

A Systematized Literature Review of the Experiences of Women in the Engineering Workplace

H. Paige Brown, Purdue University-Main Campus, West Lafayette (College of Engineering)

H. Paige Brown is an Engineering Education Ph.D. student and George Washington Carver Fellow at Purdue University. Prior to beginning her doctoral studies, Paige was employed with the US government. She began her career as an electrical engineer with Naval Air Systems Command. Her most current role was with the Food and Drug Administration where she performed the regulatory review of medical devices.

Outside of her professional career, Paige enjoys working with students and has developed and implemented K-12 STEM outreach programs and informal learning experiences. She has conducted engineering workshops, spoken on STEM panels, taught engineering at summer camps, and served as a tutor and mentor to K-12 and undergraduate students. Paige chartered a NSBE Jr. chapter, NSBE's pre-college membership category for K-12 students. For her work with NSBE Jr., she was awarded the NSBE Golden Torch Award for Pre-College Initiative Director of the Year and the Black Engineer of the Year Community Service Award.

Paige has a B.S. in Electrical Engineering and a M.Ed. in Teaching and Learning.

Dr. Allison Godwin, Purdue University-Main Campus, West Lafayette (College of Engineering)

Allison Godwin, Ph.D. is an Assistant Professor of Engineering Education at Purdue University. Her research focuses what factors influence diverse students to choose engineering and stay in engineering through their careers and how different experiences within the practice and culture of engineering foster or hinder belongingness and identity development. Dr. Godwin graduated from Clemson University with a B.S. in Chemical Engineering and Ph.D. in Engineering and Science Education. Her research earned her a National Science Foundation CAREER Award focused on characterizing latent diversity, which includes diverse attitudes, mindsets, and approaches to learning, to understand engineering students' identity development. She has won several awards for her research including the 2016 American Society of Engineering Education Educational Research and Methods Division Best Paper Award and the 2018 Benjamin J. Dasher Best Paper Award for the IEEE Frontiers in Education Conference. She has also been recognized for the synergy of research and teaching as an invited participant of the 2016 National Academy of Engineering Frontiers of Engineering Education Symposium and the Purdue University 2018 recipient of School of Engineering Education Award for Excellence in Undergraduate Teaching and the 2018 College of Engineering Exceptional Early Career Teaching Award.

A Systematized Literature Review of the Experiences of Women in the Engineering Workplace

As researchers continue to investigate underrepresentation and retention of women in engineering, they often focus on undergraduate women. However, women are also departing from the engineering workforce and many attribute their decision to depart to the environment that is often characterized as masculine or exclusionary. Studies have shown that once beginning a career in engineering, 25% of women leave the field within five years.

To address the underrepresentation and retention of women in the engineering workforce, it is vital for engineering education researchers to understand the lived experiences of these women in the engineering workplace. This systematized literature review synthesizes research on the experiences of women within the non-academic, engineering workplace. This review examines female engineers from an international perspective and is not limited to female engineers in the United States. Using scholarly articles, this review seeks to answer the following questions: *1) What types of experiences do women in the engineering workforce encounter in the workplace?* *2) How do these experiences influence women to leave or persist in the engineering workforce?* In addition to answering the following questions, this review also seeks to identify any areas where further research is warranted. Using qualitative methods and analysis, three themes central to the experiences of women in the engineering workplace emerged. Women in engineering industry encounter experiences that include masculinized and non-supportive workplace cultures, various forms of discrimination and harassment, and the pressures associated with the day-to-day duties of their specific role. While some women can endure the exclusionary environments and inappropriate behavior, other women decide to depart from engineering industry altogether.

This review informs engineering industry of the experiences that may provoke women to leave the engineering workforce and thereby enables them to create workplace culture and environments that are inclusive of women—which will help broaden the participation of women in engineering.

Introduction and Literature Review

As researchers continue to investigate underrepresentation and retention of women in engineering, they often focus on undergraduate women. However, women in the engineering workforce also contribute to underrepresentation by leaving their careers. While women constituted 57 percent of the total enrollment in undergraduate degree programs in 2010, only 18 percent were awarded with a bachelor's degree in engineering. Continuing in this downward trend, "only 11% of practicing engineers are women, despite decades of academic, federal, and employer interventions to address this gender gap" [1, p. 5]. To make matters worse, Fouad and Singh [1] found that once beginning a career in engineering, 25% of women leave the field within five years. To address the underrepresentation and retention of women in the engineering workforce, it is vital to understand their experiences in the engineering workplace.

