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Unraveling the Dynamics of Immigrant Engineers' Full-utilization in Australia

Abstract

The study aims to improve our understanding of the full-utilization of immigrant engineers by answering three research questions: (1) what are the economic and social costs of the under-utilization of immigrant engineers, (2) what factors determine immigrant engineers' employment, and (3) what might be potential solutions to tackle with their under-utilization? We adopt the intersectionality theory to observe a rich set of social factors influential in immigrant engineers' under-utilization by using 188 surveys and 14 interviews of immigrant engineers living in Australia. The paper concludes with the findings' theoretical and policy implications, followed by suggestions for future studies.

Key words: employability, full-utilization, immigrant engineers, interview, and Australia.

I. INTRODUCTION

All countries want to reach full employment, the highest amount of skilled and unskilled labor that can be employed within an economy at any given time. To achieve this goal, countries need to solve both unemployment and underemployment problems simultaneously. The first problem is the most researched one and already an integral part of labor policies across countries. In contrast, the second one is a complex problem with no common understanding of its causes and solutions. Underemployment is the condition in which people in a labor force are employed at less than full-time or regular jobs or jobs inadequate concerning their training or economic needs. There are many terms for people who hold skills or qualifications beyond those required to perform their job in the economics literature [1]. These are skill under-utilization, over-skilling, overqualification, and occupational mismatch. A growing body of work examines the causes of the underemployment problem and its impact on societies and individuals [2]. This preliminary study expands these recent efforts by focusing on the full employment of a specific labor group: immigrant engineers. Throughout the text, the term full utilization is used since our study aims to improve our understanding of how immigrant engineers could utilize their full potential by working full-time using their qualifications.

Many immigrant-receiving countries, such as Australia, have points-based immigration policies [3]. These policies require immigrants to go through pre-arrival assessments of their skills and education qualifications and be certified for visa purposes. These policies also decide what type of immigrants are needed based on local labor demand [4]. If economic rules were right, the supply and demand conditions would land these immigrants jobs fitting them after their arrival. However, the reality seems to contradict with theory. Unfortunately, academic research offers few patchy and limited studies on the matter, even though popular media is full of stories about immigrant employment, mainly blaming immigrants for stealing local people's jobs [5]. Some researchers have tapped into this knowledge gap about immigrants' complex dynamics under-utilization [6].

Migrants contribute to host country economies in many ways, such as employment, skilled labor, innovation, and entrepreneurship [4], [7]-[9]. For example, a report [10] clearly shows that immigration has had positive effects on local demography in Australia, contributing to a slowing of population aging and higher education levels, labor market participation, employment, and productivity. Concerning innovation, several studies show immigrants' contributions to innovation in the USA [11], [12]. For instance, a study [13] points out that despite immigrants only making up 16% of inventors, they are responsible for 30% of the USA innovation's aggregate since 1976. Regarding entrepreneurship, a study finds that 16% of the high-impact tech ventures in the USA have an immigrant as a founder [14]. A complementary study [15] also found that nearly 20% of the USA firms had immigrant founders in the high-tech industry. When they compared the immigrant firm with natives, they found the immigrant firms outperformed their native counterparts in 15 out of 16 dimensions of innovation. Another study [8] finds a positive economic impact of a skilled visa program by allowing immigrant graduates from universities to live and work in the host country temporarily.

Considering all sorts of potential benefits a migrant could offer to their host countries, it becomes imperative to develop a deeper understanding of immigrant engineers' employment. That is why our research joins recent immigration studies by delving into utilizing a highly educated human resource in a country [5]. In particular, this paper is an empirical investigation of immigrant

engineers in Australia to search answers for three research questions: (1) what are the economic and social costs of the under-utilization of immigrant engineers, (2) what factors determine immigrant engineers' employment, and (3) what might be potential solutions to tackle with their under-utilization?

The study builds on the intersectionality theory used in sociology to consider multiple sources of individual identity [16]. The data is a triangulation of different sources: archive, survey, and interview. The online survey consisted of 188 immigrant engineers who arrived in Australia after 2015, while interviews were conducted with 14 survey respondents who volunteered for in-depth discussions after they completed the survey.

There are studies separately interested in the under-utilization problem [6] or immigrants [17]. However, to our knowledge, the paper is the first study focusing on the under-utilization problem of immigrant engineers. By observing details within an immigrant group, the paper contributes to the literature in two ways. First, the study shows the extent of the problem by presenting the economic and social costs of under-utilization of immigrant engineers in a country context. This preliminary exercise draws from the traditional economic costs, but it also adopts a unique assessment approach for social costs. Second, adopting of an intersectional approach brings a nuanced understanding of the factors affecting immigrant engineers' under-utilization and the specific solutions needed to overcome their under-utilization.

The paper has five sections. After this introduction, section two explains the literature review by adopting the intersectionality approach to immigrant engineers' employment issues. This section also presents the propositions of the paper. Then, section three introduces the paper's methodology, including data and constructs used, followed by a detailed section on findings. The final section ends with a summary of concluding remarks, implications of the study, and suggestions for future studies.

II. LITERATURE REVIEW

This study relies on the definition of immigrant used in international statistics [18, 19].

Accordingly, immigrant refers to people born outside of the host country or persons who live in a

country other than their country of citizenship. The UN [19] study reports that there are 272 million international migrants worldwide, with an increase of almost 100 million from 2010 to 2019.

Despite rapid growth in immigrant numbers, they are an understudied topic [3], [20], [21]. A study calls them forgotten minorities [22]. If policymakers hosting these immigrants do not understand them, they might not realize the full utilization of immigrants already present in their workforces [5]. Understanding immigrants requires knowing diverse social categories of immigrants, employment problems, expectations, and suggestions.

As the intersectionality approach emphasizes, human experiences are shaped by a combination of factors such as nationality or gender to overcome limitations imposed by considering single factors such as age working independently [5], [16]. Even though the intersectionality approach has been initiated in feminist studies, it has been applied to many social phenomena such as immigration studies [21], [23]. This is because the intersectionality approach allows the observation of combinations of many factors by taking care of the context for each particular immigrant group.

Existing data sources for immigrants are general, like the OECD report [18], publishing descriptive data at aggregate levels like their share in total population or employment. None of them have data on the costs of immigrant unemployment. In general, the costs of operating an economy below full employment fall into two categories: economic and social costs [24]. Both costs arise from not utilizing human resources at their full capacity, but calculating them is a rather tricky task [25]. For example, a study [3] considers calculating the cost of under-utilization of immigrants to the economy as an impossible task.

Nevertheless, many economics studies attempt to assess economic costs through different techniques, particularly unemployment [24]. Only a few studies refer to the underemployment costs of immigrants [26], [27]. Therefore, the costs of under-utilization of skilled immigrant engineers are not comprehensively understood in the literature (Gap 1). The need for quantifying and documenting these costs lead us to our first research question (RQ).

