traditional engineering industry sectors such as civil, mechanical, etc. (Rottmann et al., 2019; Chan et al., 2024).

3. Methods

The data for this research were collected as part of the 2021 Canadian Census and accessed through customized data tables provided by Statistics Canada. The data were estimates based on 25% sampling used for the long-form questionnaire of the census. For this research, our population of focus was those 25 to 64 years of age, with a university Bachelor's degree or higher in engineering.

For this group, we retrieved information on the following variables: Gender (Male+, Female+), Visible Minority Status.[2] (Visible Minority, Not a Visible Minority), Indigenous Identity[3] (Indigenous Identity, Non-Indigenous Identity), Location of Study (Completed the highest degree in Canada, Completed the highest degree outside of Canada), Occupation, and Industry. For more details on the variables, please refer to Appendix A.

In this report, engineering graduates are considered "Racialized" if they identify as being a Visible Minority group member or as an Indigenous person.

For research objective 1, we utilized the census dictionary for definitions of the occupational categories under the NOC, to sort the categories into our refined engineering occupational typology.

For research objectives 2 and 3, we disaggregated our population of engineering graduates by our demographic variables of interest for between-group descriptive comparisons. The data tables from Statistics Canada required extensive restructuring in order to meet research objectives 2 & 3. Once the data were organized into appropriate cross-tabulations, the analyses were straightforward and involved mostly examining proportional differences between categories.

[2] The Employment Equity Act defines visible minorities as "persons, other than Aboriginal peoples, who are non-Caucasian in race or non-white in colour."

[3] Indigenous Identity "refers to whether the person identified with the Indigenous peoples of Canada. This includes those who identify as First Nations (North American Indian), Métis and/or Inuk (Inuit), and/or those who report being Registered or Treaty Indians (that is, registered under the Indian Act of Canada), and/or those who have membership in a First Nation or Indian band." (Statistics Canada, 2023).

4. Findings

4.1 Demographic Analysis

In 2021, men composed the majority of engineering degree holders in Canada, with a representation of 36% of degree holders identifying as White Men and 42% of degree holders identifying as Racialized Men, while 8% of degree holders identified as White Women and 18% of degree holders identified as Racialized Women. The total number of engineering graduates (*N*=674,120) by gender and race are shown in Figure 1, below. It should be noted that the age range for our population is 25 – 64 years, so more recent trends of equity-seeking recruitment and retention initiatives within Canadian engineering programs (Engineers Canada, 2020; Wilson et al., 2021) likely will not have affected our population of interest.

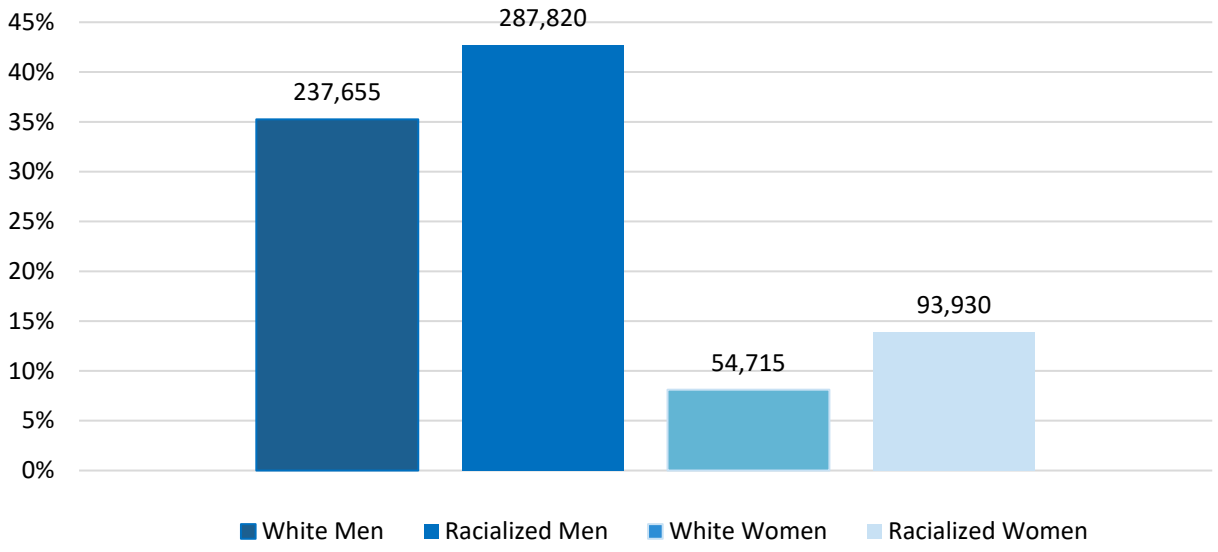

Figure 1: Engineering Graduates with Bachelor's degree or higher in Canada, by gender and race

We further disaggregated the population of interest by location of study, finding that 53% of engineering degree holders obtained their degree within Canada, and 47% obtained their degree outside of Canada. When further disaggregated by race and gender, we see that the majority of White Men (76%) and White Women (64%) obtained their engineering degree within Canada, while the majority of Racialized Men (61%) and Racialized Women (67%) obtained their engineering degree outside of Canada.

