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Barriers in the Workplace: An Analysis of Engineering Workplace Culture and Climate

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Abstract

Engineering workplace culture and climate have been cited as a reason for attrition in the field. In order to meet the complex needs of the future, we need to retain the population of current engineers and create an inclusive and supportive culture. Therefore, this pilot study investigates barriers to inclusive climate and culture in the engineering workplace through a quantitative survey. This study aims to provide insight into common elements of engineering workplace culture by examining demographic differences in survey responses. The survey was specifically designed based on extant qualitative research studying obstacles faced by millennial engineers in the workplace. Through exploratory factor analysis, we found four factors representing harmful corporate culture aspects that may cause engineers to leave the field. These barriers include Limited Innovation and Growth, Unproductive and Isolated Work, Discriminatory Work Environment, and Imbalanced Workload. The analysis reveals that gender and department age accounts for 11.8% of the output in perceptions of the Discriminatory Work Environment factor, underscoring the influence of these factors on workplace experiences. Further, a third of women reported experiencing harassment or discrimination in their current role, indicating this is a persistent issue in the engineering and technology workplace. Our analysis has identified professional stagnation, isolation, and overwork as harmful elements of workplace climate in addition to harassment and discrimination. Future work should investigate these areas and support efforts to improve workplace culture and climate.

I. Introduction

Diversity in engineering fields is vital to ensure greater innovation and problem-solving because engineers play a pivotal role in solving complex problems for the betterment of society [1]. However, the field of engineering has high attrition, meaning that many people with engineering degrees decide to leave the field [2]. Further, women and engineers with marginalized identities leave the field at higher rates [3], [4]. One of the reasons that engineers cite leaving the profession is due to organizational climate, as reported by 30% of women surveyed by the Society of Women Engineers [5].

Workplace culture includes the values, beliefs, and norms of a company that its employees share, and a positive workplace culture is necessary for the success of the business and the individuals. Workplace climate represents how employees feel about the work environment and the effect it has on them. A positive work culture ensures that employees feel a sense of belonging, develop strong psychological safety, have opportunities to grow in their careers, and are allowed flexibility in their roles [6]. However, in engineering, many women and engineers with marginalized identities leave because of the workplace culture and climate [7]. For example, limited pay and promotion opportunities, which may be due to a lack of mentorship or discrimination by colleagues, are some of the most prominent reasons women leave the workplace [8]. Moreover, a study analyzing the reasons women engineers left after working in the field found that inequitable, inflexible, and demanding working conditions, lack of recognition or limited advancement opportunities, and underutilized technical skills were all reasons that women chose to leave engineering [3]. This shows that workplace culture and climate strongly affect engineers' decision to leave the field.

In order to retain engineers and create a more supportive work environment, it is necessary to understand the current state of engineering workplace culture and climate. Fostering a more inclusive culture in engineering companies will reduce attrition and create more productive workplaces. Therefore, this study aims to investigate factors related to climate and culture in engineering workplaces. A survey was developed and piloted to working engineers to understand workplace culture factors. The following research questions guide our study:

- **RQ1:** What underlying factors can be identified from working engineers' responses to a workplace culture survey?
- **RQ2:** How do these factors contribute to understanding engineering workplace culture?
- **RQ3:** What personal and company demographics contribute to an engineer's perception of their workplace culture?

II. Background Information

A. Engineering Workplace Culture and Climate

Workplace culture can impact engineers' decisions at every point in their professional life. Even prior to graduation, women report having poor experiences in their engineering internships due to cultural issues, discrimination, isolation, and harassment [9]. Poor workplace climates and mistreatment by managers and co-workers have long been cited as reasons that women leave the field of engineering [10], [11]. The engineering workplace culture is strongly associated with masculine gender roles, and occupational status and mobility for women tend to be the worst when this culture is strongest [10]. Undesirable features of workplace culture are also salient for engineers with minoritized racial identities [12], [13].

