Promoting Social Sustainability for Minority Populations through Understanding their Challenges in Professional Engineering Certification

Ms. Erika Judith Rivera, Florida International University

Erika Rivera is a Licensed Professional Engineer with a bachelor's degree in Civil Engineering from the University of Puerto Rico Mayaguez Campus and two Master's degrees one in Engineering Management and a Master's in Civil Engineering from the Polytechnic University of Puerto Rico. She is currently a Ph.D. Student at Florida International University, in Moss School of Construction, Infrastructure, and Sustainability College of Engineering and Computing.

Mr. Mohamed Elzomor, P.E., Florida International University

Dr. Mohamed ElZomor is an Assistant Professor at Florida International University (FIU), College of Engineering and Computing and teaches at the Moss School of Construction, Infrastructure and Sustainability. Dr. ElZomor completed his doctorate at Arizona

Mr. Piyush Pradhananga, Florida International University

Piyush Pradhananga is a Ph.D. Candidate in Civil and Environmental Engineering at Florida International University (FIU). Piyush holds a B.S. in Civil Engineering from Tribhuwan University (TU). Piyush is currently a Dissertation Year Fellow at FIU where he focuses on multidisciplinary research that harmonizes sustainability in construction. His research interests include Sustainable Construction, Robotics and AI-based Construction, Engineering Education, Sustainable Infrastructure, Resilient and Sustainable Post-Disaster Reconstruction, and Circular Economy. He also holds professional credentials in LEED Green Associate for sustainable buildings and ENV SP for sustainable infrastructures as well as several micro-credentials in the commercialization of research. As a Ph.D. Candidate, Piyush has published a dozen peer-reviewed journals and several conference papers.

Promoting Social Sustainability for Minority Populations through Understanding their Challenges in Professional Engineering Certification

Abstract

As the population of the United States of America continues to be more diverse, educational pedagogies must embrace the different components of diversity so that the workforce represents a diverse society. Construction and engineering education must foster the social sustainability components of increasing diversity, equity, and inclusion to better position our future workforce. In the Science, Technology, Engineering, and Math (STEM) profession, minorities, females, and underserved communities are yet staggering in representation within the engineering and construction industry. In the United States, approximately five million residents are of Puerto Rican descent, accounting for 1.8 percent of the overall population in 2019, where 20.3 percent of that population have an education of Bachelor's Degree or Higher. In the 2021's Professional Engineering Examination performed in Puerto Rico, only 24 percent of the professionals that participated in the examination passed the test, while the national average for passing the Professional Engineering examination was 58 percent. This study aims to address the problem of the current shortage of diversity, equity, and inclusion in the Engineering and Construction industry, focusing on the Puerto Rican minority group and their challenges. This study will focus on determining the obstacles Puerto Rican engineering students and graduates have that limit their possibilities of excelling in the Professional Engineering Examination and improvements to the curriculum to increase the likelihood of success in the P.E. exam and address the poor passing rate. The research analyzes large-scale perishable historical data provided by the Puerto Rico examination board and Universities. This study will have two theoretical and methodological contributions to the literature. It will: (1) advance our understanding to address diversity, equity, and inclusion issues related to our workforce and their success in the engineering and construction industry; (2) inform the literature on how to reform our education curriculum to accommodate the necessary tools needed to prepare minority students to succeed in the Professional Engineering Certification. This study will focus on the obstacles Puerto Rican engineering students and graduates have that limit their possibilities of excelling in the Professional Engineering Examination and improvements to the curriculum to increase the likelihood of success in the P.E. exam.

Author Keywords: Social Sustainability; Professional Certification; Diversity; Inclusion.

Introduction and Background

Construction and engineering education must integrate the social sustainability components of diversity, equity, and inclusion to improve the work environment and reduce unconscious biases in the construction industry [2]. Diversity and inclusion promote the integration of different cultures and groups that can stimulate creativity and productivity in the workforce [3]. Additionally, it also plays a vital role in enhancing the country's Gross Domestic Product (GDP)[4]. Based on the recent Society of Hispanic Professional Engineers (SHPE) report, only 7 percent of the STEM workforce is of Hispanic descent, despite representing 20 percent of the

population in the United States [5]. In the United States, approximately five million residents are of Puerto Rican descent, accounting for 1.8 percent of the overall population in 2019 [1], [6]. In Puerto Rico, only 20.3 percent of the population have a bachelor's degree or higher education. Even though many of Puerto Rico's engineering institutions are on the top 200 list of best undergraduate engineering programs [7], many of their graduates and professionals cannot enter the engineering workforce upon completing their degrees because they do not comply with the proper certification, particularly the Professional Engineering (P.E.) to perform as an engineer as per state laws.

