Examining Gender Bias in Engineering in India

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Introduction

Many issues are influencing women's decisions to enter into and stay in the engineering workforce. While much work has been done to understand how we can encourage more girls to consider a career in engineering, there is also a great deal of attention around the structural and cultural factors that influence women once they enter the workplace. One area of study focuses on the influence of gender bias on decisions that have a direct impact on girls' and women's experiences, both in education and in their careers. Much of the research on bias in the workplace has focused on U.S. and European women engineers. Forty years of social science research have shown the prevalence of implicit bias against women and the ways in which such biases impact decisions in hiring, performance evaluations, and compensation. However, similar studies are scarce in India.

Extremely few women in India were earning engineering degrees in the 1980s. Compared to the United States, where about 10% of engineering degrees were earned by women, less than 2% of engineering degrees were earned by women in India [1, 2]. Fast forward 20 years, and in the year 2000 women in India had surpassed women in the U.S., earning 24% of engineering degrees awarded compared to about 21% in the U.S. [1, 2]. Unfortunately, this rapid increase has slowed in India, where about 32% of engineering degrees are earned by women [3].

Interestingly, research has found that the "chilly climate" that women engineering students in the U.S. experience does not seem to be an issue in India. Women engineering students in India report that they are treated respectfully by their male peers, and few report feelings of exclusion [4, 5]. The challenges facing women engineers in India seem to take place after graduation. The unemployment rate for women with engineering degrees is about 40%, roughly five times the rate for men, and the unemployment rate for women engineers appears to be increasing in many parts of the country [1, 6, 7]. For women who enter the workplace, the biggest barrier to gender equality appears to be societal pressures to conform to traditional gender roles. For example, 84% of Indians believe that when jobs are scarce, men should be given preference over women for available positions [8]. In India, the ability for a married woman to stay at home enhances a family's social status, pressuring women to leave the workforce after marriage [8].

Research on women's experiences in the Indian engineering workplace is scarce. Building on the decades of social science research on bias in the workplace conducted in Western nations, this paper presents findings from a study investigating the state of the engineering workplace for men and women in India.

Background

Prior studies on workplace gender and racial bias have typically taken place in social psychology laboratories in college settings. One such study of bias in the sciences involved asking professors to rate resumes for a job as a lab manager [9]. Both male and female professors rated male applicants as more competent and hirable than their female counterparts. Male applicants were offered more money and career mentoring as well.

Another study involving resumes of women with and without children found that mothers were 79% less likely to be hired, only half as likely to be promoted, and offered a lower salary than women without children [10]. This study was conducted among college students as well as actual employers, and employers were found to have a stronger bias against mothers.

Rather than using an experimental design to find out about the experiences of bias, we asked both men and women in India what they have personally experienced in the engineering workplace.

Theoretical Framework

To understand the bias experiences of engineers in India, researchers tested for four basic patterns of bias identified in Joan Williams & Rachel Dempsey's work [11].

Prove-It-Again bias occurs when certain groups must provide more evidence of their competence to gain the same recognition as their colleagues. Research has shown that women and people of color often face this bias pattern. Social and economic class, sexual orientation and gender identity, region of origin, accents, and other factors can also trigger Prove-It-Again bias [12, 13]. Prove-It-Again bias is evident when people feel that their mistakes are noticed more and remembered longer, when their ideas are ignored, and when their successes are attributed to luck rather than skill.

Tightrope bias occurs when a narrower range of behavior is accepted from some groups than from the dominant group. These expectations are tied to prescriptive stereotypes about how people should behave based on stereotypes about their group. When someone does not conform to these expectations, they can face backlash. Women often walk this tightrope between being seen as "too masculine," and thus respected but not liked, and "too feminine," and liked but not respected. Women can experience the Tightrope bias pattern when they face pushback for advocating aggressively for a raise, asserting themselves as a team leader, or speaking in a straightforward manner [14, 15].

Maternal Wall bias arises when women face bias due to motherhood or pregnancy. In the workplace, being a mother can trigger strongly negative assumptions about a woman's competence and commitment [16, 10]. People assume that mothers are less committed to their jobs because they "should" have a greater focus on their families. On the flip side, if a mother tries to show her commitment at work, she might be perceived as a "bad mother". People may view her as less warm and less likeable in the workplace [17].