The experiences of women in the engineering workplace vary, and numerous women have indicated that the workplace climate was a major influence in their decision to not enter, depart, or stay in the engineering profession [1]. At work, women have experienced discrimination and

harassment [2][3], gender and racial bias [2][4], and challenges in hiring, performance reviews, or promotions [1][4]. Fouad, Singh, Cappaert, Chang, & Wan [5, p. 80] stated, “Some have argued that women leave engineering or STEM careers because they lack confidence, others cite women's lack of interests in technical areas, and still others suggest that women's departure is linked to a chilly climate.” When it comes to persisting, Fouad & Singh [1] asserted that while support systems within organizations can influence the choice to stay, a decision to remain in engineering is best projected by a combination of organizational climate and psychological factors.

If the engineering education community understands the experiences faced by women in engineering careers, then they can help address underrepresentation and retention of this group. Engineering educators, engineering education programs, and engineering professional societies can teach engineering students about the potential experiences that they may encounter and provide them with the tools to be resilient and successful when encountering adversity. Engineering industry will also be able to examine their workplace culture and environments and then make modifications in order to create environments that are inclusive of women.

Scope and Research Questions

Scope

This analysis investigated women in the non-academic engineering workforce. It was not limited to the United States and included literature from multiple countries around the world. The non-academic workforce as defined in this paper includes female engineers who work in industry or government. The reason for this distinction is because academia and industry typically vary in their aims and therefore have different cultures and philosophies. Differences can also be found in the role of practicing engineers and engineers who serve as faculty researchers at higher-education institutions. Mlambo & Mabokela [6] found that female engineers who left industry to pursue a position in academia indicated that industry was rigid and discrimination was prevalent while a position in the academy provided them with more flexibility and support. The terms engineering workforce, engineering workplace, engineering career, and engineering industry are used synonymously in this paper.

Research Questions

There are numerous explanations that have been cited to explain why women leave their engineering careers. Some of those include factors intrinsic to women, such as identity, confidence, and personal values (e.g., spending more time with family) [2]. Other factors include those relating to workplace culture and engineering environments in which women work [2][4]. This review focused on those experiences that are related to external factors such as the engineering environment and workplace climate. While aspects relating to the characteristics of the individual are likely to impact one's decision to remain in engineering, they were not examined in this review. This review focused on factors external to women that they do not control.

The goal of this review was to answer the following research questions:

1. What types of experiences do women in the engineering workforce encounter in the workplace?

2. How do these experiences influence women to leave or stay in the engineering workforce?

Methods

This study conducted a systematized literature review, which involved a structured and systematic search of the literature followed by a narrative description and synthesis from the resulting articles on the subject [7]. The search procedure and analysis to find the three resulting themes are described below.

Search Procedure

Using practically identical search strings, several databases were queried in order to locate articles relevant to the research questions. The following databases were selected: Scopus, ERIC, Education Source, PsycINFO, and Women's Studies International. Scopus was selected because it is one of the largest databases of scholarly literature that includes research relating to both technical and social science disciplines. EBSCOhost was used to query ERIC, Education Source, PsycINFO, and Women's Studies International databases simultaneously. This platform was especially helpful in that it helped facilitate a more efficient search process. ERIC and Education Source were chosen for their selection of educational journals that would be pertinent to the field of engineering education. PsycINFO was utilized for its ability to provide peer-reviewed journal articles relating to behavioral science and Women's Studies International offered literature centered on women. This vast range of databases is essential to grasping the experiences of women in engineering industry.

The search string used included six major components. The first component allowed for query of documents that included "women" or "woman" using a question mark as a character to detect differences in vowels (i.e., wom?n). The second component, queried for variations of the word engineer. For example, "engineer", "engineers", or "engineering." Then to find documents discussing the engineering workplace, "career," "job," "work," "occupation," "profession," and "industry" were used. The fourth component yielded results that spoke of persistence or retention. In order to capture the vast experiences of women in engineering industry, "experience/experiences," "discriminate/discrimination," "inequity," "inequality," "bias," and "racism" were used. These terms were selected because of their prominent use in scholarly articles and they were also cited as reasons for women departing from engineering. Finally, in order to omit journal articles discussing academia and pre-college students, the terms "academia" and "high school" were excluded.

When searching the Scopus database, the search string was used to search the title, abstract, and keywords of journal articles. For the EBSCO search, the abstract, subject, and title was searched. For both searches, the results were filtered to display peer-reviewed journal articles only. Scopus yielded 83 peer-reviewed articles and the EBSCO search returned a total of 60 articles. There were 10 results from ERIC, nine from Education Source, 20 from PsycINFO, and 21 from Women's Studies International. The search strings and results from each database are shown in Table 1.