A study on OECD countries [1] shows how economies achieve inclusive and robust growth when utilizing their human capital most effectively. The study invites policymakers to ensure a good match between skills acquired in education and on the job and those required in their labor market. The same study also indicates that about one in four workers in OECD countries is over-qualified, underlining how big the over-qualification problem is for countries. A similar study is recently carried out in Europe [6], showing an under-utilization problem across all European countries.

Underemployment has become a severe social and economic issue for many countries, such as Canada [23]. Similarly, the OECD report [18] has revealed that in 2019, the part-time employment rate was 25.5%, while the temporary employment rate was 5.3%. In the context of Australia, over 30% of Australians are working under temporary, seasonal, or contract employment [28].

Even though there are studies about macro-level under-utilization problems in the labor market, few studies analyze immigrants' cases [25], [29]. One reason for under-utilization is the skill or qualification mismatch where workers' skills exceed or lag behind those employers seek [30, p. 136]. Studies claim that the higher and more persistent the incidence of such mismatches are among immigrants [29]. Thus, the mismatch issue becomes a potential economic problem for countries such as Canada, where immigrants are either a substantial part of the labor force or a pillar of employment growth.

Social costs are diverse, and they are more challenging than economic costs to calculate. Society suffers from the under-utilization of immigrants in several ways. First, migrants will feel dissatisfied with their job, disengaged from their work, and highly unmotivated [31], [32]. Thus, full utilization would lead to healthy and happy employees, generating a positive environment at the job, increasing productivity and innovation. Second, migrants become under the mental pressures such as anxiety, anger, disappointment, and stress of being unemployed, resulting in deteriorated well-being [33], [34]. That is why these unhappy individuals make life worse for themselves and those around them. They could also hamper their relationships with their

community and family. Third, inequality among the workforce hurts individuals who are not valued for their contributions, hurts organizations that fail to benefit from employee skills and abilities, and hurts nations that fail to capitalize on their human capital [1]. This negative impact also applies to immigrant engineers, a subset of the high-skilled labor force in host countries.

According to the extant literature, the most common factors determining the employment of immigrants include personal factors such as English proficiency and qualification [35], [36], [37]. Some studies argue the lack of English language fluency to be the most significant barrier to their employment [38]. Qualification refers to formal education, technical skills, and work experience [39]. However, work experience is sometimes limited to local experience rather than home country experience. Besides personal features, social factors such as culture and discrimination stand out as critical factors influential in immigrants' employment [6]. Culture is a broad category, ranging from societal culture to workplace culture and country of birth [37], [40]. For example, a study [41] argues that immigrants' lack of familiarity with contextual knowledge about local job search processes in host country has reduced their employment chances. Another study points out that immigrants might not know how to sell their skills to host countries [42] effectively. However, it seems a significant challenge is racial discrimination by employers [43], [44]. To our knowledge, there is no study available in the literature examining the factors behind the employability of immigrant engineers per se (Gap 2). Considering that engineers are skilled immigrants with comparatively higher personal characteristics than the average immigrant features, our second RQ aims to explore what factors determine immigrant engineers' employment.

Most studies prefer to focus on a single social category of immigrants like gender and ignore the intersections between different social categories to which immigrants belong [45]. By doing so, these studies fail to observe the interactions of various factors. In other words, academic literature fails to offer nuanced studies about subgroups of immigrants belonging to different social categories. This negligence is critical since any solution associated with these subgroups cannot be resolved by general ones developed to an eclectic population. This paper focuses on immigrant engineers since engineers make a significant part of skilled immigrants in many countries, offering visas based on skills [8]. Some recent studies also point out how immigrant

engineers contribute to the economy and society in many ways [11], [13]. However, the literature fails in understanding their employment problems and hence cannot offer solutions. We think that having a well-defined immigrant group such as immigrant engineers could enrich our understanding of the problem of under-utilization, allowing us to develop potential solutions. As a result, our third RQ examines what potential solutions might help to tackle their under-utilization.

Table 1 shows a summary of the gaps in the literature review and our research questions.

TABLE 1
THE GAPS IDENTIFIED IN THE LITERATURE REVIEW AND RESEARCH QUESTIONS

Gap	Research Question (RQ)
G1: Literature lacks studies calculating the costs of under-utilization of skilled immigrant engineers.	RQ1: What are the economic and social costs of the underutilization of immigrant engineers?
G2: To our knowledge, there is no study available in the literature examining the factors behind the employability of immigrant engineers.	RQ2: What factors determine immigrant engineers' employment?
G3: Academic literature fails to offer nuanced studies about immigrant engineers. Hence it cannot offer feasible solutions to their under-utilization problems.	RQ3: What might be the solution to tackle the underutilization problem?

III. METHODOLOGY

Sample and Data Collection

In this study context is Australia, and the unit of analysis is immigrant engineers. Australia is an appropriate choice for studying immigrant engineers in practice since they constitute 59% of Australian workforce engineers [28]. Australia has been filling its labor shortages through skilled migration categories. Since 2010, data shows that 69% of migrants enter via the skilled program [46]. In the decade to December 2019, net overseas migration accounted for 58.9% of the Australian population increase. Consequently, the share of Australia's overseas-born population rose from 26.4% in 2009 to 29.7% in 2019. However, more importantly, during 2015 and 2020,

the labor force increased by 5.3%, of which new migrants accounted for 85%. On average, one-fourth of new migrants coming to Australia each year have engineering degrees [47], [48].

Despite their critical role in the Australian economy, a few studies examine the problems of immigrant engineers in Australia, and their alarming findings warrant further studies. For example, government statistics [49] show that 28% of skilled professional migrants (e.g., teachers, civil engineers, and accountants) experience a change in occupation after arrival. Another study examines the failure of the skilled migration program in South Australia [50]. The study consists of all migrants, including engineers, and sheds light on a critical labor mismatch. The study is based on a survey of more than 1,700 skilled migrants living in South Australia and found that more than half of them were not utilizing their skills and abilities.

There are no available data to respond to the research questions about the extent of the problem regarding the under-utilization of immigrant engineers, the factors behind under-utilization, and potential solutions to the problem. The lack of data forced us to triangulate data using a mixed-method approach, both quantitative and qualitative. Data collection is based on two sources: surveys and interviews.

We conducted a survey approved by the UTS Ethics committee (HREC# ETH20-4880) and prepared it in Qualtratics. It was then circulated through email invitation among the Engineers Australia (EA) members throughout August 2020. Almost all engineers are EA members, so having their support in distributing the survey was an excellent opportunity to reach a broad audience. There were 304 respondents, with 188 fully completed surveys. We employed several quantitative techniques to analyze survey data, such as Linkert analysis, logistic regression, and crosstabulation tables to probe our hypothesis.