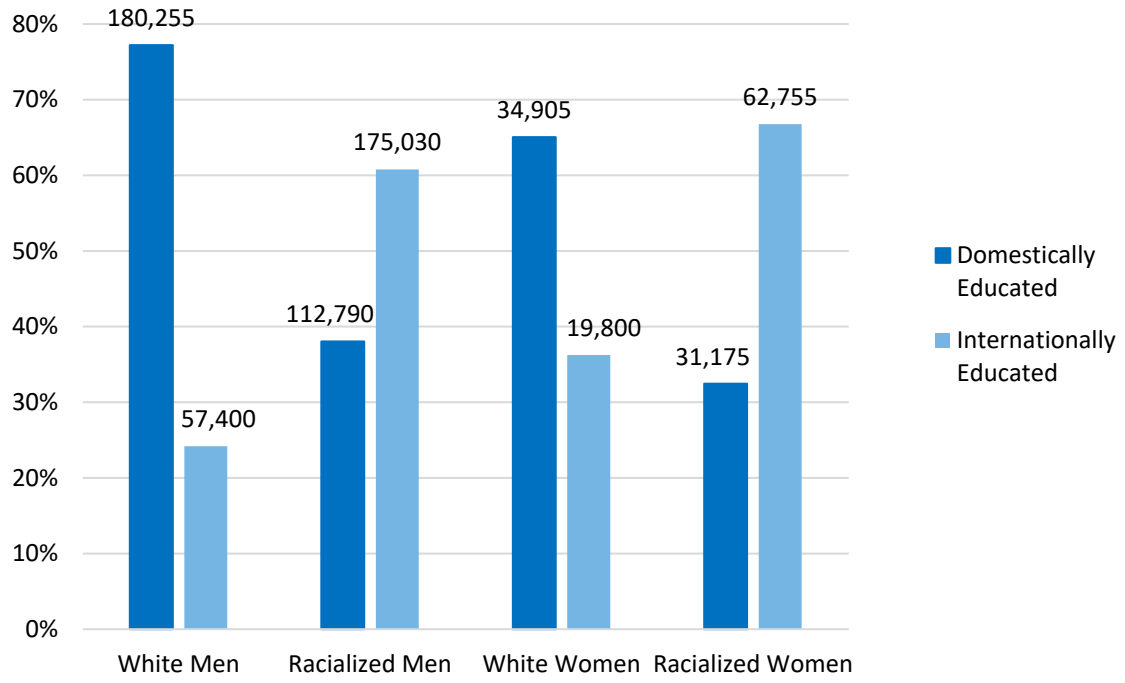

Figure 2: Proportion of Engineering Graduates in Canada by Gender, Race, and Location of Study

4.2 Expanded Occupational Typology for the Canadian Context

Traditionally, engineering graduates have been categorized as either working or not working in an engineering profession (e.g. Lichtenstein, 2009; Sheppard, 2010). When analyzing the 2021 Census data with this narrow typology, we find that 27% of all engineering graduates are working in an engineering profession, while 73% of all engineering graduates are not working in an engineering profession, as shown in Figure 3, below.

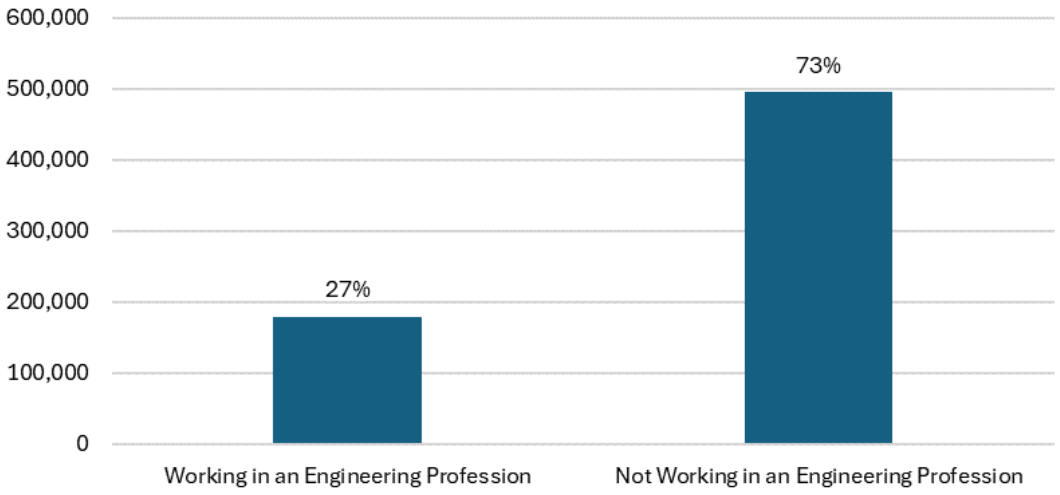

Figure 3: Proportion of Engineering Graduates in Canada Working in an Engineering Profession

This dichotomous typology only provides a crude and perhaps misleading overview of occupational outcomes for engineering graduates and limits our understanding of the variety of occupations held within these categories. A more comprehensive typology is required to understand the diverse occupations of engineering graduates, including those not in a traditional engineering profession. Drawing from work by Salas-Velasco (2021), we present a typology that broadly categorizes occupations by "expertise level" (i.e. management; professional; occupation not requiring a university degree) (Araujo & Salerno, 2021; Konnikov, 2023) and engineering-relatedness (i.e. engineering; engineering-related; and non-engineering) (Frehill, 2010). Expertise level was assessed using the Training, Education, Experience, and Responsibilities (TEER) level required for an occupation (NOC, 2021), while engineering-relatedness was assessed using the Broad Occupational Categories (BOCs). The category "Occupation not Applicable" includes those who never worked for pay or in self-employment, or last worked for pay or in self-employment before 2020. Due to the constraints of the data tables, we present eight occupational categories for the understanding of engineering career paths, presented in Table 2, below.