Table 1. Complete Search String and Database Query Results 10/12/2018

Search String	Database	Results
TITLE-ABS-KEY ((wom?n) AND (engineer*) AND (career OR job OR work OR occupation OR profession OR industry) AND (persist* OR retention) AND (experience* OR discriminat* OR inequity OR inequality OR bias OR racism)) AND NOT (academia OR high school)	Scopus	83
AB (wom?n) AND AB (engineer*) AND AB (career OR job OR work OR occupation OR profession OR industry) AND AB (persist* OR retention) AND AB (experience* OR discriminat* OR inequity OR inequality OR bias OR racism) OR SU (wom?n) AND SU (engineer*) AND SU (career OR job OR work OR occupation OR profession OR industry) AND SU (persist* OR retention) AND SU (experience* OR discriminat* OR inequity OR inequality OR bias OR racism) OR TI (wom?n) AND TI (engineer*) AND TI (career OR job OR work OR occupation OR profession OR industry) AND TI (persist* OR retention) AND TI (experience* OR discriminat* OR inequity OR inequality OR bias OR racism) NOT TX (academia OR high school)	<i>EBSCO Search:</i> ERIC (10) Education Source (9) PsycINFO (20) Women's Studies International (21)	60

Inclusion/Exclusion Criteria

Following the search procedure, duplicates were removed from the combined database search using the process recommended in the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) guide [8] as seen in Figure 1. Then inclusion and exclusion criteria was used to further eliminate articles not of relevance to the research questions. Articles were eliminated first by title, abstract, and then full text. A total of 11 articles were identified as relevant and reviewed.

For an article to be included in the literature review, we required that it be a peer-reviewed journal article written in English with a population that included women. The journal article also needed to include a discussion of engineering careers. Articles were excluded if women in academia or pre-college students were the only population examined. The inclusion and exclusion criteria can be found in Table 2.