For RQ1, we rely on survey data to indicate economic and social costs. We also include findings related to social cost based on the interview data. For RQ2, we use survey data by running a logistic regression technique to identify the factors determining immigrant engineers' under-utilization. Logistic regression is the most frequent regression model used to analyze binary data [51], [52]. The objective of using logistic regression is to describe and predict the relationship

between the dependent and independent variables [51]. Lastly, for RQ3, we use survey data in crosstabulation tables that describe the relationship between two categorical values: the number of observations of each categorical value [53]. The data obtained from survey participants were analyzed with IBM SPSS Statistics for Windows, Version 21.0.

Semi-structured interviews were conducted to enable participants to share their lives and events through telling their own stories [54]. Out of all completed interviews, 102 respondents volunteered for a follow-up interview. Among these volunteers, we randomly chose 12 candidates to approach based on category and gender type. However, some of these initial contacts did not respond to our invitation, then another set of random respondents are selected and contacted. In two cases, initial invitation holders reached out and wanted to do the interview. We included them as additional interviews as well. These two were in the category of temporary and permanent visa-holder categories. Except for two phone-based interviews, others were carried out through Google Meet software, using Tacqui transcribing. All 14 interviews are recorded, and the audio recordings of the interviews are transcribed. All of them took place in August 2020, with a length of 30-40 minutes. All authors read the transcripts and developed a coding of social costs of under-utilization.

Variables

For RQ1, we calculated the cost of unemployment to reflect on economic cost. We drew on the employee well-being construct to assess the social costs. The employee well-being construct has the 17-item defined by the Utrecht Work Engagement Scale (UWES), including statements about how frequently the respondent feels at work [55]. The responses range from 1 to 5; 1 reflects when he/she has never had this feeling, while 5 refers to feeling that particular feeling every day. We think that the well-being of an employee could reflect the social costs of under-utilization.

For RQ2, our dependent variable: Employment status refers to the employment status of the immigrant engineer. If the respondent responds to the question with Yes (n=116), the follow-up question requests the type of employment, being either part-time (n=19) or full-time (n=97). If the respondent responds to the question with No (n=72), the employment status is unemployed.

Participants responded to a set of questions despite their employment status. Their answers were integrated as independent variables (see table 2) to determine the explanatory outcomes of the model.

TABLE 2
INDEPENDENT VARIABLES DESCRIPTION

No.	Independent variable	Details
1	Type of visa*	Refers to the different types of visas the participants hold when entering Australia. They needed to choose one of the following options 1) permanent, 2) student or 3) temporary visa.
2	Continent of origin	Refers to the continent where the home country of each participant is located. The options were 1) Africa, 2) Asia, 3) Europe, 4) North America, 5) Oceania, and 6) South America.
3	Year of arrival	Refers to the year when the participant arrived in Australia between 2015 and 2020.
4	Group of age	Refers to the participant's age when arrived in Australia. They were class together into five categories 1) 18-24 years, 2) 25-34 years, 3) 35-44 years, 4) 45-54 years, or 5) 55 years and above.
5	Marital status	Refers to the civil status of each participant. There were three categories 1) married, 2) separate, divorced, widowed, and (3) single.
6	Years of experience	Refers to the professional experience that each participant has and expressed in years. The options were 1) none, 2) less than a year, 3) 1-5 years, 4) 6-10 years, and 5) more than ten years.
7	Member of an organization	Refers to the participant's status of belonging to an organization such as churches and professional networks. This variable was defined as a dichotomy variable 1 (yes) and 0 (no) .
8	English level	Refers to the dominion of the English language when the participant arrived in Australia. According to their level, participants chose among three options 1) neither competent nor incompetent, 2) somewhat competent, and 3) extremely competent.
9	Qualifications	Refers to participant's highest academic background. They chose among four categories (1) bachelor's degree, (2) post-graduate certificate, (3) master's degree, and (4) doctoral degree
10	Gender	Refers to participant's biological sex. This variable was defined as a dichotomy variable 1 (male) and 0 (female).
11	Salary	Refers to the amount of money each participant made during one year. They chose among four categories 1) less than \$50,000, 2) between \$50 and \$74,999, 3) between \$75 and \$99,999, and 4) more than \$100,000.
12	Size of company	Refers to the type of company each participant is working, defined by the number of employees. They chose among four categories 1) 1 to 9 employees, 2) 10 to 49 employees, 3) 50 to 499 employees, 4) +500 employees.
13	Discrimination	Refers to the participant's experience of discrimination either at work or during the hiring process. This variable was defined as a dichotomy variable 1 (have experienced discrimination) and 0 (have not experienced discrimination).

* The Australian visa system is complicated but there are three main categories that skilled-stream applicants could apply for: student, temporary, and permanent visa.

Discrimination has been a complex social phenomenon. Hence studies treat it differently [43], [56]. In this study, the survey participants respond to a question investigating whether discrimination of employers affects employment or not. So, it is not a direct measure of their exposure to discrimination, but their opinion about its role.

There are a few explanations on the decisions regarding the variables. For example, we limited the study to immigrants who have arrived in Australia since 2015, considering the importance of new migrant status, referring to their lack of knowledge about labor market processes [37]. The respondents choose one year that fit their arrival time.

Our study measures the cultural factor by asking the respondents' membership to an organization [36]. This decision is based on the belief that integration occurs where individuals have an interest both in maintaining their original culture and in taking part in daily interactions with other groups. Options of membership have been various, ranging from religious organizations to sport ones. The goal was to understand the involvement of the respondent with the host country culture through a commitment to an organization by becoming a member.