Table 2: Occupational Typology for Engineering Graduates in Canada

Occupational Category	**Expertise Level**	**Engineering Relatedness**
Working in STEM Management	Management	Engineering/Engineering related
Working in Other Management	Management	Non-engineering
Working in an Engineering Profession	Typically Requiring Undergraduate	Engineering
Working in a STEM Profession, except engineering	Typically Requiring Undergraduate	Engineering Related
Working in Other Professions	Typically Requiring Undergraduate	Non-engineering
Working in Technical STEM	Typically Not Requiring an Undergraduate Degree[4]	Engineering/Engineering related
Working in Other Occupations Not Typically Requiring a University Degree	Typically Not Requiring an Undergraduate Degree	Non-engineering
Occupation Not Applicable	N/A	N/A

Ideally, "Working in Engineering Management" and "Working in Technical Engineering" occupations would be their own categories, however, due to the nature of the Census 2021 data tables received, we were unable to separate these categories from "Working in STEM Management" and "Working in Technical STEM", respectively. Future work may use these additional categories to provide insight into engineering graduates specifically in these occupations.

[4] We recognize that technical occupations are bona fide occupations that can provide gainful employment, and a college diploma is a credential for many technical occupations. However, because such occupations are classified as typically not requiring an undergraduate degree, we interpret this as a potential education-occupation mismatch for engineering graduates.

The improved typology allows us to further investigate the nuances of those graduates who would otherwise be categorized as “Not working in an engineering profession”, as well as those in management positions, and those in occupations that do not necessarily require a university degree. Figure 4, below, shows the distributions of all engineering graduates in Canada across the eight categories described in the typology. As previously discussed, 27% of engineering graduates are employed in Engineering Professions. Surprisingly, “Other occupations not requiring a university degree” account for 23% of engineering degree holders. This is a concerning trend, as it indicates that many graduates are in occupations where they are not fully utilizing the skills and knowledge gained from their engineering degree.

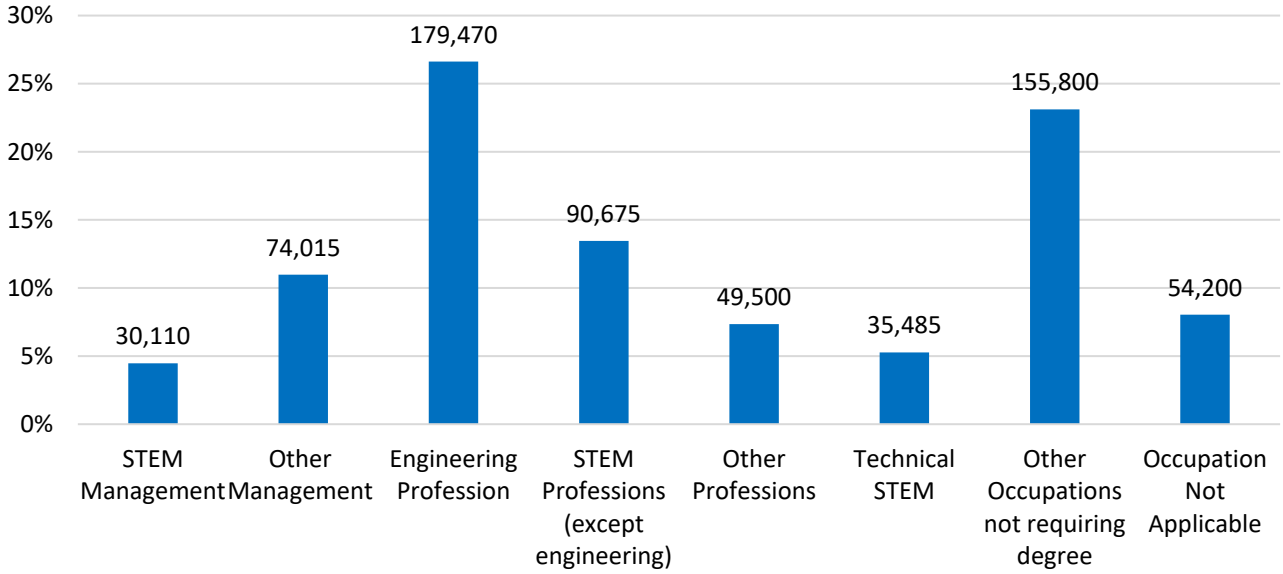

Figure 4: Occupational Outcomes of all Engineering Graduates in Canada categorized using new typology

4.3 Inter- or Intra-occupational segregation by race, gender, location of study, and their intersections

To understand the effects of race, gender, and location of study on these occupational outcomes, the data was disaggregated and further analyzed. We conducted analysis first along the managerial level, followed by the professional and technical levels.

4.3.1 Occupations in Management

The two managerial categories in our typology, “Management in STEM” and “Other Management” were disaggregated by race, gender, and location of study to investigate if inter- or intra-occupational segregation is present. The proportion of engineering graduates within these management categories is shown in Figure 5.