In 2021, only 24 percent of the Puerto Rican professionals that pursued the P.E. examination passed the test, while the national average for passing the P.E. examination was 58 percent [8]. Hence, such a low success rate in professional certification impedes Puerto Rican engineering graduates from exploiting better professional opportunities in the AE&C industry. Puerto Rico currently has five approved institutions accredited by the Accreditation Board for Engineering and Technology (ABET) on the island that have different engineering disciplines that graduate approximately 1,000 engineering students annually. Professional Engineering Certification provides value to the professional and the organization that the individual works for, increases the credibility of the position, office, or department that the individual represents, and increases confidence with the public [9]. Certification helps develop and mature the professional standard of practice, increase the value of the employee, improve the range of employment opportunities, and provide the minority employee to be in the same professional status as their peer to be competitive in the workforce, increasing diversity and inclusion.

Professional Engineering Certification helps develop and mature the professional standard of practice, increase the value of the employee, improve the range of employment opportunities, and provide the minority employee to be in the same professional status as their peer to be competitive in the workforce, increasing diversity and inclusion. Professional Certification provides society with a level of trust that indicates whether a professional has the knowledge and skills to perform duties and responsibilities associated with the life and welfare of the community. According to the National Society of Professional Engineers (NSPE), an engineering student must complete a four-year college degree, gain a minimum of four years of working experience, and pass two intensive competency exams to earn a P.E. license from their respective state's licensure board. One of the main goals of enforcing a P.E. license is to ensure engineering graduates follow ethical responsibility to protect public health, safety, and welfare. Currently, every state regulates the practice of engineering to ensure public safety by granting only Professional Engineers (PEs) the authority to sign and seal engineering plans and offer their services to the public [10].

Historical data to regulate engineering practices in the United States dates back to the early 1900s when the state of Wyoming established licensing requirements in 1907 [10]. The country's westward expansion focused on cultivating land, mapping, and designing water resources and irrigation systems. The state proceeded with a study finding that many individuals who provided engineering services were inexperienced and unqualified, resulting in Wyoming's inability to supervise the state's water distribution effectively. As a result, in 1907, the Wyoming Legislature passed a bill requiring the registration of those presenting themselves as engineers and created a

state board overseeing this registration. This bill created the first governing body for professional engineers.

Furthermore, Professional Engineers not only shall be registered in their respective states to practice the engineering profession but must also continuously demonstrate their competency as well as maintain and improve their skills by fulfilling continuing education requirements depending on the state in which they are licensed. As stated by the National Society of Professional Engineers, the responsibilities of a Professional Engineer (P.E.) include: (1) prepare, sign, and seal, as well as submit engineering plans and drawings to a public authority for approval or seal engineering work for public and private clients; and (2) be responsible for the life and safety of the population affected by their work and accountable to high ethical standards of engineering practice [10]. Certain governmental engineering positions shall be licensed professional engineers in many federal, state, and municipal agencies, particularly those considered higher-level managerial positions. Therefore, this study focuses on Puerto Rico, which is one of the U.S. minority territories, to investigate the challenges that Puerto Rican engineering graduates face to pass the P.E. certification examination. A comprehensive understanding of the challenges would consequently help increase the diversity in the construction workforce, thereby addressing the social sustainability issues in the construction industry.