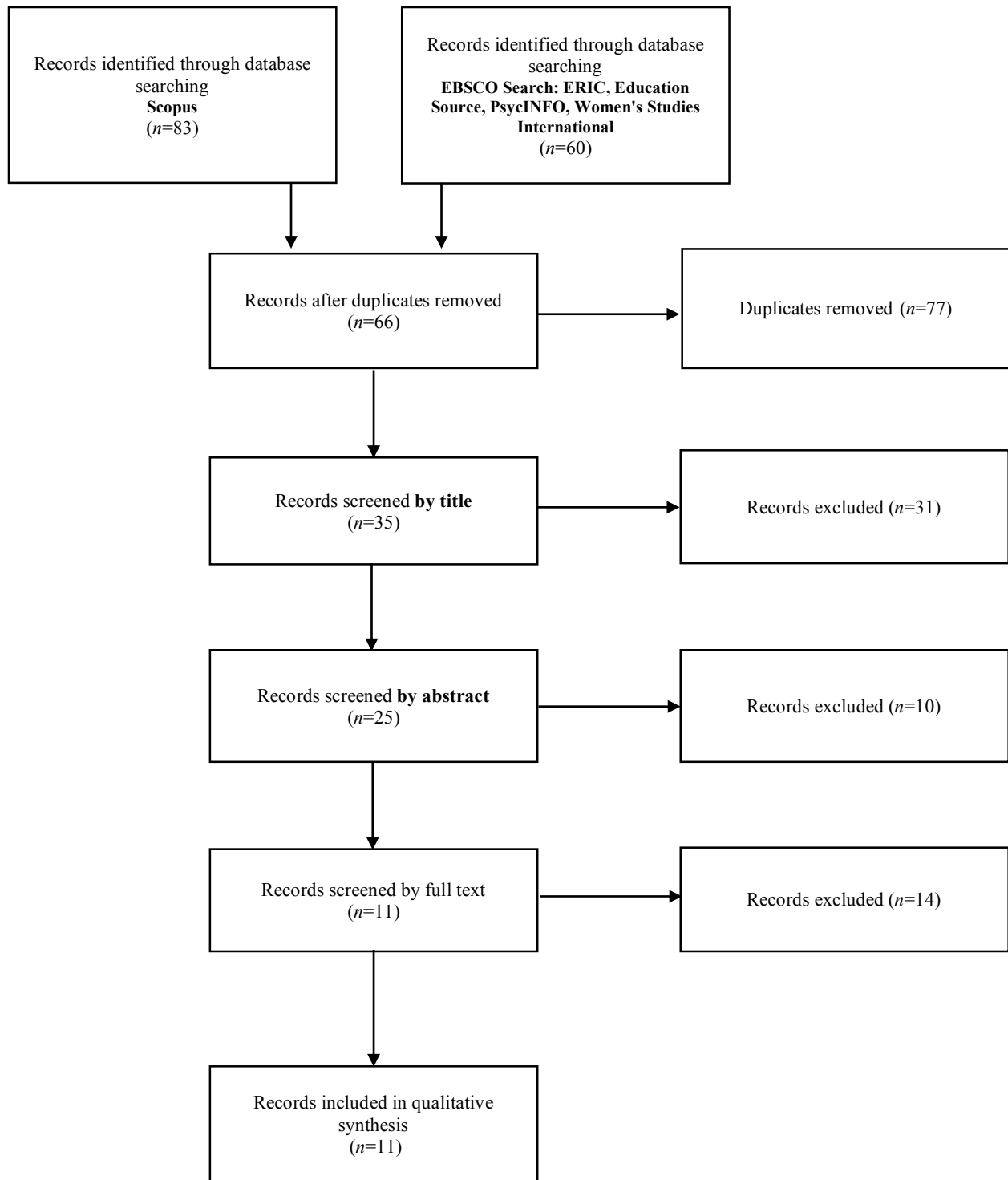


Figure 1. Flow of Article Search and Eligibility Screening Process. Flowchart adapted from PRISMA flowchart.

Table 2. Inclusion and Exclusion Criteria

Inclusion Criteria	Exclusion Criteria
<ul style="list-style-type: none"> • Peer-reviewed journal article • Written in English • Population includes women • Discussion of experiences in engineering careers (industry or government) 	<ul style="list-style-type: none"> • Women in academia only • Population includes pre-college students • Population includes undergraduate or graduate students only

Analysis

A thematic analysis was conducted to systematically identify the recurring and/or main themes across the various studies. This method of analysis was chosen in order to “work with, and reflect directly, the main ideas and conclusions across studies, rather than developing new knowledge although this is possible” [9, p. 18]. The initial review of the articles consisted of a high-level examination of the articles in which the researcher noted the purpose, questions, and results of each study. During this review, the first author reflected on what was read, noting key findings and making initial connections. The second review included an examination of the methodology, results, discussion, and any implications or limitations of the studies. During the second review of the data, themes common to the articles were extracted.

Results

Three themes emerged from the analysis of 11 articles collected in the systematized search. The themes describe the types of experiences women encounter in engineering industry. Most of the articles described negative experiences of women, while a few described the positive experiences. When discussing persistence in and departure from engineering industry, there were reasons discussed relating to factors intrinsic to women and external factors such as workplace culture.

Theme 1: Workplace Culture

The workplace culture or values, social interactions, and behaviors that make up the environment were discussed in the articles. Several types of cultures present in the engineering workplace were described. They include masculine or male-dominated culture, family-oriented culture, and a culture characteristic of support.

Masculine/Male-dominated culture

The workplace culture in engineering industry was described by women to be masculine and male-dominated. In other words, the environment mostly influenced by men and characterized by practices that are exclusionary to women. Buse et al. [2] interviewed 31 women engineers and found that engineers who stayed and left the field both recognized the male-dominated culture of their work environments. Ayre, Mills, and Gill [10, p. 216] sought out to answer the question, “What makes some women stay when many others leave?” They surveyed 56 female engineering graduates, 53 of who were still working in the engineering field. Sixteen of the women who stayed in engineering were interviewed. Many of the women brought up the fact that their male counterparts outnumbered them, which caused isolation for some [10]. Comments from women continued to indicate this male-dominated culture. One woman indicated that:

The industry that I am working in is very male dominated. There are many views that females do not belong in the industry. Some state that females are too emotional and there's no room for it in engineering. [11, p. 304]

A construction engineer detailed her experience in a male-dominated work site:

I was the construction engineer for several road projects and I was the only woman on site. There were basic issues, like having to use the men's toilets on site and the lunch rooms being plastered wall to wall with posters of naked women. [10, p. 225]

In addition to being outnumbered, isolated, and subjected to physical work site conditions not tailored for women, the participation of women at the decision-making table was less common in comparison to men. Twenty-five percent of the women reported that they participated in the decision-making process most of the time, or always, compared to 35% of men [11]. These exclusionary practices mirror the descriptions of a "boys' club" where the women felt excluded from networking opportunities [12]. Surprisingly, Powell and Sang [13] found that in addition to women being treated differently by men, women indicated that they too treated other women differently than they did men. Nevertheless, while some women sought to endure the differential treatment and stay, others changed employers [10].