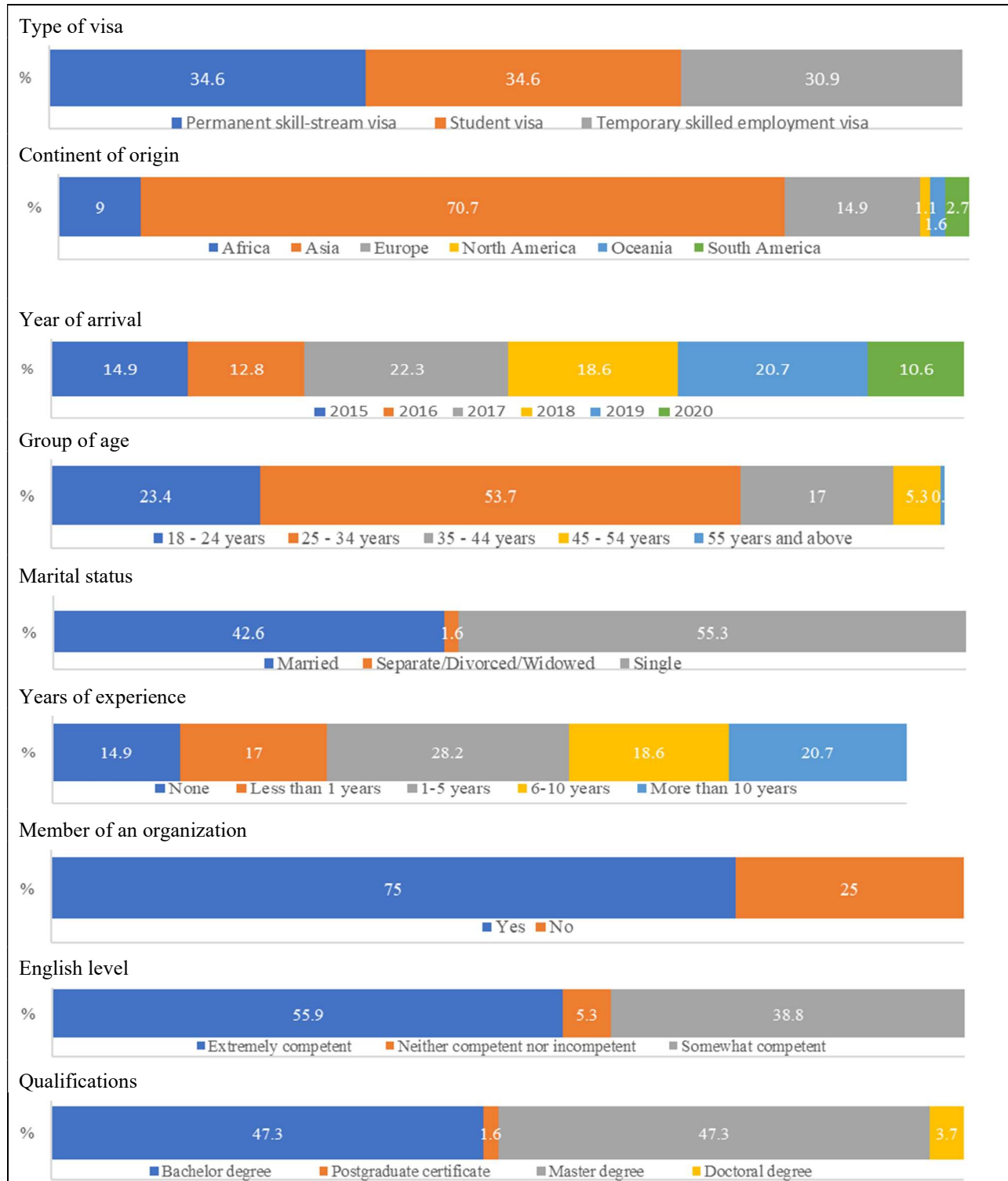
Regarding qualifications, the highest degree attained in education measures the qualification, ranging from Doctoral degree (4), Master degree (3), Post-graduate certificate (2), and Bachelor degree (1). The discrepancy between the highest qualification held by a worker and the qualification required by his/her job is defined as qualification mismatch; if the qualification is higher, it means over qualification [1].

For RQ3, the survey facilitated data collection on the problems and solutions for immigrant engineers' under-utilization. Problems include 11 options (see Table 9), while solutions cover eight options (see Table 10). These options come from literature [4],[47], [50], [57], and [58]. The crosstabulations are created to determine a difference or similarity between employed and unemployed engineers' responses to both problems and solutions to the under-utilization.

Descriptive statistics for the survey and the interviews

Descriptive statistics present the participants' attributes that willingly completed the survey (see Fig. 2.). For the study, the independent variables (Table 2) were selected to answer this paper's research questions (Table 1) since these aspects cover a wide range of participant characteristics. The descriptive statistics show interesting details among the migrant engineers in Australia. For instance, migrant engineers have been in Australia about 2-3 years ($m = \text{year 2017}$, $sd = 1.570$), they are a young migrant population ($m = 25-34$ years, $sd = 0.815$), their mastery of their level of

English is high (m= medium to high level, sd= 0.961), and a great combination of education (m= master's degree, sd= 1.00) and professional skills (m= 1-5 years of experience, sd= 1.44).



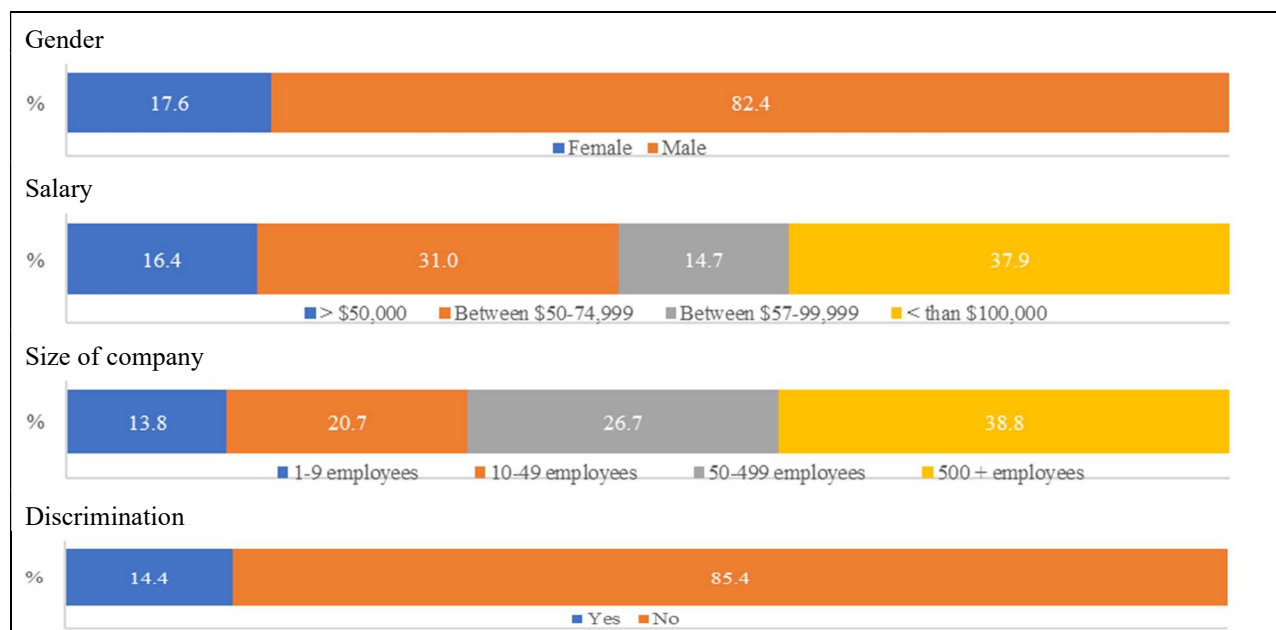


Fig. 1. Descriptive statistics of the independent variables

n=188 participants

The characteristics of interviewees are presented in Table 3. We tried to have a balanced distribution of interview participants according to their gender, visa status, and employment. Besides, half of the interviewees have rich work experience (equal to or more than six years) before they came to Australia. Interviewees are from four States: NSW, Queensland, Victoria, and Western Australia. Two of the interviewees could not find an engineering job, and they currently work in non-engineering jobs.