Literature Review

Engineering professionals are required to exhibit the highest standard of honesty and integrity. Ethics provides the framework that engineers demonstrate professional status and recognition, indicating public service with the highest stander and commitment to their social responsibility to have the integrity to make the proper decision for society. Ethics education and social responsibility are challenging for engineering institutions where the industry has implemented laws requiring ethical education for professional certification. As defined by [11] engineering ethics is (1) the study of moral issues and decisions confronting individuals and organizations engaged in engineering and (2) the study of related questions about the moral ideals, character, policies, and relationships of people and corporations involved in the technological activity. To ensure that safety, environment, health, and community welfare are handled with the utmost professionalism by engineers, ethical guidance has been provided to professional engineers in the U.S. Additionally, the ethical guidelines of Professional Engineering highlight how engineers should promote, steer clear of conflicts of interest, remain objective when testifying as experts, and safeguard client confidentiality [12]. Considering that the P.E. certification test evaluates and creates awareness about such ethical and social responsibilities of engineering professionals, all engineering graduates are encouraged to take and pass the test to practice the engineering profession. However, many minority engineering graduates struggle with the certification test, which has increased social sustainability concerns in engineering.

The Architecture, Engineering, and Construction (AEC) industry has traditionally been a field dominated by certain groups, such as men and those from certain racial and ethnic backgrounds [13]–[15]. Consequently, the stereotype is one of the social sustainability barriers that has impeded an inclusive environment in the AEC industry, and there has been little progress since the 1950s. The narrow stereotype has ultimately influenced the individual perspective of what an

engineer is, does, is interested in, and looks like, and has influenced individuals' career aspirations, academic achievement, college retention, and professional identity formation. Ensuring that the engineering profession is inclusive and welcoming to all students and educators, regardless of their background, is a critical challenge. For Engineering, diversity is attracting students and professionals to this field to ensure that engineering has a similar percentage of representation from different areas of society as the wider population [15]. The engineering and construction industry is significantly impacted by globalization, transforming the workplace and education. The necessity of engineers to not only have the technical competency in their field of expertise but also to have the knowledge to provide engineering services outside their native context and culture [16] has become a critical aspect that can affect the workforce's ability to be successful in the interaction with the diverse workplace. The National Center for Science and Engineering Statistics 2021 report highlighted that recent undergraduate and graduate enrollment trends reflect the increasing diversity of the U.S. college and graduate-school populations. For example, the study highlighted that Hispanic or Latino undergraduate students increased from 18.9 percent in 2016 to 20.2 percent in 2018. In 2018, underrepresented minority students received 24.0 percent of all Science and Engineering (S&E) bachelor's degrees awarded to U.S. citizens and permanent residents, 22.1 percent of S&E master's degrees, and 13.6 percent of all S&E doctoral degrees. Underrepresented minorities have earned an increasing share of degrees at all three-degree levels over the past 10 years, the only exception being a slight decline in doctorates since 2016. Despite the slight dip in the share of doctoral degrees, the number of underrepresented minority doctorate recipients increased nearly 50 percent over the past 10 years, from 2,247 in 2008 to 3,351 in 2018 [17]. Two-thirds of scientists and engineers employed full-time are White. White scientists and engineers represent a larger share of those not in the labor force because of retirement (84.3 percent) than those from other racial or ethnic groups. Among scientists and engineers, Hispanics or Latinos had an unemployment rate of 3.8 percent, which is greater than the unemployment rate of Whites (2.1 percent but similar to that of the U.S. labor force (3.7 percent)[17].

There is a gap in the literature in past studies to reflect the efforts to increase professional certification in the United States. According to [18], adopting professional engineering education certification has shown different nations how to manage the latest tendencies of scientific and technological advancements and further laid the groundwork for developing practical professional talents. The author provides an example with required foundational courses for civil engineering majors is the fundamentals of designing concrete structures, however, there are certain flaws in how it is actually taught, including strong teaching content, a single form, a lack of new technology combinations, and a lack of practical expertise. Future professionals will need to engage on international teams utilizing their professional abilities such as communication and cultural and global adaptability. Effective intercultural teamwork is becoming more critical. At the same time, it is evident that modifications have been made to engineering and construction education to better prepare aspiring professionals for working in these complex teams [16].