Family-oriented culture

An organization that is comprised of a culture that is family-oriented aims to create an environment that aids employees in managing both their professional and personal responsibilities. Women enjoy the supports in place at work for individuals with families and many women even choose their employer because of the familial opportunities offered at work [10]. However, Ayre et al. [10] found that women felt that taking advantage of the family-friendly policies (e.g., maternity leave, etc.) impacted how they were viewed and treated. One woman left because she was "sick and tired of being criticized" [10, p. 226]. Women also said that their careers have suffered due to them making use of the familial programs. One woman said:

I do feel that even though employers are prepared to employ me part time since I have children they are not really prepared to promote me. I actually have significant and rare experience that is increasingly sought after but feel that since I am a parent I am denied opportunities for promotion. [11, p. 306]

Although women valued a family-oriented culture, they also feared taking advantage of the benefits due to possible retaliation.

Supportive culture

Four articles indicated that a supportive work environment is important to women. Ayer et al. [10] found that the women engineers who intended to stay at their jobs talked about the major aspect that caused their contentment. That aspect was the positive support from their supervisors towards women in engineering. One woman said:

... right through my career I've met men that have been interested in doing that [increasing the number of women]. [X], a very early mentor of mine, was very supportive of women in engineering... And I've stayed in contact with him even after his retirement and my moving on. And later [Y] was the same. And I think they both set out to deliberately increase the percentage [of women engineers] they had in their sections, recognising that that was a good thing. Our CEO here has always been very pro getting females into engineering roles... and trying to break down that bloke culture. [10, p. 228]

Buse and Bilimoria [14] found that the dedication women have to remain in a career was significantly influenced by their relationship with a supervisor. Fouad et al. [5] discovered that workplace support contributed to women who persisted in engineering. Their quantitative study examined the differences between women engineers who departed from engineering versus women engineers who decided to continue in engineering. Their hypothesis, which projected that “women who leave engineering have experienced lower levels of workplace social support than women who stay in the field” [5, p. 81], was proven in part. This hypothesis was based on Social Cognitive Career Theory, which indicates, “contextual factors in the form of barriers and supports exercise a significant influence on individuals' career choices” [5, p. 81]. Fouad et al. [5] had participants complete 18 surveys, three of which addressed workplace support. The scales used were the work-family culture scale, perceived social support from supervisors and coworkers scale, and perceived organizational support (POC) scale. The work-family culture scale measured the organization's position towards prioritization of work over family and supervisory support and sensitivity towards employees' familial obligations. The perceived social support from supervisors and coworkers scale assessed the perceived social support from managers and colleagues while the POC was evaluated the extent to which employees believed their company acknowledged their work and welfare.

Women who remained in engineering varied in their experiences of content specific support—perceived support in which one believes they are cared for and given tools to address the needs or stresses of the job. When it came to content general support, general expressions of care toward their well-being, there was no difference among those who left and those who persisted. Fouad et al. [5] believed that the type of support matters as content specific support may be a better indication of women's decisions regarding engineering career choice. Similarly, Buse et al. [2] found that women who stayed in engineering discussed their experiences of support in terms of “reciprocal engagement with others, including collaboration and providing support, counsel and advice” (p. 146). The literature suggests that women who feel supported in their workplace environments tend to persist in engineering.

Theme 2: Discrimination

This general theme of discrimination included a wide array of different examples and was seen throughout the articles. It encompassed various forms of discrimination such as harassment, sexism, racism, and ageism, all of which emerged throughout this literature review. Šidlauskienė [15] investigated women engineering researchers with positions in industry and found that discrimination occurred openly and covertly. Ayre et al. [11] examined the research published related to women in the engineering workforce then they conducted a quantitative examination and comparison of two Australian national surveys. The researchers examined why women were

leaving the field of engineering. The first survey, The Careers Review of Engineering Women (CREW1), was conducted in 2000 recruiting both female and male members from Engineering Australia. A follow-up qualitative study, CREW2, consisted of interviews conducted between 2002-2003.

The first survey, CREW1, found that over a third of female engineers endured discrimination and harassment. After initiatives were put in place to improve diversity and equity, the survey was administered again in 2007. CREW1 discovered that 36% of the women surveyed experienced discrimination. The percentage of reported discrimination increased to 42.3%, most of which was gender-related, when the women were surveyed again in CREW2. One limitation to note of this comparative study is that the women who left the field of engineering were likely to not have participated due to them no longer being a member of Engineers Australia. But, part of this increase in discrimination could have been in part to women being more knowledgeable of the types of discrimination.