Another way in which the Maternal Wall bias presents itself is when women request family leave or a flexible work schedule. For men, they may face pushback when requesting time off to care for children or other such family responsibilities. People without children can also face Maternal Wall bias when they are asked to work extra hours to make up for missed time by colleagues with children.

Tug of War bias exists when gender bias against women leads to conflicts among women. In engineering, women may distance themselves from other women as a strategic move, wanting to avoid being seen as a "woman" rather than "an engineer" [18, 19]. Another way this bias pattern

occurs is when women believe that there is only one "woman's spot" in the leadership team, so women compete against each other for the spot. Tug of War bias can also be triggered by race, age, region of origin, and other factors [20]. Tug of War can also include pass-throughs from the other three bias types when a woman perpetuates the biases with other women. For example, an older woman engineer might hold younger women engineers to a higher standard than a man, or she might question another woman's priorities if she chooses to prioritize her family over work.

Methodology

The Workplace Experiences Survey [21] was initially developed for use in the U.S. To ensure its applicability in India, the researchers conducted focus groups with women engineers in India to ensure that the four bias patterns were cross-culturally relevant. The Workplace Experiences survey was modified by refining questions and adding new variables of interest based on issues identified during the focus group discussions. New variables focused on bias based on language or region of origin and the effects of the Shops and Establishments Act.

The Workplace Experiences Survey tests for the four basic patterns of bias. The survey includes Likert scale questions using a strongly disagree-to-strongly agree (1-6) scale. To calculate percentage of agreement to the questions, researchers considered a response of 1 or 2 (strongly disagree or somewhat disagree) as analogous to "No, I have not had that experience" and a response of 3-6 as "Yes, I have had that experience at least once." While findings were reported as percentages, the statistical analyses were conducted using the Likert scale data.

To understand the experiences of engineers in India, survey respondents' answers were analyzed based on responses to individual questions as well as the overall responses for certain issues or bias patterns. Each issue has multiple components, so multiple questions were asked in the survey to address different aspects of each bias pattern. Composite variables, or scales, were created to allow researchers to incorporate the responses from related questions and report the experiences of bias within each of the four patterns.

In addition to the quantitative data obtained from the Workplace Experiences Survey, researchers utilized the qualitative data obtained from the initial focus groups as well as comments left on the online survey in response to open-ended questions.

A total of 693 engineers participated in this study. Table 1 provides the demographics of the sample. The data analysis included a confirmatory factor analysis to ensure that the data were a good fit for the hypothesized four-patterns model. Researchers also conducted simultaneous multiple regression analyses to examine the influence of the bias patterns on workplace processes and outcomes, controlling for gender.

Table 1. Sample demographics

	Number	Percentage
Gender		
Women	423	61%
Men	270	39%
Age		
18-24	80	12%
25-34	397	57%
35-44	176	25%
45+	40	6%
Highest Level of Education		
Bachelor's degree or below	238	34%
Professional/master's degree/doctorate	438	63%
Specialization		
Aerospace engineering	91	13%
Computer engineering	141	20%
Computer science	92	13%
Mechanical engineering	89	13%
Other engineering	280	40%
Years of Employment Experience as an Engineer		
2-5	228	34%
6-10	197	30%
11-20	200	30%
20+	22	3%
Other Demographics		
Have dependent children	298	43%
First-generation college grad or professional	248	36%
Work in corporate sector	521	75%

Findings

The results from the Workplace Experiences Survey indicated that a large percentage of Indian engineers, across both genders, are experiencing high levels of bias in the workplace. However, there were differences in the patterns of bias experienced by men and women engineers.

Prove-It-Again bias

> *"Male colleagues ask me more questions and wish to detract me more. I have to prove it to them that I know what I am doing and that I have done my homework."*

The percentages of both men and women engineers in India reporting Prove-It-Again bias through survey responses was 76%. This level of reported bias in the workplace is similar to the percentages reported by women engineers in the U.S. [22]. Women engineers in India shared their experiences with Prove-It-Again bias during the focus group discussions and in comments on the survey, indicating that they have to prove themselves over and over again to get the same respect as their colleagues. While their comments indicate a bias based on gender, the

researchers infer from responses to survey questions about region of origin that the high levels of bias reported by men in India are based on region of origin, race, language, or nationality.