TABLE 3
CASES OF IMMIGRANT ENGINEERS

Code	Year at entry	Age at entry	Highest degree	Eng. Comp.	Eng. Type	Experience (years)	HC / location in AU	Sector
PFE	2017	>50	Ph.D.	EC	IE	20	Asia/NSW	Education
PFU	2017	35-44	M.S.	SC	CE	5	Asia/NSW	Construction
PME	2018	35-44	M.S.	EC	CE	7	Asia/NSW	Health*
PMU1	2019	35-44	M.S.	SC	CE	14	Asia/NSW	Construction
PMU2	2019	35-44	B.S.	EC	CE	15	Asia/WA	Construction
TFE1	2015	18-24	B.S.	EC	EE	None	South America/WA	Mining
TFE2	2020	35-44	B.S.	EC	ME	6	Africa/WA	Mining

TFU	2020	18-24	B.S.	SC	CE	1.5	Asia/Victoria	Emergency worker*
TME	2018	35-44	B.S.	EC	CE	6	North America/ NSW	Construction
TMU	2020	25-34	B.S.	EC	ME	1.5	Asia/Victoria	Manufacturing
SFE	2016	25-34	B.S.	SC	ChE	None	Asia/NSW	Food*
SFU	2017	25-34	M.S.	SC	ME	<1	Asia/Victoria	Manufacturing
SME	2016	18-24	M.S.	EC	ME	<1	Asia/Victoria	Professional services
SMU	2015	18-24	B.S.	SC	CE	None	Asia/Queensland	Construction

Ph.D.-doctorate degree; M.S.-masters; B.S.-bachelor; Eng- Engineering; HC - Home country; *Non-engineering job; IE-industrial eng.; CE-civil eng.; EE-electronic eng.; ME-mechanical eng.; ChE-chemical eng.; EC - extremely competent; SC-somewhat competent.

P-permanent visa holder; T-temporary visa holder; S-student visa holder; F-female; M-male; E-employed; U-unemployed.

IV. FINDINGS

Findings regarding the RQ1: Costs of under-utilization of skilled immigrants

(1) Economic costs of under-utilization

Economic costs happen from unemployment and underemployment. Our survey data gives some details on unemployment; a few significant findings are as follows:

- 38% of survey participants are unemployed. This ratio is much higher than the Department of Home Affairs' [48] (2019b) data, where unemployment of skill stream migrants in the first two years of their arrival is 21.3%, and it drops to 14.5% in the second two years of their arrival.

Besides unemployment, economic costs increase from being underemployed, having part-time employment, and working at non-engineering jobs. We could not calculate those costs' exact monetary values, but the following paragraphs indicate their existence and extent based on our findings from the survey.

Based on participants' responses, we found out that 50 (43.10 %) out of 116 of those working either part-time or full-time are overqualified for their current jobs. As shown in Table 4, the overqualification phenomenon is more frequent for those who work full-time (n=40, 80% of the participation) versus part-time (n=10, 20% of the participation).

TABLE 4
THE EMPLOYMENT STATUS AND OVER-QUALIFICATION OF SURVEY
PARTICIPANTS

Employment status	OVERQUALIFICATION		Total
	Yes	No	
Part-time	10	9	19
% of total	8.62%	7.75%	16.37%
Full-time	40	57	97
% of total	34.48%	49.13%	83.62%
N	50	66	116
%	43.10%	56.89%	100%

After analyzing unemployed participants' responses, we found out that 28 out of 72 unemployed participants (38.88 %) have not ever worked in Australia (mean of arrival =(2018.7) even though that some of the participants have been in Australia since 2015. For those unemployed participants who have experience in Australia between 2015 and 2020, we found out that 26 out of 44 participants (59.10 %) have worked in non-engineering jobs. 16 out of 29 participants did not want to do non-engineering jobs, while the other 10 chose at some point work in non-engineering jobs. Also, most of the participants are looking for engineering jobs to end unemployment.

Even though our study could not quantify the underemployment in economic terms, it has shed light on the extent of it thanks to the survey results:

- 38% of the unemployed immigrant engineers have experienced employment after they arrived in Australia, while 62% of the employed immigrant engineers have experienced unemployment. These high figures demonstrate the difficulties of finding good-fit employment in the first years of settlement in Australia.

- 43% of employed immigrant engineers are over-qualified, having a degree more than needed at their current job.
- 24% of employed immigrant engineers are not employed as engineers (93% say this is not by choice).
- 6% of employed immigrant engineers have a part-time job.

(2) Social costs

Our survey findings point out a social cost based on immigrant engineers' well-being who are employed in a job fitting to their qualifications versus having jobs below their qualifications. After graphing the data (see Fig. 2.), the difference between both groups becomes apparent. The engineers working as non-overqualified tend to have better satisfaction levels (Most of the time 51.82 % and always 37.88 %) with their jobs compared to those working as overqualified (About half the time 28 % and most of the time 50%).