Buse et al. [2] investigated the contextual circumstances that characterize women who continue in engineering careers. When comparing women who stayed in engineering versus those who departed, both groups had experiences of discrimination and harassment. These women spoke about their experiences:

Technical Manager with 24 years of experience: I didn't get that next job up. HE did. My boss said, "We didn't know you wanted that job. You never said you were interested in that job." [. . .] I was like "I'd assume you would know that I want to progress in my career." That's the logical progression. I didn't realize I had to tell them what I wanted. I was on his leadership team. [2, p. 148]

Fifteen-year engineering career now a homemaker: Despite what anybody says in terms of equal opportunity for everyone, there is a clear discrimination for women in manufacturing in terms of giving them promotions, equal pay and treatment. [2, p. 148]

Eleven-year engineering career now a college business professor: He was really just a bad, bad boss [. . .] he would make sexual innuendos whenever he had the opportunity. I found that I was choosing my words very, very carefully so he couldn't turn it around and make it a sex joke. [2, p. 148]

Sexual harassment as indicated in the excerpt above is a type of harassment that occurs in the engineering workplace. Lafontaine and Tredeau [16] defined sexual harassment as "any action occurring within the workplace whereby women are treated as objects of the male sexual prerogative. Furthermore, given that women are invariably oppressed by these actions, all such treatment is seen to constitute harassment, regardless of whether the victim labels it as problematic" (p. 435). Women who held positions in fields primarily composed of men (e.g., engineering, science, and management) were surveyed ($n = 136$) to investigate the origins and rate of sexual harassment. Participants were asked if they experienced various forms of sexual harassment such as "verbal abuse; subtle pressure for sexual activity; sexual remarks regarding clothing, body, or love life; touching, patting, or pinching; leering; brushing against the body;

overt demands for sexual activity; or physical assault” (p. 435). Lafontaine and Tredeau [16] found that over three-fourths of the women surveyed had faced at least one form of harassment in comparison to the 50% generally cited for the entire population. Women who were managers and engineers reported higher levels of harassment in contrast to women working in the sciences, with computers, or in public administration roles [16].

Sexual humor, another form of sexual harassment, was not generally considered as harassment by women. Powell and Sang [13] conducted three qualitative studies of women and men at various stages in their career. The first study interviewed undergraduate engineering students and the second consisted of interviews with architects. The third study involved interviews with professionals in the construction industry and they held roles that ranged from manager, to engineer and architect. In the third study, sexism was a significant topic of discussion. Almost all of the participants indicated that the sexist humor should be taken lightly. A female engineering student from the first study who was just beginning a position in industry indicated that she did not want to prevent her male counterparts from engaging in humor:

I would probably join in with it nine times out of ten, and I can honestly say that I was never offended through anything at all they said in banter or sexually or anything. [13, p. 925]

This theme indicated that the majority of studies on women in engineering industry document some form of discrimination or harassment in the workplace. This hostile environment may be a primary reason why women choose to leave the profession.

Theme 3: Engineering Position Type

The specific engineering position that one held in industry was a common theme identified as a contributor to women’s attrition. Cardador [17] examined 61 engineers in industry and found that women were disproportionately represented in managerial positions while men were disproportionately represented in technical positions. A follow-on study was conducted to see if these outcomes were sustained in a larger sample. Cardador and Hill [18] investigated the association of gender and career path in a group of 274 engineers, 40% of which were female. The effects of career path choice for five outcomes were explored. The five outcomes were “intent to leave engineering, identification with engineering colleagues, intragroup respect, work satisfaction, and meaningful work” [18, p. 97]. The career paths examined were managerial, technical, and hybrid—a combination of managerial and technical.

The results indicated that some career paths may increase the chance of attrition. For example, “Pairwise comparisons showed that engineers on hybrid path were significantly more likely to report intent to leave engineering as compared to those on the technical path” [18, p. 100]. While the experiences of women in each career pathway were not discussed or stated explicitly, there is reason to assume that the experiences in each of these roles contributed to them leaving or staying within engineering. It also warrants further investigation into the specific experiences of the career paths.

Discussion

In addressing each research question, we have found that women in engineering industry encounter experiences that include masculinized and non-supportive workplace cultures, various forms of discrimination and harassment, and the unclear pressures associated with the day-to-day duties of their specific role. While some women can endure the exclusionary environments and inappropriate behavior, other women decide to depart from engineering industry altogether. It is worth to note that “the reasons women persist are not the inverse of the reasons women leave” [2, p. 153].

Engineering industry workplace culture is shaped by everyone, men and women, who are a part of the organization. The so-called “boy’s clubs” and “sexist humor” described in this review were created by men; however, these issues are tolerated by women in some instances. Faulkner [19] would argue that accepting behavior such as sexist humor sends hidden messages. In this case, tolerating inappropriate behavior allows an environment to be crafted where masculinity and harassment is acceptable.