The College of Engineers and Land Surveyors of Puerto Rico (CIAPR) was founded in 1938 through Law No. 319, to ensure the public interest and serve as advisors to the Government in technological matters as well as adopting and implementing canons of professional ethics and defending the interests of engineering, surveying, and architecture professionals [12]. The CIAPR group's engineers and land surveyors are licensed or certified by the Board of Examiners

of Engineers and Land Surveyors of Puerto Rico, to practice as such, they must belong to the CIAPR. This prestigious institution has a significant impact on the work and socio-economic progress of Puerto Rico and has an important social responsibility [19]. In compliance with its responsibility, the CIAPR collaborates closely with public and private agencies to strengthen Puerto Rico's infrastructure. It is a legal entity or quasi-public corporation with perpetual existence, comprised of all engineers and land surveyors admitted to practicing their professions in Puerto Rico.

The CIAPR ensures that the below-mentioned responsibilities are accomplished as an organization: (1) Ensure the interests and well-being of the Puerto Rican community; (2) Safeguard and protect the rights of its members concerning the exercise of their professions; (3) Promote the progress of culture, science, and technology, especially in relation to engineering and surveying; (4) To rule on issues of public interest in those matters that concern the CIAPR; (5) Promote the beautification and environmental improvement of the Puerto Rican community. [20] In 2021, the CIAPR reported 8,180 active registered professional engineers and land surveyors in Puerto Rico [20]. This quantity of professionals does not suffice the current demand for professional engineers on the island and in other states where professional certification can be endorsed. Presented by the United States of America Bureau of Economic Analysis report for the first quarter of 2022, the construction industry's nominal value added was 4.1 percent of the GDP and projected to reach a Compound Annual Growth Rate of 5 percent from 2022-2026 [21]. This projection of industry growth exacerbates the ongoing crisis of workforce shortage that currently exists in the industry in the United States. According to the Bureau of Labor Statistics report published in April 2022, employment in engineering and architecture professionals projected to increase by 6 percent between 2020 and 2030. As a result, the construction sector urgently needs to diversify to fulfill the increasing demands for a competent and qualified labor force.

Methodology

The study adopted an exploratory approach to investigate the current diversity, equity, and inclusion shortage in the Engineering and Construction industry and pedagogy alternatives to improve the P.E. passing rates focusing on Puerto Rican minority graduates. The authors conducted a survey to determine the causes of the low passing rate for the P.E. certification test. The obtained quantitative and qualitative survey data and large-scale perishable historical data provided by the Puerto Rico examination board and Universities are analyzed using descriptive analysis.

Survey Design

The research team surveyed participants of the CIAPR certification review workshops, including students planning to attempt the professional certification test and students who have previously taken the test from Puerto Rico. The survey design focused on the following research question, 1) What is the role of an academic institution in helping minority engineering graduates in the professional certification process? The survey included open-ended, multiple-choice, Likert scale, and demographic questions to validate these hypotheses. The open-ended questions focused on recording challenges that can limit the possibilities of retaking the test and recommendations that participants of the workshops can provide to improve the deliverables.

The multiple-choice questions collected data about the potential impact of Academia on supporting study efforts, funding to take the professional certification test, whether Academia prepared the respondents for the examination process, and challenges that students faced during the test that prevented them from successfully passing the first attempt. At the same time, the demographic questions recorded participants' academic institution, A&E professional degree, and age. An online surveying tool, Qualtrics, was used to distribute the survey for two months.

Results and Discussion

This section analyzes historical and survey data results to determine the causes of the low passing rate for the P.E. certification test.

Historical Professional Engineering Examination Data Comparison

The authors collected data from the National Council of Examiners for Engineering and Surveying (NCEES) and compared different disciplines of Civil Engineering Professional Engineering Examination results in Puerto Rico from 2018 to 2021. Additionally, to highlight the low passing rate in Puerto Rico, Figure 1 also compared the latest P.E. examination results in Puerto Rico from 2021 with the U.S. national average for the P.E. examination year 2021. As shown in Figure 1, the P.E. examination passing rate trend has not improved in the past few years. In academic years 2018-2022, the University of Puerto Rico Mayaguez Campus and Polytechnic University of Puerto Rico graduated 2,211 and 1,516 students, respectively. However, minority-qualified professionals, such as those of Puerto Rican descent, are decreasing in the industry, as shown in Figure 1. In the last 4 years, 765 graduates have taken the P.E. test, and only 158 graduates have passed the test representing a 20.65 percent passing rate [8]. Compared to the undergraduate students that received their engineering degrees from 2018 to 2022, 158 passing graduates represent 4.24 percent, and this does not include other education institutions or exclude the graduates retaking the professional examination.