Researchers linked the experiences of workplace bias to workplace processes and found that an increase in reported Prove-It-Again bias was associated with a decrease in feelings of belonging at work, perceptions that performance evaluations were fair, perceptions that sponsorship and networking opportunities were fair, and perceptions that compensation was fair. Prove-It-Again bias also impacted workplace outcomes, as an increase in this bias was linked to a decrease in career satisfaction, a decrease in enjoyment of work, and an increase in reporting considering looking for a new job elsewhere.

Tightrope bias

"While women are seen to be bossy, rude and assertive, males are right to behave like this."

Across both genders, 77% of survey respondents indicated that they had experienced Tightrope bias in their workplaces, or feeling that they have to walk a tightrope between being too assertive and being too submissive at work. These levels of reported bias were similar to the levels of Tightrope bias reported by women engineers in the U.S. study.

Within the Tightrope bias pattern, there was a statistically significant gender difference in responses to a question about traditional gender roles at work. Approximately 45% of women engineers agreed that they felt pressure to play a traditionally feminine role in the workplace, such as office party planner or meeting note taker, compared to 30% of men. This finding aligns with prior research that shows that women are often pressured into such roles and can face pushback if they resist [11, 23, 24]. Women face not being seen as a team player if they refuse to play these roles, but agreeing to do so can make it harder for them to get ahead, as these tasks can take away from their actual work.

Tightrope bias had the strongest impact on workplace processes and outcomes of any of the bias patterns studied. The reason for this strong impact is likely twofold: Tightrope bias was reported by large number of participants, and Tightrope bias encompasses the problems associated with being both too assertive and too submissive. An increase in Tightrope bias was associated with decreases in feelings of belonging in the workplace, perceptions that performance evaluations were fair, perceptions that the assignment process was fair, perceptions that diversity is supported in the workplace, perceptions that sponsorship and networking opportunities were fair, and perceptions that compensation was fair. An increase in Tightrope bias was also associated with decreases in feeling that others are invested in your career at work, seeing a clear path for advancement, career satisfaction, enjoyment at work, feeling happy for your career to continue as it has been, and seeing a long-term future for yourself at your organization. Engineers were also more likely to consider looking elsewhere for a new job.

Maternal Wall bias

"Several times my boss asks me not to travel as I have young kids."

The responses from the survey and the focus group discussions indicate that family care responsibilities often fall to the mothers in the family in India. Approximately 40% of women and men engineers agreed that there is an attitude in their workplaces that mothers should work less because they should be caring for children. Also, 27% of survey respondents, regardless of gender, indicated that their colleagues think fathers should work more after having children. These responses indicate the expectation for men and women to align with traditional gender roles, where mothers should work less and be home with the children, while fathers should work more.

For Indian women with caregiving responsibilities, survey responses suggest that they have a harder time getting ahead and face negative competence and commitment assumptions. Approximately 71% of women engineers and 69% of men engineers observe these biases against people with caregiving responsibilities in their workplaces. Across both genders, engineers reported that they have trouble getting flexible work arrangements for family care, but more women than men reported this issue (60% versus 51%).

For engineers without children, 50% of men engineers and 39% of women engineers in India reported that they have to work longer hours because they do not have children. This contrasts with the higher percentage of women engineers in the U.S. who reported being asked to compensate for the schedules of coworkers with children. Based on the qualitative data collected from these studies, researchers found that women in India are more likely than women in the U.S. to be expected to take care of extended family (parents, in-laws, etc.), so even women without children have responsibilities besides work.

An increase in Maternal Wall bias was associated with a decrease in perceptions of diversity support and an increase in feelings of exclusion at work. People who experience this bias believe that their coworkers do not see value in supporting diversity at work, and they feel excluded from informal gatherings and information-sharing at work.

Tug of War bias

"My woman senior manager is the one who least understands and puts pressure even after knowing the personal limitations, though my immediate manager (male) is very adjustable."

While the Tug of War bias was less prevalent in the U.S., the existence of conflicts between women in the workplace was present in India. In response to question about tokenism, or whether women feel that they have to regularly compete with their female colleagues to get the one spot that is available to them, 45% of women engineers agreed, while only 42% agreed that their female colleagues generally support each other.

Within the Tug of War bias pattern, two questions were asked to capture this bias based on age differences. In India, 63% of junior women engineers reported that they felt that more senior women engineers have just "turned into men," and are not trying to change things to help women feel more comfortable. On the flip side, 74% of senior women engineers reported that younger women engineers do not understand what it takes to succeed as an engineer. These responses highlight the generational differences that exist among women in the Indian engineering workplace.