Engineering workplace culture has been studied primarily from a qualitative lens [12]. The culture has been described in ethnographic studies as "patriarchal," "masculine," "chilly," and "hostile" [14], [15]. To further characterize culture in science, engineering, and technology (SET) fields, Hewlett and colleagues surveyed over 2,400 men and women, and they identified five negative elements, or antigens, of workplace culture [16]. The antigens are 1) hostile cultures (being marginalized by masculine workplace practices or sexual harassment and other predatory behavior), 2) isolation (feeling alone with limited opportunities and a lack of community), 3) mysterious career pathways (feeling stuck in one's career with no mobility for promotion and advancement), 4) extreme work pressure (stress due to long hours and constant deadlines), and 5) diving catch (a perceived disadvantage for those that do not take chances or risks in the workplace). A qualitative study of 45 millennial (i.e., born between 1981 and 1996) engineers in the U.S. studied the experiences of the five antigens among millennials [15]. They uncovered seven additional barriers specific to the millennial engineers interviewed related to the type of work they performed (work that was boring, inconsistent, or underutilized their skills), the nature of their work environment (marked by job insecurity, oppressive physical environments, and poor management), and the work-life conflict they felt (wherein work interfered with personal priorities, and vice versa). Women in the study experienced hostile culture and isolation more frequently than men [15] and pointed to experiences specifically related to gender.

While qualitative studies have led to a deep understanding of challenges and barriers to engineers' full participation and success in the workplace, these studies only cover a small sample of workplaces in SET. We turn to quantitative instruments for a broader view of engineering workplace culture across the United States.

B. Quantitative Measures of Workplace Culture

Several instruments have been developed to measure specific aspects of workplace culture, including hostile culture or harassment. Jung et al. [17] conducted a literature review of the many instruments available to measure organizational culture. Seventy instruments were found, including several specific to geographic location and profession [17], but none were specific to the engineering context. There are instruments specific to negative elements of workplace culture, such as harassment and workplace bullying. For example, workplace bullying and victimization are typically measured through the Negative Acts Questionnaire [18], which is specific to the workplace context. Another broadly administered instrument is the Organizational Culture Assessment Instrument (OCAI). The OCAI, developed by Cameron and Quinn, is based on the competing values framework for organizational culture [19]. This instrument focuses on overarching values and structures within a company, rather than obstacles or opportunities faced by individual employees. High-level cultural assessments can obscure the experiences of a minority group, particularly when they are underrepresented in management.

Another limitation of many traditional workplace questionnaires is their lack of suitability in capturing the perceptions of women, due to the workforce having predominantly men. In response, the Women Workplace Culture Questionnaire [20] was developed and used to survey 104 women working in a male-dominated field in Sweden. Three major factors emerged with strong evidence of validity and reliability: the perceived burdens on women, the perceived burdens on individuals, and sexual harassment. The survey focused on issues specifically brought up by women in the workplace in a grounded theory study. Further, a survey was conducted to collect data from science and engineering faculty members to understand workplace climate based on multiple demographic identities. They found that engineering faculty perceived aspects of workplace culture more positively than science faculty, and male respondents perceived aspects of workplace culture more positively than female respondents [21].

The field of engineering has unique cultural elements that may amplify issues compared to other industries, and some surveys have sought to examine this. A research team has recently developed a Workplace Climate and Persistence Scale to assess departmental climate factors for STEM faculty [22]; this may have applicability to other STEM/engineering workplaces. Further, a team led by Dr. Denis Wilson, whose work identified the barriers experienced by millennial engineers, recently developed the CAReS (Competence, Autonomy, Relatedness Study) to evaluate engineering workplace climate based on basic psychological needs theory [23]. The current research is beginning to understand engineering workplace culture and climate and its impacts on specific demographics of engineers. A survey specific to engineering industry workplace culture for people with marginalized identities in the field, based on literature documenting experiences in the field, may provide additional context to understanding cultural change and the prevalence of attrition in engineering.

III. Theory

A common approach to understanding workplace culture is the Competing Values Framework [24]. The framework describes corporate culture in terms of two axes: the tension between flexible and controlled management activities on one axis and the tension between internal (i.e., employee-focused) and external (i.e., customer-focused) drivers on the other (Figure 1). The quadrants created by these axes represent four cultural types: Clan, Hierarchical, Market-driven, and Adhocratic. A Clan culture is flexible and internally focused, which creates a focus on internal cohesion, communication, and employee development. A Hierarchical culture is controlled and internally focused, emphasizing efficiency, consistency, and structure. Market cultures are also controlled but externally focused, leading to a focus on external competition and production. Lastly, an Adhocracy culture is externally focused and flexible, which values innovation, creativity, and transformative behaviors.