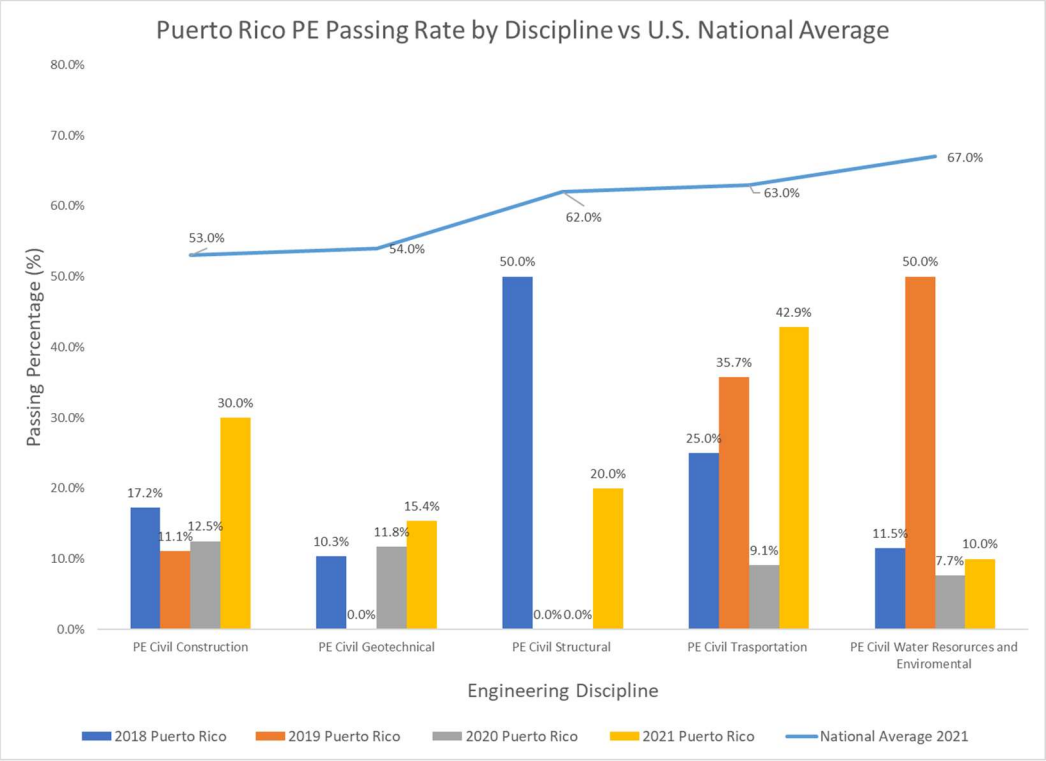


Figure 1. Puerto Rico PE Passing Rate by Discipline vs. U.S. National Average

Socio-Demographic Survey Results

On the other hand, 52 graduates from five undergraduate education institutions in Puerto Rico participated in the survey. The survey data collected socio-demographic information such as academic background, age, type of degree, and professional certification. In this study, 35.71 percent of the participants were from the University Of Puerto Rico Mayaguez Campus, 45.24 percent from the Polytechnic University of Puerto Rico, 7.14 percent from the InterAmerican University of Puerto Rico, 2.38 percent from the Caribbean University and 4.76 percent from Turabo University. As shown in Figure 2, 9.52 percent of the respondents were 20-25 years old, 14.29 percent were 26-30 years old, 30.95 percent were 31-39 years old, and 45.24 percent were above 40 years old. Thus, the data shows that younger engineering graduates are not prioritizing the achievement of professional certification. Similarly, as shown in Figure 2, the survey had the highest percentage of civil engineering graduates, with 38.1 percent of respondents, followed by Mechanical engineers, land surveyors, electrical engineers, environmental engineers, industrial engineers, and chemical engineers. The results of this study show that time restrictions, knowledge, language, work-life balance, and test-taking speed were all identified as impediments.