While women should not tolerate any adverse treatment, organizations should take the lead in creating environments that are inclusive to all people. Fouad and Singh [1] recommend creating a culture within organizations that respect women engineers and the work that they do through providing transparent pathways to promotion, supporting a balance between work and personal life, and offering mentoring opportunities. But, it is also imperative that individual actors that impact the culture on a daily basis respect women engineers. Pless and Maak [20] suggested four phases to build an inclusive culture after identifying barriers that obstruct inclusion:

The first phase focuses on raising awareness, building understanding and encouraging reflection. The second phase deals with the development of a vision of inclusion as an important step to define the change direction. In a third phase key management concepts and principles should be re-thought. This leads to the fourth, action-oriented phase, that focuses on an integrated Human Relations Management system that helps implement change by doing both, translating the founding principles via competencies into observable and measurable behavior and fostering the development, reinforcement and recognition of inclusive behavior. [20, p. 129]

As demonstrated in the literature, the experiences of women in the workplace have contributed to their decisions to persist in or depart from the field. In order to resolve this issue, action is needed from several stakeholders. Universities must educate women on the types of environments that exist and the experiences that occur in order to prepare them for tackling these challenges. Educators must also educate all students, not only women, about diversity and creating cultures of inclusiveness so that as students transition to professionals in industry, they do not continue to contribute to and perpetuate cultures or negative experiences that women influence women to leave. Rather they should serve as actors that help eradicate this type of culture and create workplace environments open to all.

Engineering industry must also take accountability for the experiences and culture that they are crafting. Environments of inclusion and support should be cultivated. As indicated by the literature, family-friendly environments and practices are appealing to both men and women.

Limitations

During the EBSCO database search, we omitted the terms “academia” and “high school” from all text. By omitting these terms, potentially relevant articles that used the two terms in passing may have been excluded from my results. Another limitation is the small number of articles used in this synthesis. A small number of articles could potentially influence the breadth of the literature review; however, the yield of a small number of articles in my case is a potential indicator that there is limited research examining the experiences of women in engineering industry.

Future Research

Mlambo & Mabokela [6] found that female engineers who left industry to pursue a position in academia indicated that industry was rigid and discrimination was prevalent while a position in the academy provided them with more flexibility and support. This search procedure did not specifically pursue literature related to pathways of female engineers who left industry for academia or female engineers who left academia for industry. This search also did not yield any literature that speaks to those scenarios. Future research examining those pathways of female engineers could provide valuable information about the experiences of women in engineering industry versus academia.

Rincon & Yates [4] have found that women of color are held to higher standards than white women and the challenges faced for women of color are multiplied. There are also differences in how white and Black women view their experiences. Smith and Joseph [21] found that white women accredited organizational culture and not race and/or gender to organizational setbacks unlike Blacks who always believed race and gender had a big influence on their experiences in the workplace, even serving as barriers. However, almost all of the studies failed to address the experiences of women at intersections of both gender and race.

As Riley, Slaton, and Pawley [22] suggest, when approaching issues of underrepresentation and diversity, complete categories of identity and intersectionality of various types of people should be examined in order to maximize inclusion. There is little literature discussing Black women in engineering industry, and they are grossly underrepresented in engineering (comprise only 0.72 % of engineering industry; [23]). This lack of representation in industry and the literature calls for future work to be done in examining the experiences of Black women or underrepresented Women of Color in engineering industry.

As mentioned earlier, further work investigating the experiences of women in different engineering positions (e.g., managerial, technical, and hybrid) should be conducted due to the differences in women’s intent to leave engineering. Finally, an examination of the interventions designed to build inclusive workplace culture should also be evaluated to assess their effectiveness.

Conclusion

This systematized literature review investigated the experiences of women in the engineering workplace and how these experiences influence women to leave or depart from engineering industry through a discussion of the existing literature. A search of five databases yielded 143 articles that were later reduced to 11 articles that met the inclusion/exclusion criteria. A review of the articles resulted in three themes related to the types of experiences women encounter in the engineering workforce. These findings describe the type of experiences women endure and how the experiences may influence their decision to persist in or depart from engineering industry.

Acknowledgements

The authors would like to thank the peer reviewers, Bárbara Fagundes and Behzad Beigpourian for assistance with this project. The authors would also like to acknowledge Moses Olayemi, Jacki Rohde, and Dr. Monique Ross for their feedback and support.