The Competing Values Framework has been used to analyze workplace values and interactions, address organizational effectiveness, and change corporate culture [19]. Therefore, this framework can help diagnose engineering workplace culture and identify imbalances that may cause value misalignment with employees [24]. The survey presented in this paper categorizes common workplace obstacles within the competing values framework. Every company has a combination of these values that determines its organizational culture profile. Companies usually experience one dominant value and culture, although ideally, there should be a balance. Importantly, no culture type is considered better than the others, as each contains advantages and disadvantages. It is important to recognize that extremes within any quadrant can lead to detrimental outcomes for companies and employees [25]. For example, a paper describing managers within the Competing Values Framework showed that pushing too much emphasis in any quadrant can lead to ineffectiveness [26].

Figure 1. Quadrants of the Competing Values Framework

	Internal Focus	**External Focus**
Flexible	**Clan** - Employee participation in decision-making process - Teamwork - Empowerment	**Adhocracy** - Change oriented - Creative thinking - Entrepreneurial behaviors
Controlled	**Hierarchy** - Rules and regulations - Values internal efficiency - Highly structured	**Market-Driven** - Goal achievement - Competition - Producer/Competitor Roles

IV. Methods

A. Survey Instrument

The survey instrument used in this study combines several existing approaches for studying corporate values, including the Competing Values Framework, the OCAI, and obstacles or barriers identified through existing qualitative literature on women in engineering [15], [16]. The new survey instrument measured the perceptions of workplace culture among workers in the engineering and technology industry. The survey also included personal and company demographics to study the influence of demography on how culture is perceived and experienced. The goal of developing this instrument is to evaluate the degree to which negative aspects of the engineering workplace culture, as highlighted in qualitative studies, can be generalized to a broader population of engineering and technology workers. This instrument can reveal the persistence of cultural issues in engineering and the dominant cultural values in the engineering workplace.

The instrument items focus specifically on cultural issues identified by several studies of the engineering workplace, such as the Athena Factor Project, which identified five powerful "antigens" (i.e., negative elements) of Science, Engineering, and Technology (SET) corporate culture that influence women's decision to leave the field [16]. Additionally, categories identified by interviews with 45 Millennial engineers [15] were also considered. Together, the ten obstacles considered were as follows: hostile cultures, isolation, mysterious career pathways, extreme work pressure, disadvantages to being risk averse, feeling bored or underutilized, job insecurity, oppressive physical environments, poor management, and work-life conflicts. The categories identified by interviews with millennial engineers were considered because, at the time of data collection (2020), millennials were the majority of the younger generation in the workplace. Further, the focus of the study is on the science, engineering, and technology fields to align with the Athena Factor Project that identified negative elements of the corporate culture in SET fields.

Items to capture the obstacles of engineering workplace culture were written by combining sentiments from previous qualitative studies of engineering workplace culture and overlaying these with the negative elements associated with each workplace culture type in the competing values framework [19]. Six to seven items were developed for each of the four types, resulting in an initial survey instrument with 26 items. Participants were asked to report the frequency of occurrence of each item at their job, on a five-point Likert scale, from 1-Almost Never to 5-Almost Always. This scale was selected to provide a neutral option and avoid absolutes. Since items describe undesirable workplace occurrences, high item scores were indicative of an undesirable workplace culture.

The survey items were reviewed by graduate students who had prior engineering industry experience and engineers currently working in the industry to ensure the face validity of the instrument. Each participant was asked to read the items and share their thoughts on their meanings. Based on the feedback, items were changed to improve readability, including consistently starting each item with a verb. A "prefer not to respond" option was also added to the item response options. Additionally, content validity was evaluated by consulting with engineers in the industry, as well as engineering education faculty that have conducted workplace culture research. These experts were asked to review items and the demographic survey. Based on this feedback, additional demographic categories, such as information on team composition and remote work, were added. The feedback also supported the development of new items for each category.