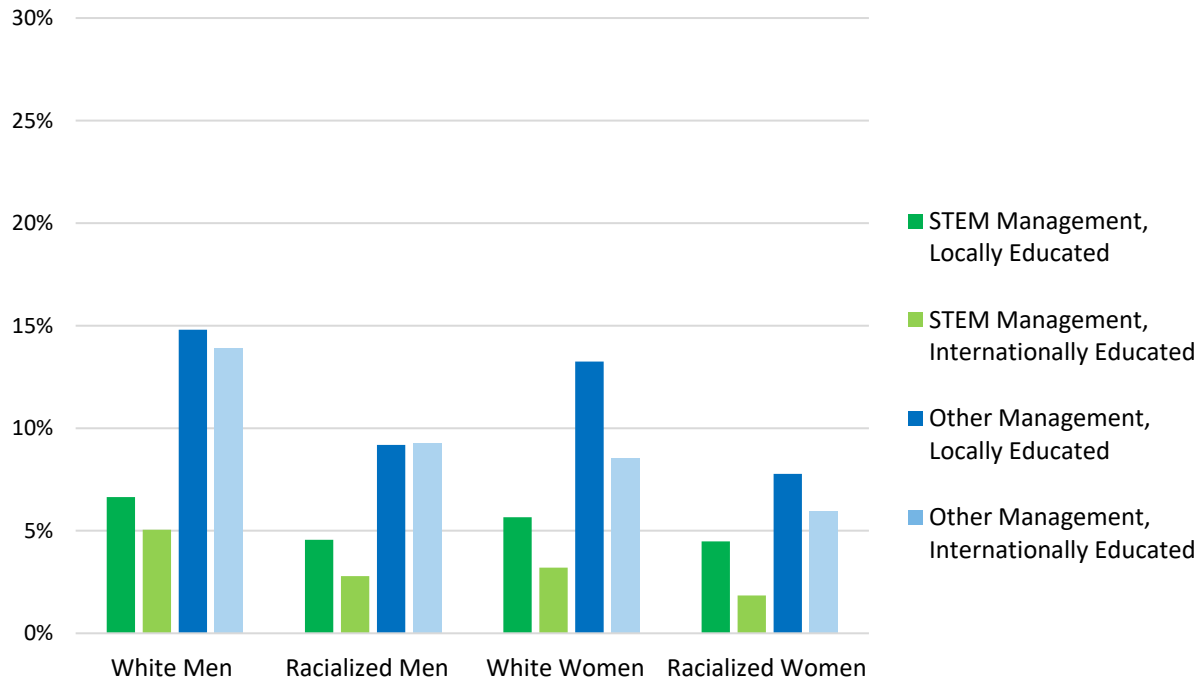

Figure 5: Proportion of Engineering Graduates in Canada Working in STEM Management and Other Management by Race, Gender, and Location of Study

Within these management categories, we see clear disparities between groups by race, gender, and location of study. Overall, we see that a higher proportion of all graduates are working in Other Management compared to STEM Management. For almost all Race x Gender groups, those who have studied inside Canada were proportionately more represented in STEM Management and Other Management compared to those who studied outside of Canada (except for Racialized Men, who have equivalent proportions of working in Other Management).

Generally, White Men and White Women, regardless of location of study, have higher proportions in STEM Management and Other Management, compared to Racialized Men and Racialized Women. White Men who studied in Canada have the highest occupancy of both Management in STEM (7%, *n*=11,995) and Other Management (15%, *n*=26,755). In contrast, Racialized Women who studied outside of Canada have the lowest proportion of Management in STEM (2%, *n*=1,155) and Other Management (6%, *n*=3,740).

4.3.2 Occupations in Professions

Next, we analyze the occupational outcomes for Race x Gender x Location of Study groups for Occupations in an Engineering Profession, Professional Occupations in STEM except Engineering, and Other Professional Occupations (Typically requiring an undergraduate degree). Results are shown in Figures 6 – 9, below.