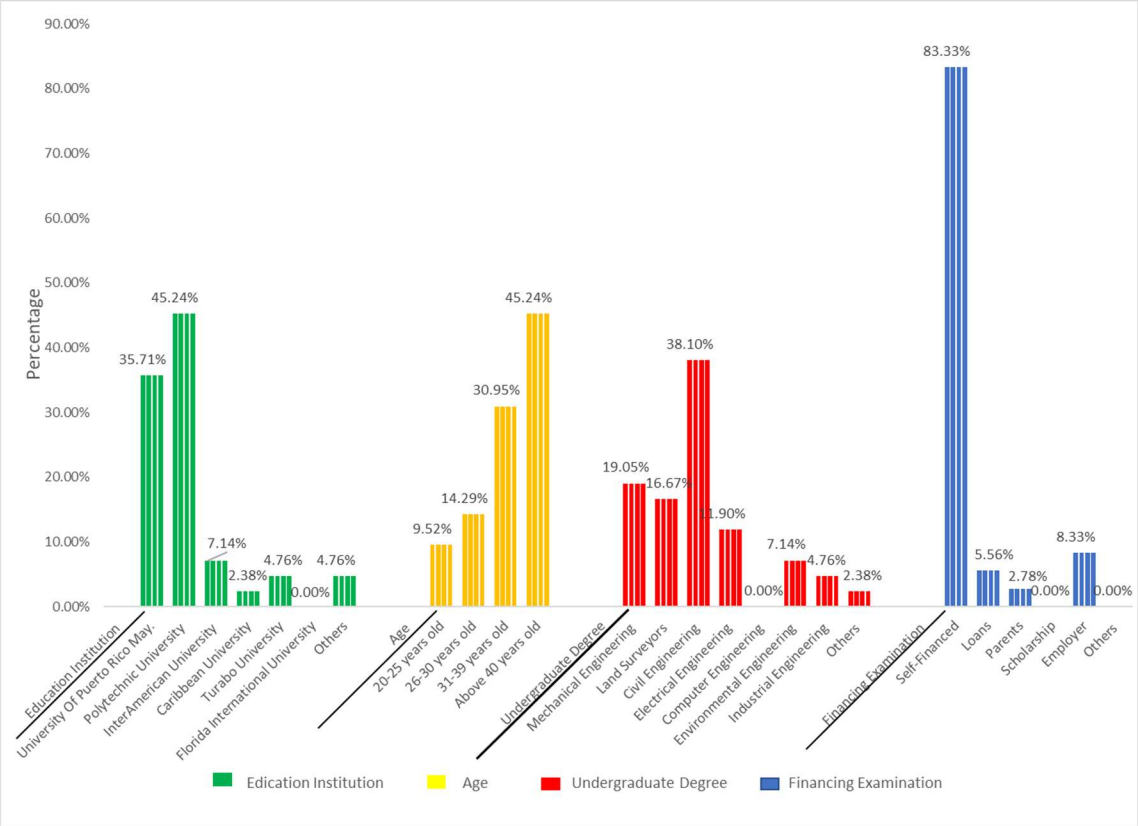
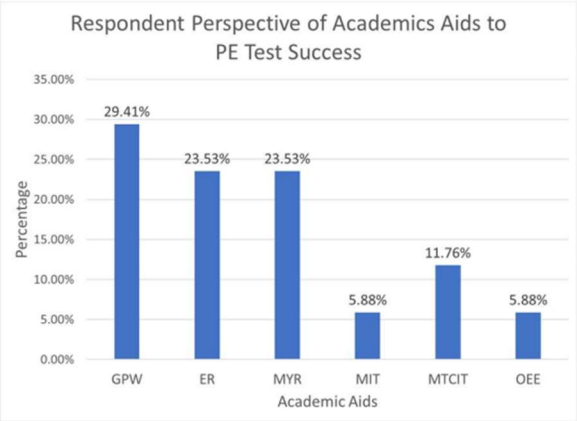


Figure 2. Respondents' percentage of sociodemographic background.