B. Data Collection

The target population for this instrument was engineers currently working in the United States. The majority of data was collected during the first week of March 2020 from local industry networks and engineering alums at a large, Southwestern public university. Recruitment was done by email, with a recruitment timeframe of two weeks. The survey was administered online through Qualtrics. At the completion of the survey, participants were directed to a second survey to be entered into a random drawing to win a $20 Amazon gift card. The survey response rate was 9 percent, and the completion rate for participants who began the survey was 78 percent. IRB approval was obtained prior to the administration of the survey.

1) Demographic Overview: The data set consisted of 152 responses collected from industry professionals. Table 1 shows the demographic characteristics of the sample, noting that not all participants responded to all demographic questions. The average age of participants was 30.47 (SD= 7.25). There was diversity in the engineering field of participants, including aerospace engineering (11.3%), civil engineering (11.9%), biomedical engineering (11.9%), software engineering (10.6%), mechanical engineering (7.9%), electrical engineering (7.9%), chemical engineering (4.0%), computer science (10.6%), materials engineering (4.0%) and other disciplines (19.9%).

C. Data Analysis

The survey instrument data were analyzed in a two-phase process. The first phase was exploratory factor analysis (EFA), and the second phase was a multiple regression analysis to examine the impact of individual and company demographics on factor scores.

EFA was conducted in SPSS (version 29.0.2.0 (20)). Missing data were removed using listwise deletion, as most of the incomplete responses were missing multiple questions. Before conducting EFA, the sample was tested for sampling adequacy and sphericity. The KMO test for sampling adequacy had an overall MSA of 0.867, and the measures for every individual item were larger than 0.5. Bartlett's test for sphericity was significant ($p < .001$), indicating that a reductive technique such as EFA is appropriate. The a priori number of factors was determined by using a scree plot and Kaiser's test because multiple methods are recommended to attain the most robust results [28]. The scree plot indicated that three or four factors would be suitable, while Kaiser's test indicated six factors. Based on the theoretical framework (Competing Values Framework) used to categorize the barriers, four factors were used for the extraction of the data. Principle Axis Factoring (PAF) and a Promax rotation with a kappa of 4 were used to extract factors. Items with a factor loading below 0.4 or were cross-loaded with a loading above 0.3 were removed one at a time. The authors also examined the alignment between factors and items for theoretical coherence and face validity. The final factors, items, and reliability metrics are reported in the results. The factor loadings for the final items can be found in the Appendix.

Table 1. Demographic Variable Distributions of Sample

Variable	Frequency	Percent in Sample (%)	% in Engineering (2022)*
Gender			
Men	93	61.2	84.3
Women	57	37.5	15.7
Race & Ethnicity			
White	100	65.8	72.4
Black or African American	6	3.9	6.3
American Indian or Alaskan	6	3.9	-
Asian	30	19.7	18.2
Other	9	5.9	-
Hispanic or Latino	15	10	8.8
Company Size			
Very Small (0-25 employees)	12	7.9	35.2
Small (25-99 employees)	13	8.6	
Medium (100-999 employees)	30	19.7	23.2
Large (1,000-5,000 employees)	28	18.4	41.5
Very Large (5,000+ employees)	68	44.7	
Age			
16-19	0	0	5.4
20-24	18	12.3	9.7
25-34	99	67.8	35.0
35-44	23	15.8	21.8
45-54	4	2.7	15.1
55-64	1	0.7	10.9
65+	1	0.7	2.1

*This data was adapted from the Bureau of Labor Statistics [27]

Phase two of the analysis was a multiple regression model of factor scores. Factor scores were calculated by averaging the item scores within the factor, as is appropriate for an exploratory study [29]. Before conducting regression, assumptions were checked using VIF, Q-Q plots, and residual plots. For all predictors, the VIF was less than 10, Q-Q plots of residuals were linear, and no patterns were identified in the residuals vs. predicted plots [30]. To increase the statistical power of the regression model, responses to some demographic questions were grouped together; for example, the 14 options for a participant's engineering field were grouped into four main categories (civil, electrical, mechanical, and other). This reduction resulted in 23 predictor variables. For each factor, a standard multiple regression model with all variables was used to determine the order of addition for forward regression analysis [31]. Final equations were determined through forward regression with a significance cutoff of $p < 0.05$.