References

- [1] N. A. Fouad and R. Singh, "Stemming the tide: Why women leave engineering," *Department of Energy*, 2011 [Online] Available: https://www.energy.gov/sites/prod/files/NSF_Stemming%20the%20Tide%20Why%20Women%20Leave%20Engineering.pdf. [Accessed: Sep. 4, 2018]
- [2] K. Buse, D. Bilimoria, and S. Perelli, "Why they stay: women persisting in US engineering careers," *Career Development International*, vol. 18, no. 2, pp. 139-154, 2013.
- [3] P. Brown, *Conqueror: A black woman's guide to conquering challenges in the workplace*. Washington, DC: Paige Brown, 2018.
- [4] R. M. Rincon and N. Yates, "Women of color in the engineering workplace: Early career aspirations, challenges, and success strategies," *Society of Women Engineers*, 2018 [Online]. Available: <http://alltogether.swe.org/wp-content/uploads/2018/02/Women-of-Color-in-the-Engineering-Workplace.pdf>. [Accessed: Sep. 4, 2018]
- [5] N. A. Fouad, R. Singh, K. Cappaert, W. Chang, and M. Wan, "Comparison of women engineers who persist in or depart from engineering," *Journal of Vocational Behavior*, vol. 92, pp. 79-93, Feb. 2016.
- [6] Y.A. Mlambo and R. O. Mabokela, "'It's more flexible': Persistence of women engineers in the academy," *European Journal of Engineering Education*, vol. 42, no. 3, pp. 271-285, 2017.
- [7] M. J. Grant and A. Booth, "A typology of reviews: An analysis of 14 review types and associated methodologies," *Health Information & Libraries Journal*, vol. 26, no. 2, pp. 91-108, 2009.
- [8] D. Moher, A. Liberati, J. Tetzlaff, and D. G. Altman, "Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement (Chinese edition)," *Journal of Chinese Integrative Medicine*, vol. 7, no. 9, pp. 889-896, 2009.

- [9] M. Petticrew and H. Roberts, "Why Do We Need Systematic Reviews?," in *Systematic reviews in the social sciences: A practical guide*, Malden, MA: Blackwell, 2006, pp. 1-26.
- [10] M. Ayre, J. Mills, and J. Gill, "'Yes I do belong': The women who stay in engineering," *Engineering Studies*, vol. 5, no. 3, pp. 216-232, 2013.
- [11] M. Ayre, J. Mills, and J. Gill, "Two steps forward, one step back: Women in professional engineering in Australia," *International Journal of Gender, Science & Technology*, vol. 3, no. 3, pp. 293-312, 2011.
- [12] P. Roberts and M. Ayre, "Did she jump or was she pushed? A study of women's retention in the engineering workforce," *International Journal of Engineering Education*, vol. 18, no. 4, pp. 415-421, 2002.
- [13] A. Powell and K. J. C. Sang, "Everyday experiences of sexism in male-dominated professions: A bourdieusian perspective," *Sociology*, vol. 49, no. 5, pp. 919-936, 2015.
- [14] K. R. Buse and D. Bilimoria, "Personal vision: Enhancing work engagement and the retention of women in the engineering profession," *Frontiers in Psychology*, vol. 5, Dec. 2014.
- [15] V. Šidlauskienė, "Gendered career paths in engineering and technology in cross-national and west-east perspective," *Gender Studies & Research*, vol. 6, pp. 4-29. 2009.
- [16] E. Lafontaine and L. Tredeau, "The frequency, sources, and correlates of sexual harassment among women in traditional male occupations," *Sex Roles*, vol. 15, no. 7/8, pp. 433-442, 1986.
- [17] T. M. Cardador, "Promoted up but also out? The unintended consequences of increasing women's representation in managerial roles in engineering," *Organization Science*, vol. 28, no. 4, pp. 597-617. 2017.
- [18] T. M. Cardador and P. L. Hill, "Career paths in engineering firms," *Journal of Career Assessment*, vol. 26, no. 1, pp. 95-110, 2018.
- [19] W. Faulkner, "Becoming and belonging: Gendered processes in engineering," in *The Gender Politics of ICT*, J. Archibald, J. Emms, F. Grundy, J. Payne, and E. Turner, Eds. London: Middlesex University Press, 2005, pp. 15-26.
- [20] N. Pless and T. Maak, "Building an inclusive diversity culture: Principles, processes and practice," *Journal of Business Ethics*, vol. 54, no. 2, pp. 129-147, 2004.
- [21] J. W. Smith and S. Joseph, "Workplace challenges in corporate America: Differences in black and white," *Equality, Diversity and Inclusion: An International Journal*, vol. 29, no. 8, pp. 743-765, 2010.
- [22] D. Riley, A. E. Slaton, and A. L. Pawley, "Social Justice and Inclusion," in *Cambridge Handbook of Engineering Education Research*, A. Johri and B. M. Olds, Eds. New York: Cambridge University Press, 2014, pp. 335-356.
- [23] M. Ross, "A unicorn's tale: Examining the experiences of Black women in engineering industry," Ph.D. dissertation, Department of Engineering Education, Purdue University, West Lafayette, IN, 2016.