Students Academia assistance to Achieving P.E. Certification

Based on the results, more than 66 percent of the respondents have taken the professional certification test at least once. Consequently, when asked if Academia should assist in training to pass the professional certification, 76.19 percent of respondents indicated definitely yes, 4.76 percent indicated probably yes, 14.29 percent indicated possibly, 4.76 percent indicated Probably no, and 0.00 percent indicated Definitely no. On the other hand, respondents agreed that Academia had assisted students in preparing them to pass the exam. When responders are asked how Academia has assisted, 29.41 percent of respondents indicated that General public Workshops and Exam Training, 23.53 percent indicated that Elective Review classes to refresh the required knowledge to pass the exam, 23.53 percent indicated that Mandatory Review classes, 5.88 percent indicated that Mentorships through Academia, 11.76 percent indicate that Mentorships through conducting Industry Trainings, or connections with industry professionals, and 5.88 percent of respondents indicate that others explaining that the regular material of the classes provided where sufficient to be successful as shown in Figure 3.



GPW:	General public Workshops and Exam Trainings
ER:	Elective Review classes to refresh the required knowledge to pass the exam
MYR:	Mandatory Review Classes
MIT:	Mentorships Through Academica
MTCIT:	Mentorships Through conducting Industry Trainings, or connections with industry professionals
OEE:	Others, Explain

Figure 3. Respondent Perspective of Academics Aids to P.E. Test Success

The survey also asked students where Academia can improve to support students' efforts in passing the test. The results presented that 25.00 percent of respondents reported that an elective course related to professional license could improve the support students' efforts in passing the test, 27.78 percent would benefit from exam type of question in courses, 27.78 percent reported exam workshops with Best Practices could improve the support students, and 19.44 percent of respondents reported mandatory review sessions could support students' efforts in passing the test.

Limitation and Future Work

The research acknowledges some limitations, such as the subjective nature of the survey responses due to the participants' personal opinions and self-judgments. Furthermore, focusing on one minority ethnic U.S. territory may be a limitation. However, the in-depth study of such a minority group can evaluate with different underrepresented groups in the U.S. Future work can incorporate different institutions that offer review courses to participate in the research and include documented results determining if there is a difference in the gender and age are factors that influence in the success rates. Furthermore, the research can include institutions of Historically Black Colleges & Universities, Hispanic Serving Institutions, and Minority Serving Institutions. Expanding this research to other states with low passing rates and investigating if similar pedagogies can be incorporated to improve the P.E. passing rates will make a significant difference in addressing social sustainability factors of diversity and inclusion in the construction industry. Expanding these studies to incorporate a workshop dynamic in a current review course and evaluating the results of the participants' knowledge after the workshop could incorporate into future studies.

Conclusion

This study investigated pedagogy opportunities to address the challenges that Puerto Rican engineering graduates encounter in the certification process and academic institutions' role in supporting minority engineering graduates in the professional certification process. The results of this study show that time restrictions, knowledge, language, work-life balance, and test-taking speed were all identified as impediments. This study's results demonstrated that incorporating different dynamics to enhance the knowledge and understanding of the test process and

information can assist them in preparing to be successful in P.E. certification. Recommended changes in pedagogies found in this study were mandatory courses, affordable workshops, mentorships with the industry, and mentoring in Academia that, if incorporated into the student's academic life, will improve their opportunities, furthermore improving social sustainability challenges. This discovery contributes to the body of knowledge by enabling academic institutions and organizations to develop practical engineering courses and giving the industry a deeper understanding of the challenges minorities and underrepresented groups face when taking Professional Engineering certification tests. With these methodologies, the certification process would ensure inclusion, sensitivity to cultural variations, and fairness and impartiality in resolving social inequalities.

References

[1] U.S. Census Bureau., "'B03001 HISPANIC OR LATINO ORIGIN BY SPECIFIC ORIGIN - United States - 2019 American Community Survey 1-Year Estimates,'" 2019. Accessed: Jan. 06, 2023. [Online]. Available: https://data.census.gov/cedsci/table?q=B03001%3A%20HISPANIC%20OR%20LATINO%20ORIGIN%20BY%20SPECIFIC%20ORIGIN&tid=ACSDT1Y2019.B03001&hidePreview=true

[2] P. Pradhananga and M. ElZomor, "Developing Social Sustainability Knowledge and Cultural Proficiency among the Future Construction Workforce," *Journal of Civil Engineering Education*, vol. 149, no. 2, Apr. 2023, doi: 10.1061/(ASCE)EI.2643-9115.0000075.