V. Results

A. Factor Analysis

An EFA (Exploratory Factor Analysis) was conducted to identify four factors. After removing cross-loaded items and re-running the analysis, a factor with only two items emerged. We chose to keep this factor and not reduce the number of factors to three. This decision was guided by theoretical considerations, as the two items strongly fit under one theme (i.e., 'An unmanageable workload' and 'You have a lack of work life balance'). Additionally, when we reduced the model to three factors, the overall analysis became less coherent, further justifying our choice to retain the two-item factor. Internal consistency for each factor was determined by a Cronbach's alpha value higher than 0.70 [32]. The breakdown of each factor can be found in the tables below.

As part of the exploratory factor analysis, we named the factors to determine underlying themes in grouping the survey items. Factor 1 included survey items related to limited growth, lack of flexibility, and discouraged creativity, so we called this factor "Limited Innovation and Growth." Factor 2 included survey items related to slow work, unproductive work, and isolation, so we called this factor "Unproductive and Isolated Work." Factor 3 included survey items related to harassment and discrimination, so we called this factor "Discriminatory Work Environment." Finally, Factor 4 included survey items related to workload and work-life balance, so we called this factor "Imbalanced Workload."

Table 2. Factor and Item Assignment

Item Number	Item	Mean Rating	Cronbach's Alpha
Factor 1 - Limited Innovation and Growth		2.467	.809
1	A lack of personal growth opportunity	2.671	
2	Risk taking is discouraged	2.895	
4	A lack of flexibility	2.375	
5	Creativity is discouraged	2.138	
22	Your ideas are ignored	2.257	
Factor 2 - Unproductive and Isolated Work		2.376	.753
14	You are underutilized	2.546	
15	The pace of work is slow	2.375	
17	Your work lacks urgency	2.197	
19	You are unproductive	2.355	
20	Isolation from other people	2.408	
Factor 3 - Discriminatory Work Environment		1.557	.745
11	Unfair treatment by fellow employees	1.783	
25	You have experienced sexual or physical harassment by someone at work	1.322	
26	You have experienced discrimination by someone at work	1.566	
Factor 4 - Imbalanced Workload		2.556	.774
12	An unmanageable workload	2.625	
24	You have a lack of work life balance	2.487	

B. Multiple Regression

An a priori analysis showed that for a 0.15 Cohen's f^2 effect size, with 23 predictors (including dummy variables) and a power of 0.80, a sample of 163 is recommended. The sample collected varied from 132 to 152 depending on the demographic variable included. Although the sample sizes collected fell slightly short of the recommended sample size, they were nearly sufficient to achieve the desired power and effect size in the analysis. Forward selection was utilized for each regression model.

1) Factor 1 - Limited Innovation and Growth: The final results are shown in Table 3. The adjusted R^2 value of 0.047 indicates that approximately 4.7% of the output of Factor 1 can be explained by the independent variables in the model. This is a 0.057 Cohen's f^2, which is considered a small effect size. A post-hoc power analysis revealed that 65% power was achieved. The coefficients for this model are shown in Table 4.

2) Factor 2 - Unproductive and Isolated Work:. The final results are shown in Table 3. The adjusted R^2 value of 0.027 indicates that approximately 2.7% of the output of Factor 2 can be explained by the independent variables in the model. This is a 0.035 Cohen's f^2, which is considered a small effect size. A post-hoc power analysis revealed that 43% power was achieved. The coefficients for this model are shown in Table 4.

3) Factor 3 - Discriminatory Work Environment: The final results are shown in Table 3. The adjusted R^2 value of 0.118 indicates that approximately 11.8% of the output of Factor 3 can be explained by the independent variables in the model. This is a 0.151 Cohen's f^2, which is considered a medium effect size. A post-hoc power analysis revealed that 94% power was achieved. The coefficients for this model are shown in Table 4.

Demographic differences were observed in relation to this factor. Overall, 34.7% of respondents reported experiencing discrimination at work, and 19% reported experiencing sexual or physical harassment (33% of women participants and 9.7% of men participants; there was not a notable difference across race/ethnicity) in their current position. Notably, a factor like this also existed in the Women Workplace Culture Questionnaire, suggesting that this is, unfortunately, an explicit aspect of workplace experience for women in the workplace generally and elicits a need for more investigation.