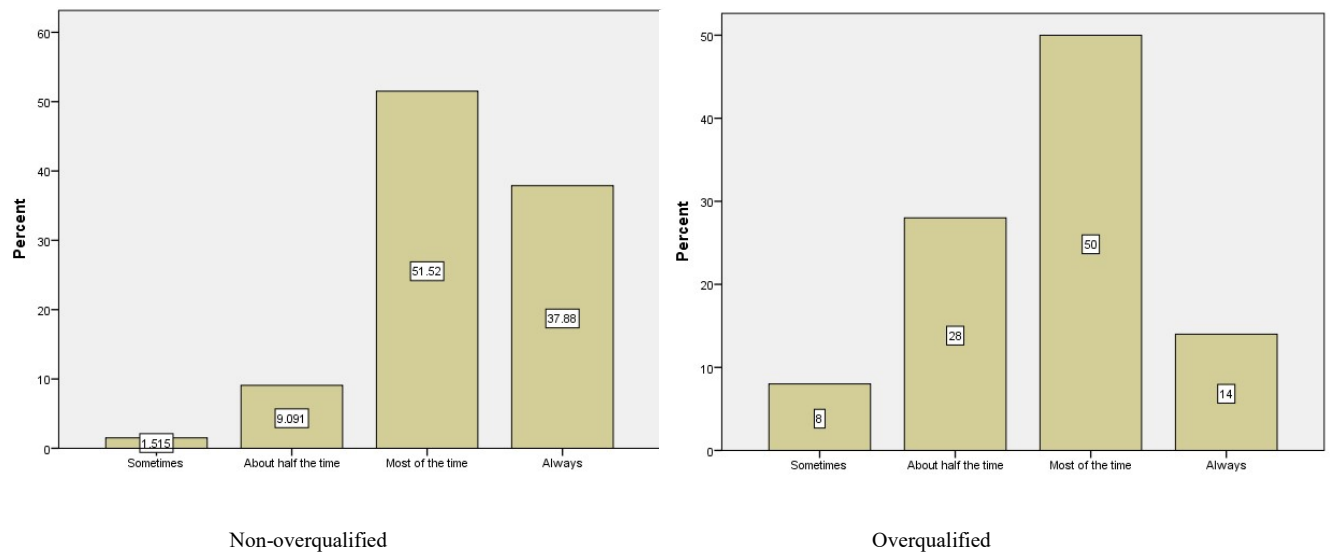


Fig. 2. The distribution of responses to the question of “how do you feel at work?”

The social cost of unemployment/underemployed is the sum of the private costs immigrant engineers are facing. Even though it is hard to quantify those costs in monetary terms, as shown above, the employee well-being construct shows statistically how immigrant engineers' well-being drops for those who are overqualified for their jobs.

Additionally, interviews with 14 immigrant engineers show that unemployment causes both disappointment and frustration, reflecting two private costs. The following quotes are from the interviews to illustrate social costs.

- “My six years of experience in my home country means nothing here; companies do not care.”
- “I applied for 1,000 jobs in six months and received no response.”
- “It is unfair; we came here with lots of hopes and expected to have a better life.”
- “I went through three years of misery because of racist and sexist work experience. I quit working as an engineer, and now I am working in a non-profit organization.”
- “When I came to Australia, I thought they would put a red carpet for me, and I would be the one who chooses between different jobs. But after some months, step by step, I lowered the level of the positions I apply. Well, I am trying to apply for some casual jobs at McDonald’s and similar companies. All of them were rejected with no response. 10 months passed with no job. I have a family to feed.”
- “I drained out all my savings and then got a casual job, which is not related to my field.”
- “When you quit engineering, after a while, there is no turning point. I lost my chance.”
- “I thought Australia wanted engineers. I spent one and a half years for the visa process, paid for the visa (around 9,000 Australian dollars), and passed exams. I am here with my visa, but I am unemployed.”
- “I completed a post-graduate degree in accounting in Australia and found my accountant job after six months of job search. If I have tried to find a job as an engineer, I would have found one, perhaps. But, it is a time-consuming and frustrating process. I know it from my husband; he got his job after searching for two years.”

Overall, our findings point the following:

Proposition 1: The higher levels of under-utilization of immigrant engineers increase the economic and social costs to the national economy.

Findings regarding the RQ2: Factors determining the under-utilization of immigrant engineers

(1) The quantitative analysis of the survey

We performed a logistic regression analysis with a response (yes versus no) as the binary dependent variable under-utilization. Independent variables entered on step 1 using SPSS are: Type of visa, Continent of origin, Year of arrival to Australia, Age when arrived in Australia, Marital status, Years of experience, Membership to an organization, English level, Qualifications, Gender, and Discrimination. The findings are given in Table 5.

TABLE 5
LOGISTIC REGRESSION RESULTS*

Logistic Regression Summary for Dependent Variable: under-utilization R= .448 ; R2= .564; p< .001			
Independent variables entered the model	B	Sig. (p)	Exp (B)
Year of arrival to Australia (2017)	2.669	.042	14.028
Year of arrival to Australia (2015)	2.437	.017	11.44
Year of arrival to Australia (2016)	2.720	.044	9.081
Age when arrived in Australia (25-34 years old)	2.606	.024	9.025
Membership to an organization (Yes)	1.804	.020	6.075
Years of experience (No experience)	-2.880	.030	1.001
Discrimination (Yes)	- 0.940	0.05	.391
English level (Somewhat competent)	-1.285	.002	.277
Type of visa (Student visa)	-2.623	0.34	.162

* Only statistically relevant ($p < 0.05$) variables are given.

The model predicted up to 56% of RQ2 with seven variables included, significantly associated with the dependent variable, under-utilization.

Statistical results help to observe the main personal and social factors. Regarding personal factors, the results suggest that migrant engineers who arrived in Australia between 2015 and 2017 (up to 14 %) have more probabilities of ending under-utilization than those who arrived later in Australia. Migrant engineers between 25 to 34 years have 9 % more probabilities of finding a job than others. In addition, immigrant engineers who have a competitive English level and some years of professional experience are more likely to be employed than those with lower English competency levels and lack of job experience. Finally, student visa holders are affected negatively compared to the other two visa holders, permanent and temporary. Regarding the

social factors, being a member of an organization significantly increases the employability of immigrant engineers (a magnitude of 6%), while discrimination slightly reduces their chances to get a job.

The literature is populated with the role of language for the employment of immigrants [35]. However, our results indicate that discrimination has a higher impact on immigrant engineer's overall employability than their language skills.. Further analysis of the discrimination shows that different ethnicities experience it unevenly, as mentioned in the literature [43]. According to the 27 survey participants who chose discrimination as one of the causes for unemployment, we observe the majority of them are Asians (Asians 88.88 %). Another interesting observation is that unemployed participants see discrimination as a big barrier to finding a job (59.25 %) compared to employed participants (40.75%).

(2) The qualitative findings from the interviews

When we asked the interviewees about the challenges they faced during their job search, they suggested three key challenges: local experience, skills, and discrimination. The details about these challenges are presented in Table 6.

TABLE 6
CHALLENGES OF FINDING JOBS

Theme	Categories (Final Codes)	Preliminary Codes
Local experience/culture	Workplace experience in Australia	Working experience, local knowledge, Not knowing, internships, 1st job is critical, limited internships (students), jargon, workplace codes, terminology, culture shock at work
	Network	Connections, volunteering, social media
Skills	Software	Local practice, software skills, custom programs
	Driving-licence	Field visits, customer visits
	No feedback	No responses to job applications, people find a job not ads, not knowing qualifications, different local education, too many job applications, job ads, no reply
	English	Communication skills, pressure on networking, culturally aware, not so much in conversation but writing, language difficulties
Discrimination		Business culture, workplace culture, Australian culture, indifferent recruiters, junior work-senior responsibility, same position- different treatment, cannot pronounce name, sexist attitude, to get a job versus

	Unjust, unfair	to stay at a job
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Having good English competency and belonging to local and professional organizations increase the likelihood of employment. These two features make it possible to network and communicate, helping immigrant engineers while searching for jobs. Interviewees mention the length of the job search period as a critical problem. The job search ranges from a minimum of six months to 24 months. Even in a non-COVID environment, interviewees indicate that securing a job takes thousands of job applications. Interviewees point out an unexpected macro-level problem: companies do not ask for assessments made during the visa application process, and hence they do not understand the quality of applicants.