[3] P. Pradhananga and M. Elzomor, "Nurturing Social Sustainability Within our Future Workforces Piyush Pradhananga Mohamed Elzomor (Assistant Professor) Nurturing Social Sustainability Within our Future Workforces," in *Excellence Through Diversity* , 2022. [Online]. Available: www.slayte.com

[4] M. A. Musarat, W. S. Alaloul, and M. S. Liew, "Impact of inflation rate on construction projects budget: A review," *Ain Shams Engineering Journal*, vol. 12, no. 1. Ain Shams University, pp. 407–414, Mar. 01, 2021. doi: 10.1016/j.asej.2020.04.009.

[5] Society of Hispanic Professional Engineers, "Most Magical Year," 2021. Accessed: Jan. 07, 2023. [Online]. Available: https://shpe.org/

[6] Center for Puerto Rican Studies, "Socio-Demographic Data of Puerto Ricans in the United States and Puerto Rico: 2010-2021," 2023. doi: 10.18128/D010.V11.0.

[7] USNews, "Mayaguez Campus 2022 Ranking USNews." https://www.usnews.com/best-colleges/rankings/national-universities (accessed Jan. 06, 2023).

[8] The National Council of Examiners for Engineering and Surveying (NCEES), "JUNTA EXAMINADORA DE INGENIEROS Y AGRIMEMSORES DE P.R. CBT/PAPER PASS RATES 2018 - 2021," San Juan, 2021.

[9] P. S. Adams, R. L. Brauer, B. Karas, T. F. Bresnahan, and H. Murphy, "Professional Development Professional Development Professional Certification Its value to SH&E practitioners and the profession," 2004. [Online]. Available: www.asse.org

[10] National Society of Professional Engineers, "National Society of Professional Engineers-What is a P.E.?," 2022. https://www.nspe.org/resources/licensure/what-pe (accessed Jan. 06, 2023).

[11] M. W. Martin and R. Schinzinger, *Ethics in Engineering*, Fourth Edition. McGraw-Hill Education, 2005.
[12] W. J. Frey and E. O'Neill-Carrillo, "Engineering ethics in Puerto Rico: Issues and narratives," *Sci Eng Ethics*, vol. 14, no. 3, pp. 417–431, Sep. 2008, doi: 10.1007/s11948-008-9065-6.
[13] A. Johri and B. M. Olds, *Cambridge handbook of engineering education research*. 2013.
[14] S. Azhar and M. K. A. Griffin, "Women in Construction: Successes, Challenges and Opportunities-A USACE Case Study," 2014.
[15] A. Peixoto *et al.*, "Diversity and inclusion in engineering education: Looking through the gender question," in *IEEE Global Engineering Education Conference, EDUCON*, May 2018, vol. 2018-April, pp. 2071–2075. doi: 10.1109/EDUCON.2018.8363494.
[16] R. Valdes-Vasquez, "Cross-cultural Collaboration Inspired by a Sustainable Building Course in Costa Rica," 2018.
[17] B. and E. S. N. S. F. National Center for Science and Engineering Statistics Directorate for Social, "Women, Minorities, and Persons with Disabilities in Science and Engineering 2021 Report," 2021. Accessed: Jan. 06, 2023. [Online]. Available: https://ncses.nsf.gov/wmpd/
[18] J. Ma, K. Chen, X. Shen, and Y. Wang, "Research on the Teaching Reform of the Course of Principles of Concrete Structure Design in the Background of Engineering Education Professional Certification," 2020.
[19] CIAPR, "Communication – CIAPR," 2022. https://ciapr.org/comunidad/ (accessed Jan. 06, 2023).
[20] CIAPR, "Plan Estratégico," San Juan , 2021.
[21] U.S. Bureau of Economic Analysis (BEA), "Gross Domestic Product, First Quarter 2022," 2022. Accessed: Jan. 06, 2023. [Online]. Available: https://www.bea.gov/index.php/news/2022/gross-domestic-product-first-quarter-2022-advance-estimate