4) Factor 4 - Imbalanced Workload: The results from the multiple regression analysis were not statistically significant. Future research can further investigate this factor.

Table 3. Multiple Regression Summary for Each Model

					Change Statistics		
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	F Change	Sig. F Change
1	.233	.054	.047	.7677	.054	7.285	.008
2	.184	.034	.027	.7399	.034	5.118	.025
3	.362	.131	.118	.6969	.131	10.229	< .001
4	.160	.026	.019	1.003	.026	3.830	.052

Table 4. Multiple Regression Coefficients for Each Model

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	2.632	.089		29.713	<.001*
	Approximately how often do you work remotely? (Percentage of time)	-.007	.002	-.233	-2.699	.008*
2	(Constant)	2.965	.264		11.251	<.001*
	What is your age? (Years)	-.019	.008	-.184	-2.262	.025*
3	(Constant)	1.669	.127		13.171	<.001*
	What is your gender?	.451	.122	.295	3.691	<.001*
	Approximately what percentage of your work department is like you in terms of: Your age?	-.008	.003	-.214	-2.680	.008*

*p<0.05 is considered statistically significant

VI. Discussion

A. Factors

The four-factor model that emerged from EFA provides insight into common experiences of engineers in the workplace. Factor 1, Limited Innovation and Growth, contains five items describing how employees utilize their intellectual capacity at work for personal and company development. The items consider competencies like creativity and risk-taking that are often considered to be valuable in the engineering design process [33]. The Mysterious Career Paths antigen from Yonemura and Wilson [15] aligns with this factor, as both are concerned with an employee's mobility and advancement. The factors also go beyond career advancement by considering how employees are valued in their current position (e.g., flexibility, ideas are valued, etc.), The item with the highest mean in Factor 1 is "Risk-taking is discouraged" (σ=2.895). A lack of risk-taking could indicate a workplace where activities are highly structured and decisions are made by supervisors [19]. However, due to the nature of engineering work, risk-taking may also be discouraged because of the different priorities that need to be considered, such as safety, cost, quality, etc. [34].

Factor 2 was named Unproductive and Isolated Work. The items in this factor measure the pace of work, perceived productivity, and isolation of a respondent. Engineering is a highly collaborative field [35], so isolation and a lack of productivity are often co-occurring.

Market-driven and Adhocratic cultures embody the "move fast and break things" mentality of business because they are externally focused. A culture that is too internally focused can lose its sense of urgency and desire for innovative collaboration. This factor is also an important contribution to measuring the impacts of workplace culture on marginalized engineers in the field. There is significant evidence that engineers with marginalized identities experience higher levels of isolation in the workplace [36], [37]. Thus, the theoretical underpinnings of this factor connect back to studies of women [16] and racial minorities [38] in engineering. Isolation was also one of the five antigens for SET professionals in the workplace, adding to the importance of inclusion.

Factor 3, Discriminatory Work Environment, addresses a major problem in workplace culture. The fact that more than one-third of respondents to our pilot survey had experienced discrimination at work underscores the necessity of this factor. Unfair treatment of any kind should have no place in any workplace, as experiencing harassment or discrimination significantly degrades an individual's feelings of physical and psychological safety and mental health [39]. This factor follows the sexual harassment factor identified by the Women Workplace Culture Questionnaire [20] and the Hostile Macho Culture antigen [15]. Since the focus of this instrument was SET professionals of all genders, our factor includes other forms of mistreatment beyond gender-based violence.

Imbalanced Workload is the fourth factor that emerged from our analysis. This factor only contains two items, but both are strongly connected to work balance. The work-life conflict antigen experienced by millennials in Yonemura and Wilson's study is similar to this factor; however, millennials were more concerned with values alignment between work and personal life than time allotment. Balancing work with other priorities is of growing interest to the workforce, so this is an important consideration for companies [40]. We would assume that engineers in high-pressure work environments, like those in Market-driven and Adhocratic cultures, are more likely to experience a work-life imbalance. However, recent work has shown that there is no significant relationship between the organizational leadership culture and the work-life balance of employees [41].