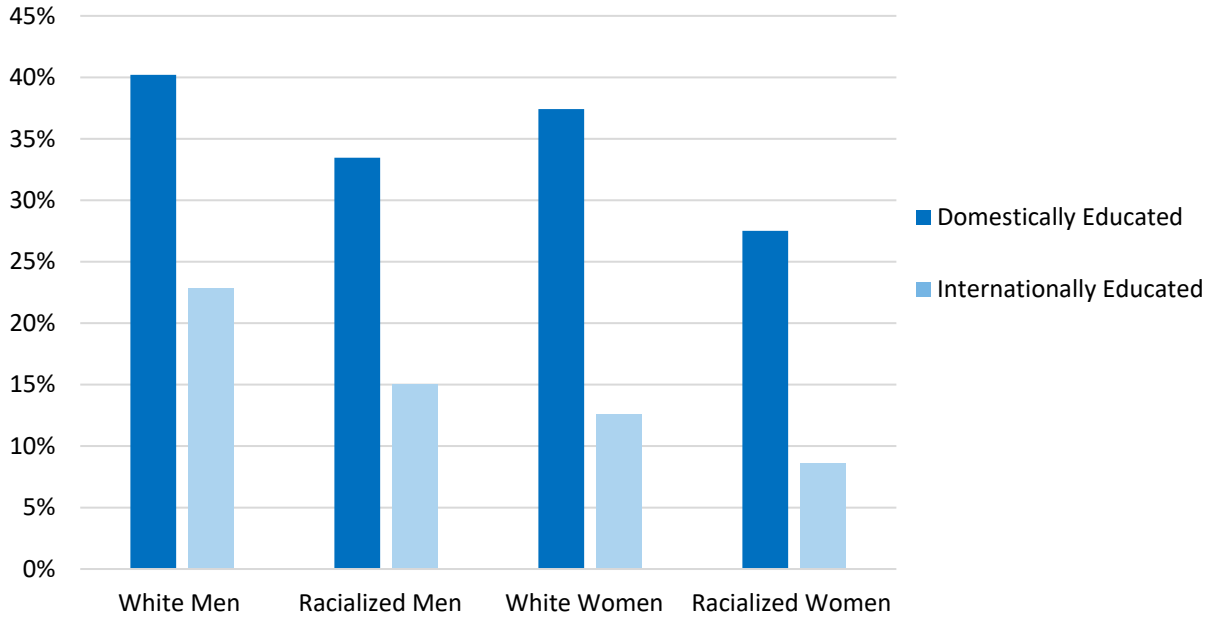

Figure 6: Proportion of Engineering Graduates in Canada Working in an Engineering Profession by Race, Gender, and Location of Study

Strikingly, across all groups the proportion of graduates working in an Engineering Profession is much greater for those who studied within Canada than those who studied outside of Canada. The highest proportion of those working in Engineering Professions for those who studied inside Canada and outside of Canada are White Men (40%, *n*=72,415; 23%, *n*=13,105, respectively), and the lowest proportion are Racialized Women (28%, *n*=8,710; 9%, *n*=5,400, respectively).

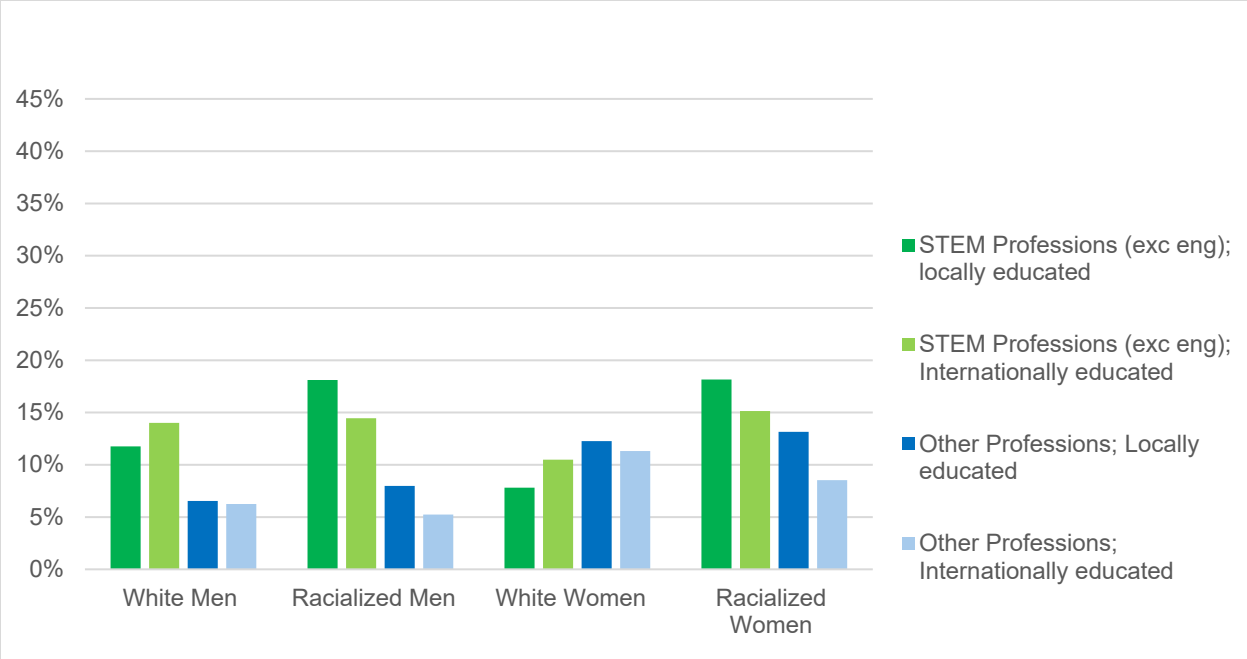

Figure 7: Proportion of Engineering Graduates in Canada Working in STEM Professions Except Engineering, and Other Professions, by Race, Gender, and Location of Study

Interestingly, Racialized Men and Racialized Women who obtained their degree within Canada have the highest proportions of those working in STEM Professions Except Engineering (18%, *n*=20,130; 18%, n=5,555, respectively). For this occupational category, we do not see the large discrepancies between those who studied inside versus outside of Canada, unlike the differences present in the Engineering Profession category. *One source of this occurrence may be the presence of IT and software engineering occupations within this category rather than in the "Engineering Profession" category, which may reflect a lower barrier to entry for those educated outside of Canada since IT work does not typically require licensure*.

Both White Women and Racialized Women, regardless of location of study, have the highest proportions within the Other Professions category (between 9% and 13%) compared to White Men and Racialized Men (between 5% and 8%).

4.3.3 Other Occupations

The categories of "Working in Technical STEM" and "Working in Other Occupations not Typically Requiring a University Degree" can be categorized as a "vertical mismatch" (Salas-Velasco, 2021), "overeducation" or "underemployment". Occupations within these categories typically do not require an undergraduate degree.