An increase in Tug of War bias was linked to decreases in feelings of belonging, perceptions of diversity support, and perceptions that compensation was fair. It was also associated with an increase in feelings of exclusion at work and reports of considering looking for a new job.

Workplace Processes

Researchers also examined the relationships between the bias patterns and workplace processes through regression analysis using the four bias patterns as predictors and controlling for gender. Regression results are listed in Table 2.

Across the board, Tightrope bias had the strongest overall impact on workplace processes and outcomes. Tightrope bias, which includes problems that individuals face when they behave in ways that are seen as "too masculine" as well as when they behave in ways that are seen as "too feminine," was widely reported among both men and women engineers in our study. Although Tightrope bias had a very strong impact, Prove-It-Again, Maternal Wall, and Tug of War bias were also all linked to some of our outcomes and workplace processes.

The Shops and Establishments Act

Researchers asked about the Shops and Establishments Act (SEA) during focus group discussions and in the Workplace Experiences Survey. The SEA was recently modified to prohibit women from working late nights without permission. The goal of the policy is to address safety concerns, as women across India have faced dangers while trying to get home at night. Companies must meet requirements set by the state to ensure women employees who work late hours can get home safely. Those companies that do not meet these requirements must ensure that women leave work by a certain time each day.

In this study, almost 58% of engineers work for companies that require women to leave by a certain time. Times reported ranged from 6:00 pm to 10:00 pm, with most falling between 7:00 and 9:00 pm. Researchers sought to understand whether the SEA had any negative impacts. While no women surveyed indicated that there was a negative impact on safety, 17% reported that the policy jeopardizes their opportunities for advancement, 14% indicated that they are forced to miss out on business opportunities, and 11% reported feeling undermined in front of their coworkers because of this policy.

Overall, 41% of women reported experiencing some type of negative impact associated with the SEA. However, 45% reported that they personally experience better work-life balance because of the policy, and 32% felt supported in the workplace because of the policy. This indicates mixes success. While the policy does appear to make it safer for working women, there is a sacrifice

that many women are making that companies should be mindful of when they interpret and implement the policy.

Table 2: Betas and p-values for regression analyses

	Prove-It-Again	**Tightrope**	**Maternal Wall**	**Tug of War**	**Gender**
Belonging	.12*	.40***	.06	.12*	.02
Performance evaluations	.37***	.32***	.06	.03	.00
Assignments	-.04	.44***	.00	-.04	-.03
Support for diversity	.01	.21***	.22***	.24***	-.14***
Sponsorship	.14*	.34***	.04	-.11	-.03
Exclusion	.07	.31***	.14**	.23***	.02
Compensation	.21***	.24***	.01	.11*	.00
Others invested in my career	-.09	-.36***	-.05	.03	.05
Clear path for advancement	-.10	-.35***	.02	.00	.04
Career satisfaction	-.15**	-.46***	.08	-.04	-.03
Career enjoyment	-.12*	-.39***	.02	-.06	-.05
Happy for career to continue	-.05	-.40***	-.02	.00	.04
Looking for new job	.17**	.28***	.02	.14*	-.03
Long-term future	-.05	-.49***	.08	-.07	.00
Recommend my company	-.04	-.30***	-.04	-.10	-.01

Limitations

The current study found that engineers reported bias based on their region of origin or language. However, we did not have the data to further explore regional differences. Future research should delve deeper into the impact of regional differences: women may be more or less likely to pursue engineering degrees and careers depending on their region of origin, and men may also face different attitudes in the workplace depending on where they are from.

Conclusion

The findings from this study show that women in India face gender bias in the engineering workplace, indicating that the research on issues facing women in engineering in western nations are shared by women engineers in India, and have similar impacts on workplaces processes and outcomes. One of the surprising findings from this study was the high levels of bias reported by men. In some cases, men reported higher levels of bias than women. Based on the survey responses, researchers conclude that women's bias experiences are due to gender bias, while the bias experienced by men is based on where they are from or the language that they speak. However, more research is needed to understand the sources of the biases reported by men engineers in India.