Findings on local experience confirm the findings of other studies on culture and networking. For example, migrants' under-developed knowledge of Australian social systems and norms, including the informal and unspoken rules, impact immigrants' employment [40]. Another study finds that the lack of social networks is the primary factor in the employment process of migrants [59].

Interview findings regarding discrimination seem to be similar to earlier studies in Australia [39], [43]. Additionally, a nuanced explanation of the discrimination problem comes from the survey data. Mario Fernando et al. [44] find out that Australian decision-makers in larger organizations show lesser discrimination towards migrant candidates during the recruitment and selection process than those in smaller companies. Considering that most part-time and full-time immigrant engineers work in companies larger than 50 employees (see Table 7), it might be their remedy strategy to avoid discrimination in small companies. Being an engineer does not prevent being exposed to discrimination.

TABLE 7
THE DISTRIBUTION OF EMPLOYMENT STATUS ACCORDING TO THE COMPANY
SIZES

Employment	Size of the company
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status	1-9 employees	10-49 employees	50-499 employees	+500 employees	Total
Part-time	0	5	9	5	19
% of GOP	0 %	26.31 %	47.36 %	26.31 %	100 %
% of total	0 %	4.31 %	7.75 %	4.31 %	16.37%
Full-Time	16	19	22	40	97
% of GOP	16.49 %	19.58 %	22.68	41.23 %	100 %
% of total	13.79 %	16.37 %	18.96 %	34.48%	83.62%
N	16	24	31	45	116
% of total	13.79 %	20.68 %	26.72 %	38.79 %	100 %

In sum, our study findings help us to assert:

Proposition 2: The social factors will be significant in determining the under-utilization of immigrant engineers like the personal factors.

Findings regarding the RQ3: Solutions-suggestions to eliminate under-utilization

We asked the survey respondents to choose unemployment reasons among a set of 11 options, as shown in Table 8. The crosstabulation was created to determine a difference or similarity between employed and unemployed engineers' responses.

TABLE 8
THE CROSSTABULATION OF REASONS OF UNEMPLOYMENT

Reasons	Unemployed participants	Employed participants	Total
No local experience	53	55	108
% within group of participation	73.60%	47.41%	
% of total (NT)	28.19%	29.25%	57.44%
Not permanent visa holder or citizen	35	27	62
% within group of participation	48.61%	23.27%	
% of total (NT)	18.61%	14.31%	32.97%

No local references	29	31	60
% within group of participation	40.27%	26.72%	
% of total (NT)	15.42%	16.48%	31.91%
No jobs, competitive market	23	15	38
% within group of participation	31.94%	12.93%	
% of total (NT)	12.23%	7.97%	20.21%
Discrimination	16	11	27
% within group of participation	22.22%	9.48%	
% of total (NT)	8.51%	5.85%	14.36%
Overqualification	6	19	25
% within group of participation	8.33%	16.37%	
% of total (NT)	3.19%	10.10%	13.29%
No skills recognition	12	12	24
% within group of participation	16.66%	10.34%	
% of total (NT)	6.38%	6.38%	12.76%
Other	9	10	19
% within group of participation	12.5%	8.92%	
% of total (NT)	4.78%	5.31%	10.10%
Language	10	8	18
% within group of participation	13.88%	6.89%	
% of total (NT)	5.31%	4.25%	9.57%
Unfamiliar application process	7	11	18
% within group of participation	9.72%	9.48%	
% of total (NT)	3.72%	5.85%	9.57%
Underqualification	0	7	7
% within group of participation	0%	6.03%	
% of total (NT)	0%	3.72%	3.72%
Participants	72	116	N (188)

N=188; p>0.006

The results show that both employed and unemployed participants chose the same three reasons as the main cause for unemployment: 1) No local experience, 2) Not permanent visa holder or citizen, and 3) No local references. Even though the top-three reasons for unemployment are the same, the ratio of unemployed participants who vote for the top-three them are roughly more than

20 % in each category when compared to the ratio of employed participants. . For instance, 73.60 % of unemployed participants consider “No local experience,” while 47.41 % employed participants say so.

We asked the survey respondents to choose the best three solutions – suggestions to eliminate the under-utilization problem among a set of eight options, as given in Table 9. After gathering the survey data, a crosstabulation was created to determine a difference or similarity between employed and unemployed engineers’ responses.

TABLE 9
CROSTABULATION OF THE BEST SOLUTIONS TO TACKLE UNDER-UTILIZATION

Solution- Suggestion	Unemployed participants	Employed participants	Total
Internship opportunities	55	74	129
% within group of participation	77.5%	63.8%	
% of total (NT)	29.4%	39.6%	69.0%
Mentoring	39	71	110
% within group of participation	54.9%	61.2%	
% of total (NT)	20.9%	38.0%	58.8%
Visa arrangement	31	43	74
% within group of participation	43.7%	37.1%	
% of total (NT)	16.6%	23.0%	39.6%
Re-skilling/up/skilling	28	44	72
% within group of participation	39.4%	37.9%	
% of total (NT)	15.0%	23.5%	38.5%
Government support	31	29	60
% within group of participation	43.7%	25.0%	
% of total (NT)	16.6%	15.5%	32.1%
Cultural shift of employers	19	35	54
% within group of participation	26.8%	30.2%	
% of total (NT)	10.2%	18.7%	28.9%
Gaining soft skills	12	12	24

% within group of participation	16.66%	10.34%	
% of total (NT)	6.38%	6.38%	12.76%
Other	5	15	19
% within group of participation	5.6%	12.9%	
% of total (NT)	2.1%	8.0%	10.2%
Participants	72	116	N (188)

n= 188; p < 0.031

According to the survey participants, the two significant unemployment solutions encompass the following actions: internship (69%) and mentoring (59%). While an internship could help with the local experience, mentoring could help immigrant engineers familiarize themselves with local culture and overcome barriers arising from discrimination and lack of skills such as specific software used in Australia. Also, upgrading their current visas to permanent status (39 %) could help engineers access to a wider range of job opportunities.

Additionally, interviews identify two critical macro-level solutions: eliminating discrimination and educating employers about qualifications. The discussions around solutions point out the stakeholders who would be involved in these macro solutions as well. Interviewers identify them as government and professional organizations.

From the interviews, the following suggestions came out as roles government could play:

- The Australian Government should educate companies on granted visas to alleviate the need for local experiences and educational standards across countries.
- Assessments prepared during visa applications are not used by companies when immigrant engineers apply for a job. Companies need to be encouraged/incentivized to take into the assessment reports during employment decisions.
- The Government could motivate companies for internship programs through some incentive schemes or regulations.