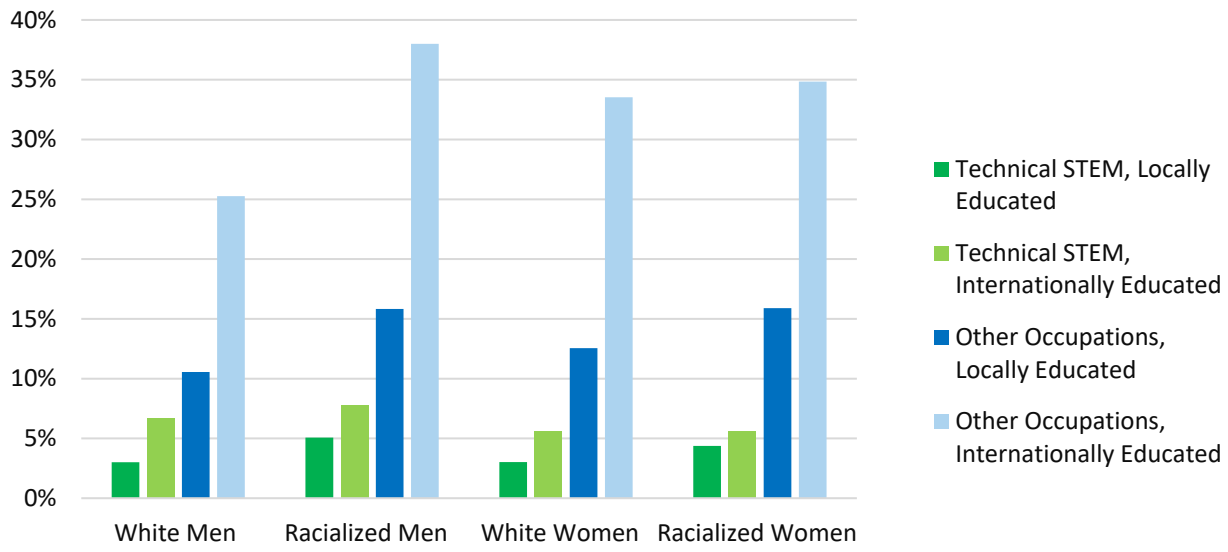

Figure 8: Proportion of Engineering Graduates in Canada Working in Technical STEM and Other Occupations not Typically Requiring a University Degree by Race, Gender, and Location of Study

Our results show that graduates who obtained their degree outside of Canada are employed in occupations *not typically requiring a university degree* at substantively higher proportions than those who studied within Canada. We see that this effect is smaller for White Men who studied outside of Canada (26%), compared to Racialized Men (38%), Racialized Women (35%) and White Women (34%), indicating that White Men who trained outside Canada have more favorable occupational outcomes than the other race x gender groups who also trained outside of Canada.

4.3.3 Occupation Not Applicable

Lastly, the occupational outcomes for those who were categorized as "Occupation not Applicable" were analysed by race, gender, and location of study. As previously described, the category "Occupation not Applicable" includes those who never worked for pay or in self-employment, or last worked for pay or in self-employment prior to 2020. Within this category are people recently retired.

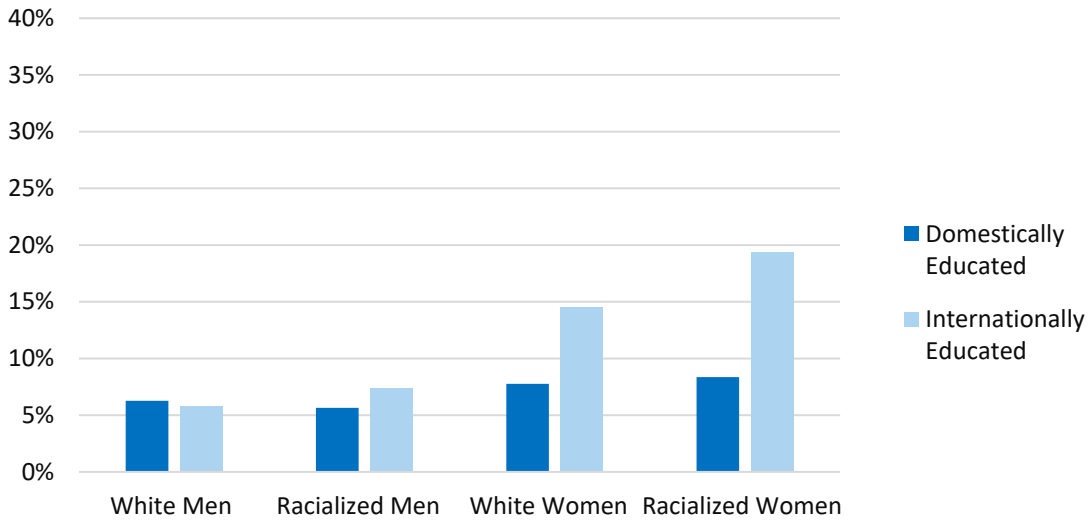

Figure 9: Proportion of Engineering Graduates in Canada Occupation Not Applicable

Within this category, we see higher proportions of Racialized Women (19%, *n*=12,160) and White Women (15%, *n*=2,875) who studied outside of Canada, than all other groups (typically 6-8%). This may indicate that internationally trained women engineering graduates in particular, compared with all other demographic groups, have greater difficulty gaining employment within Canada, or that there is a higher proportion who chose not to enter into employment at all.

4.4 Industry Sectors of Employment for Engineering Graduates

In addition to occupational outcomes by engineering-relatedness and skill level, we also analysed the industry sectors that the engineering graduates were working in, to better understand the context of their employment. Industry Classifications were defined using The North American Industry Classification System (NAICS) 2017, Version 3.0.