The impact of these biases on workplace processes and outcomes indicate that the existence of these biases in the workplace are directly connected to engineers' feelings of inclusion at work and their desire to stay or leave their organizations. Employers seeking to make diversity a priority for the company must ensure that employees understand their commitment to this goal. It is important for companies to have clear policies around hiring, promotions, performance evaluations, and compensation to help address the biases that lead employees to feel that they are treated unfairly.

References

1. Patel, R., & Parmentier, M. J. C. (2005). The persistence of traditional gender roles in the information technology sector: A study of female engineers in India. *Information Technologies and International Development*, 2(3), 29-46.
2. Corbett, C. & Hill, C. (2015). *Solving the equation: The variables for women's success in engineering and computing.* Washington, DC: American Association of University Women.
3. AISHE. (2018). All India Survey on Higher Education 2017-2018. Government of India: Ministry of Human Resource Development. Department of Higher Education. New Delhi, India.
4. Aspiring Minds. (2018). Women in engineering: A comparative study of barriers across nations.
5. Chandra, V. (2014, August). What India can teach Silicon Valley about its gender problem. *Wired*.
6. Goel, S. (2007). Women in engineering in India. *The International Journal of Interdisciplinary Social Sciences: Annual Review*, 1(6), 1833-1882.
7. Anand, C. (2016). Number of unemployed women engineers in India is as high as 40%. *The Hindu.*
8. Why India needs women to work. (2018). *The Economist.*
9. Moss-Racusin, C. A., Dovidio, J. F., Brescoll, V. L., Graham, M. J., & Handelsman, J. (2012). Science faculty's subtle gender biases favor male students. *Proceedings of the National Acadmey of Sciences, 109*(41), 16474-16479.
10. Correll, S. J., Benard, S., & Paik, I. (2007). Getting a job: Is there a motherhood penalty? *American Journal of Sociology, 112*(5), 1297-1338. Doi: 10.1086/511799.
11. Williams, J. C., & Dempsey, R. W. (2014). *What works for women at work: Four patterns working women should know.* New York: New York University Press.
12. Ameri, M., Schur, L., Adya, M., Bentley, S., McKay, P., & Kruse D. (2015). The disability employment puzzle: A field experiment on employer hiring behavior. *The National Bureau of Economic Research.* Doi: 10.3386/ w21560.
13. Tilcsik, A. (2011) Pride and prejudice: Employment discrimination against openly gay men in the United States. *American Journal of Sociology, 17*(2), 586-626.
14. Cuddy, A. J. C., Fisk, S. T., & Glick, P. (2008). Warmth and competence as universal dimensions of social perception: The stereotype content model and the BIAS map. *Advances in Experimental Social Psychology,* 40, 61-149.
15. Fiske, S. T., Cuddy, A. J., & Glick, P. (2007). Universal dimensions of social cognition: Warmth and competence. *Trends in Cognitive Sciences, 11*(2), 77-83.
16. Crosby, F. J., Williams, J. C., & Biernat, M. (2004). The maternal wall. *Journal of Social Issues, 60*(4), 675-682.
17. Benard, S. & Correll, S. J. (2010). Normative discrimination and the motherhood penalty. *Gender & Society, 24*(5), 616-646.
18. Ellemers, N., Van den Heuvel, H., de Gilder, D., Maass, A., & Bonvini, A. (2004). The underrepresentation of women in science: Differential commitment or the queen bee syndrome? *British Journal of Social Psychology, 43*(3), 315-338.

19. Derks, B., Van Laar, C., Ellemers, N., & de Groot, K. (2011). Gender-bias primes elicit queen-bee responses among senior policewomen. *Psychological Science, 22*(10), 1243-1249.
20. Carbado, D. W. & Gulati, M. (2013). *Acting white? Rethinking race in post-racial America.* New York: Oxford University Press.
21. Center for WorkLife Law. (2018). The Workplace Experiences Survey.
22. Williams, J. C., Li, S., Rincon, R., & Finn, P. (2016). *Climate control: Gender and racial bias in engineering?*
23. Allen, T. D. (2006). Rewarding good citizens: The relationship between citizenship behavior, gender, and organizational rewards. *Journal of Applied Social Psychology, 36*(1), 120-143.
24. Heilman, M. E. & Chen, J. J. (2005). Same behavior, different consequences: Reactions to men's and women's altruistic citizenship. *Behavior Journal of Applied Psychology, 90*(3), 431-441.