From the interviews, the following suggestions came out as roles professional organizations could play:

- The assessment process for immigrant engineers could be simplified.
- Companies could be encouraged to use assessments prepared by the Department of Home Affairs.
- Professional organizations could talk to companies and inform them about the qualifications of immigrant-engineers, change their mindset (many engineering types could solve the needs of customers regardless of their need in a particular engineering category)
- Professional organizations could help members with digital skills.
- It might set up internship and mentoring programs.
- It could arrange different job fairs.
- It could conduct accessible and transferrable professional certifications.
- It could reduce differences in the local engineering environment for immigrant engineers, such as guiding them on what software packages are used locally.

As a result of all these findings, we suggest the final proposition:

Proposition 3: Solutions to the under-utilization of immigrant engineers require policies targeting key problems specific to immigrant engineers.

V. CONCLUSIONS AND IMPLICATIONS OF THE STUDY

As academics in engineering and technology management, our responsibilities to the practitioners such as engineers demand us to understand their professional life experiences [27], [60]. The full-utilization of immigrant engineers is one such experience, a highly neglected topic. Without understanding their experiences, we cannot develop solutions to remedy the problems they have been experiencing because of their status of being immigrant engineers.

The study findings offer an early attempt to calculate the overall cost of under-utilization of immigrant engineers by using the example of Australia. The study shows the importance of the topic from the perspective of both economic and social costs. The study then examines the determining factors in the under-utilization of immigrant engineers and highlights key and social factors (membership to an organization and discrimination). Our empirical study confirms the role of major personal factors (age, English competency, year of arrival, and work experience). It

also highlights the role of social factors categorized as culture and discrimination. Finally, our findings underline that immigrant engineers consider the lack of local experience and local references as the two critical reasons behind their unemployment besides the visa type. Hence our empirical study points out that the solutions to immigrant engineers' under-utilization might require policies around these two key barriers/challenges. Our study participants specifically propose internship and mentoring as practical solutions for their under-utilization problem.

Implications for theory

To our best knowledge, our study is one of the early research interested in exploring a sub-group of immigrants per se rather than a broad category of immigrants [17, 34]. However, more importantly, it is the first study merely focusing on the full-utilization of immigrant engineers. By exploring an immigrant group in-depth, this paper contributes to the literature in two ways. First, we offer the construct of “the well-being at work” as a metric to quantify the social costs in literature. By doing so, we might expand the efforts of recent studies aiming to capture social costs through new measures [24]. Our study sheds light on the traditional costs, but it also assesses social costs by a unique assessment approach. Second, our focus on immigrant engineers improves our knowledge of the factors affecting immigrant engineers' employability and brings new insights into multiple policy approaches needed to resolve immigrant engineers' real problems in practice. Our study proposes expanding the investigation of factors playing a significant role in employability should include personal factors and integrate social factors for a holistic view about the under-utilization phenomenon. Thus, we think our study will attract researchers to study various intersectional groups within immigrants and, in turn, to increase our knowledge on their full-utilization.

While not a central focus of the study, the paper also enriches empirical studies through two minor offerings. First, this study will be the first study investigating immigrant engineers' under-utilization. Our findings from the mixed-method study in Australia help visualize the extent of immigrant engineers' under-utilization in terms of economic and social costs. Second, the majority of studies consider personal factors related to employability. In contrast, this study joins relatively less empirical works exploring employability's social factors to get a balanced view of personal and social factors.

Implications for policy

The problem of under-utilization of skilled immigrants is global and calls for policymakers' attention to post-arrival policies [61], [62]. In Australia's case, the problem seems a current and urgent one according to the two recent reports: the EA report [58] and the Australian Council of Engineering Deans [63]. More importantly, like any other advanced country, the Australian Government cannot risk the under-utilization of skilled immigrant engineers, the critical human capital for entrepreneurship, innovation, and science for its future vision: becoming an innovation-based economy [64].

Our study findings contribute to policy discussions by bringing several insights. For example, our study participants clarify that even small macro-level changes could make such a big difference. They mention that the Government could educate companies on visa types and show them the value of using assessment reports prepared in the visa process. Perhaps the problem could be solved with a stakeholder approach quickly by following the survey participants' suggestions: developing mentoring and internship programs. These stakeholder-involved solutions offer many advantages, not limited to actual migrant engineers. In mentoring, professional organizations, educational institutes, and consultants might work with these migrant engineers to build self-confidence and fulfill their full potential.

The findings also have implications for individual organizations such as universities, research centers, federal laboratories, and even corporate R&D laboratories. This paper's results support the basic tenets of diversity and equal opportunity employment opportunity policies for immigrants in many countries [61], [65]. Ethnic diversity does not often be translated into higher levels of productivity and societal benefit unless organizations own it and proactively implemented it.

Limitations

The study has four significant limitations. First, the current study focuses on just one of the intersectional groups of immigrants: immigrant engineers. Researchers might consider

examining other occupation-based immigrant groups. Second, we aimed to understand different social factors such as age, gender, employment status, and home-country affecting immigrant engineers' employment. However, our survey data did not give enough differentiation in the home-country category to make comparisons. For example, the majority (71%) of the survey respondents were from Asia, so we could not make a statistically significant comparison among the employability of immigrants coming from emerging countries or developed countries. Future studies might have diverse data to go deep in the analysis with respect to the home-country effect. Third, the study is conducted in one advanced country, Australia. Even though Australia is one of the few countries home to immigrants proportionally, future studies could enrich literature by conducting in many other countries, including developing countries. Only then could it become possible to compare the role of different national contexts and immigrants. Fourth, the study presents many advantages of the intersectionality approach. However, it could be interesting to observe the adoption of other social theories such as a feminist approach in understanding the experiences of immigrant groups with different social category membership and their well-being in the host countries.

Implications for Scholar and Future Avenues of Research

This study contributes to the “Management of Engineers” research stream of IEEE Transactions on Engineering Management. Prior research in this area explored organizational and social elements in engineering organizations describing or prescribing best known methods [66-70]

The study has developed three major propositions ready to be tested:

Proposition 1: The higher levels of under-utilization of immigrant engineers increase the economic and social costs to the national economy.

Proposition 2: The social factors will be significant in determining the under-utilization of immigrant engineers like the personal factors.

Proposition 3: Solutions to the under-utilization of immigrant engineers require policies targeting key problems specific to immigrant engineers.

These can now be tested in countries such as the US or EU which employ a significant number of immigrant engineers.

Of course further data can be collected to develop and test propositions to measure the long and short term benefits of policies enabling the employment of immigrant engineers.

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