Table 3. **Top 3** Industry sectors of employment, by race x gender

		Total	White Men	Racialized Men	White Women	Racialized Women
Most prevalent industry sectors of employment	Prof/Sci/Tech Services	26%	30%	24%	24%	22%
	Manufacturing	15%	17%	15%	12%	9%
	Construction	7%	9%	7%		
	Retail					7%
	Public Admin				9%	

"Professional, scientific and technical services" is the most prevalent industry sector across all demographic groups, although there are differences in the percentage of engineering graduates working in this sector by race and gender. White Men have the highest occupancy (30%) while Racialized Women have the lowest occupancy (22%). This aligns with previous findings of the streaming of underrepresented groups out of traditional engineering occupations (Chan et al., 2024). We can see further disparities when disaggregating by location of study.

Table 4. **Top 3** Industry sectors of employment of engineering graduates with degrees from Canada, by race x gender

		Total	White Men	Racialized Men	White Women	Racialized Women
Most prevalent industry sectors of employment	Prof/Sci/Tech Services	30%	31%	30%	27%	28%
	Manufacturing	15%	17%	14%	12%	10%
	Construction	7%	8%	6%		
	Education			6%		7%
	Public Admin	7%			11%	

Table 5. **Top 3** Industry sectors of employment of engineering graduates with degrees from outside Canada, by race x gender

		Total	White Men	Racialized Men	White Women	Racialized Women
Most prevalent industry sectors of employment	Prof/Sci/Tech Services	21%	25%	21%	18%	19%
	Manufacturing	14%	17%	16%	10%	8%
	Construction	7%	11%	8%		
	Transportation			8%		
	Retail					8%
	Health				7%	

“Professional, scientific and technical services” remains the most prevalent industry sector for all groups regardless of location of study. However, the percentage of occupancy within this industry sector is higher for all groups for those whose location of study was within Canada. For those who studied within Canada, the highest percentage of occupancy belongs to White Men (31%), while the lowest occupancy is White Women (27%). In contrast, the percentages are much lower for those who studied outside of Canada, with the highest occupancy of White Men (25%) and the lowest of White Women (18%).

5. Discussion

Based on the analysis presented, we see several interesting trends among the occupational outcomes of engineering graduates within Canada. First, we have shown that a comprehensive typology is critical for a fulsome understanding of engineering graduates’ occupational outcomes. Our typology categorizes occupations along two axes: the required skill/expertise for the occupation, and the engineering-relatedness of the occupation. This allows us to understand the skill-level that engineering graduates are working at, and provides some insight into the application of engineering knowledge within their occupation. Our typology is also directly linked to the numerical system within the National Occupational Classification System (2021) used by Statistics Canada, to reduce ambiguities in data analysis.

Using this typology, we have found that engineering graduates hold a diverse range of occupations in terms of both skill-level and engineering-relatedness, and there are indicators of inter- and intra-segregation within these occupations based on gender, race, and location of study.

Generally, graduates who obtained their degree from within Canada were employed in higher proportions within Management and Engineering Profession occupations than those who obtained their degree from outside of Canada. These findings align with previous work (e.g. Boyd & Thomas, 2001; Konnikov, 2023) which found that internationally trained engineers were less likely than their Canadian trained peers to be employed in engineering occupations. One explanation for this misalignment may be that internationally trained engineers must undergo a qualifications recognition process within Canada, which favours assimilation to Canadian mainstream ideals (Friesen, 2016). Friesen & Ingram (2013) also found that employers noted cultural differences and English language barriers as challenges that they often encountered when employing internationally trained engineers. Other researchers have written about the role that regulatory bodies have played in the persistent exclusion of international engineering graduates (Girard and Bauder 2007), and the sociocultural challenges they face in learning and negotiating the Canadian labour market (Shan 2013). So, in what categories are the internationally trained engineers employed? We see an overrepresentation of internationally trained engineers in “Other Occupations not Typically Requiring a University Degree”. This category can be considered to have the largest occupational mismatch, as these occupations typically are not closely related to engineering skills and knowledge. Within this category are “survival jobs” which are generally low-skilled, low-wage, insecure forms of employment (Creese & Weibe, 2012). The high proportion of engineering graduates who completed their study outside of Canada with occupations in this category indicate systemic barriers to appropriate employment

for this group, and a need for significant support for incoming engineering graduates to find employment well matched to their level of education.

Along with occupational segregation between engineers who studied inside and outside of Canada, we see differences in the occupational outcomes of women and men. Most notably, we see a higher proportion of women (regardless of race or location of study) being employed in “Other Professions Typically Requiring an Undergraduate Degree.” This “streaming” of women engineering graduates away from traditional engineering pathways has been highlighted in recent literature (Chan et al., 2024).

Our findings also highlight differences in the occupational outcomes by race. Previous research has indicated that both local and internationally trained engineers who are racialized experience greater barriers into and within engineering professions (George and Chaze, 2014). Our findings show that Racialized Men and Racialized Women have lower proportions of employment within “STEM Management”, “Other Management”, and “Engineering Profession” occupations, which has been previously highlighted in literature (e.g. Boyd and Thomas 2001; George and Chaze 2014; Ranson 2005; Wong and Wong 2006), Our findings align with work by Adams & Flores (2022), which found that members of visible minorities have fewer opportunities to exercise authority and hold management positions within the field of engineering. Interestingly, we see proportionately more Racialized graduates within “STEM Professions Except Engineering” occupations, indicating that other STEM fields outside of engineering may have lower barriers to employment for Racialized groups than engineering.

Our findings also uniquely highlight the effects of intersectionality on occupational outcomes for engineering graduates, by considering race, gender, and location of study simultaneously. Racialized Women are shown to have significant disadvantages within the field, with the lowest proportions of employment in both types of “Management” occupations, and within “Engineering Professions”, regardless of location of study. When considering location of study in addition to race and gender, Racialized Women who studied outside of Canada are particularly disadvantaged. In contrast, White Men have the highest proportions in both types of “Management” occupations, and within “Engineering Professions” when compared with the other race x gender groups for both those who studied inside and outside of Canda, respectively.

Our work also presents an investigation into the industry sectors of employment for engineering graduates. Unsurprisingly, we find that most engineering graduates are employed in “Professional, scientific and technical services”, followed in second by “Manufacturing." However, the proportions of graduates within these categories change when analysed by race, gender, and location of study. We find that White Men hold the highest proportions of occupations within this industry sector, while Racialized Women and White Women hold the smallest proportions.

The major implications of this work are two-fold. First, we have found that there are inter- and intra-occupational segregation along lines of gender, race, and location of study within Canada. By taking an intersectional approach to social identities, we were able to observe the effect of race across gender groups and location of study. Second, we have found that engineering graduates from Canadian institutions are employed in diverse occupations and industries, which prompts questions of whether the current engineering curriculum within Canada is adequately preparing graduates for the range of career paths that are available to them. For example, given the high proportion of graduates entering management fields, it may be advantageous to integrate management and leadership training more extensively throughout the engineering curricula.

There are some limitations to the work presented here. Notably this research utilizes 2021 Census data, and this data had previously been cleaned and organized by Statistics Canada, prior to our analysis. Our work is limited by the organizational structure of the custom data tables prepared by Statistics Canda. We note that the data tables used in this study presented gender as binary, whereas we recognize gender as a spectrum. We also treated Racialized graduates as one category, and we acknowledge that people of different racial backgrounds have different experiences within engineering education, the engineering workforce, and more broadly in Canadian society. This differentiation must be further explored in future research. We have also utilized binary categorization for graduates who studied within Canada versus outside of Canada, and therefore we have not disaggregated between countries of study, which may provide further insight into occupational segmentation for internationally trained engineering graduates.

Future work should continue investigating the reasons and policies which systemically reinforce the occupational segmentation demonstrated through this work. Research should further disaggregate the categories of Race and Location of study to understand the full patterns of inequity and exclusion within engineering. Further disaggregation by engineering discipline may also provide novel insight into the occupational outcomes for graduates of various engineering disciplines (e.g. civil, chemical, mechanical, etc.). Once these patterns of segmentation are further outlined, policy and supports should be developed and implemented to advance more equitable occupational outcomes for both locally-trained and internationally-trained engineering graduates.

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Appendix A

Table 1: 2021 Canadian Census Variables and Responses

Variable	Response Categories
Gender (2) - refers to an individual's personal and social identity as a man, woman or non-binary person (a person who identifies as neither a man or a woman)	Men+ (includes men as well as some non-binary persons) Women+ (includes women as well as some non-binary persons)
Visible Minority (2) - refers to whether a person is a visible minority or not, as defined by the Employment Equity Act. The Employment Equity Act defines visible minorities as "persons, other than Aboriginal peoples, who are non-Caucasian in race or non-white in colour."	Not a Visible Minority (White, First Nations, Metis, Inuk) Visible Minority
Indigenous Identity (2) - refers to whether the person identified with the Indigenous peoples of Canada. This includes those who identify as First Nations (North American Indian), Métis and/or Inuk (Inuit), and/or those who report being Registered or Treaty Indians (that is, registered under the Indian Act of Canada), and/or those who have membership in a First Nation or Indian band.	Indigenous Identity Non-Indigenous identity
Highest certificate, diploma or degree (8) – this is the classification used in the census to measure the broader concept of 'Educational attainment.'	Filter category: Bachelor's degree or higher
Location of study (2) - refers to the province, territory or country of the institution from which a person obtained their highest certificate, diploma or degree	Completed the highest certificate, diploma or degree in Canada Completed the highest certificate, diploma or degree outside Canada – specify country
Occupation (National Occupational Classification) (69) - refers to the kind of work performed in a job, a job being all the tasks carried out by a particular worker to complete his or her duties. An	https://www23.statcan.gc.ca/imdb/p3VD.pl?Function=getVD&TVD=1322554

occupation is a set of jobs that are sufficiently similar in work performed. Occupation codes are based on write-in descriptions of the respondents' job title and main duties/responsibilities.	
Industry (North American Industry Classification System (NAICS) 2017) (23) - refers to a generally homogeneous group of economic producing units, primarily engaged in a specific set of activities	https://www23.statcan.gc.ca/imdb/p3VD.pl?Function=getVD&TVD=1181553

Appendix B

Associated TEER and BOC characterization for typology

Training, education, experience and responsibility category (TEER Level)	**Skill-level**
0	Management
1	Typically Requiring a University Degree
2+	Typically Not Requiring a University Degree

Broad Occupational Category (BOC)	**Engineering-Relatedness**
213	Engineering
2 (except 213)	Engineering-Related
0, 1, 3-9	Non-Engineering