Overall, the four factors extracted from the survey instrument align with some elements of the Competing Values Framework; however, the factors do not map to the four main cultures of the framework. Our results do not capture the culture piece we had hoped; however, the factors that emerged did have some alignment with the cultural antigens. Our factors closely align with the five cultural antigens experienced by millennial engineers. The fifth antigen, diving catch, is included within the Limited Innovation and Growth factor but is only represented by one item. Alignment with the antigens makes sense, considering the age of participants. The average age was 30.47, which corresponds to a 1990 birth year. With a standard deviation of 7.25, nearly 68% of the sample is comprised of millennials.

B. Multiple Regression

We used multiple regression analysis to explore the potential predictive relationship between personal and company demographics and the factors. This analysis provides insight into how personal and company demographics may impact workplace culture. Notably, other than Factor 3, effect sizes were small.

For Factor 1 (Limited Innovation and Growth), we found that the percentage with which participants worked remotely had a significant negative relationship with Factor 1. This indicates that employees who work remotely are less likely to report feeling limited innovation and growth in their roles. This suggests that remote work may lead to more positive experiences in the workplace. The survey was implemented at the start of the COVID-19 pandemic (March 2020), so it is difficult to know if participants were considering their experiences working remotely before the pandemic or once work-from-orders began. The literature in recent years has shown that working remotely improves employee flexibility [42] and team creativity [43], which has many positive effects on employee and organizational productivity. However, there has been concern that working remotely may impact promotion rates [44].

For Factor 2 (Unproductive and Isolated Work), we found the participant's age had a significant negative relationship to Factor 2. The negative coefficient indicates that the older employees are, the less likely they are to experience negative working conditions related to productivity and isolation. This suggests that age might contribute to greater engagement and productivity in the workplace. Literature has shown mixed results on the relationship between age and productivity in the workplace [45].

For Factor 3 (Discriminatory Work Environment), we found that not identifying as a man had a significant positive relationship with Factor 3. This indicates that non-men participants are more likely to face discriminatory workplace experiences. Additionally, the percentage of the department similar in age to the participant was a significant negative predictor with Factor 3. This indicates that participants with more colleagues around their age are less likely to face discriminatory workplace experiences. It is well known that women in engineering are much more likely to experience workplace harassment and discrimination [46], [47], so this finding was unsurprising.

Overall, the multiple regression analyses provide insight into how personal and company demographics may impact workplace culture and climate. Some of the significant predictors were surprising, revealing unexpected relationships between demographics and workplace culture, while others were unsurprising, reinforcing known experiences. These findings highlight the complex relationships between workplace culture and demographic factors and provide possible areas for further exploration.

C. Limitations

This study is limited in a few ways. First, the original factors intended to capture the Competing Values Framework were not reflected in the EFA. The results regarding the antigens also show that an instrument measuring these constructs specifically could be useful, but workplace culture and climate will likely have to be captured in separate constructs.

Additionally, the survey was conducted on a relatively small number of participants with a relatively low response rate, so increasing the number of participants could help strengthen the significance of the results. While the findings provide some insight into the interaction between workplace climate and demographic variables, the complexity of individual experiences and organizational culture may not be fully captured in the models. Many of the demographic variables are intertwined in ways that can be difficult to isolate the effects of specific individual factors. Moreover, due to the limited number of participants and low response rate, the demographics of participants may differ from those of non-respondents and, thus, may not fully capture the experiences of SET workplace culture. Further, the survey was sent out during the first week of March 2020, so responses were collected at the beginning of pandemic-related work disruptions. The parallel timing of the survey and the beginning of the pandemic may have influenced the response rate or responses.

One of the goals of the survey was to examine engineering workplace culture and climate and their impacts on specific demographics of engineers. We had anticipated that differences across race and ethnicity would be present in the data; however, that was not the case. With the limited sample size, there was a limited power of the results. Future work can specifically focus on a larger sample of engineers across marginalized racial and ethnic identities and specifically look at intersections between gender and race.

VII. Conclusion

In summary, the survey results indicate that the current workplace culture within the engineering and technology sectors is suboptimal, signaling a pressing need for comprehensive strategies aimed at fostering a more inclusive and supportive environment. Specifically, the field particularly has negative elements related to innovation and growth, unproductive and isolated work, discriminatory work environments, and work-life balance. The data also reveal that perceptions of workplace culture vary across demographic lines, including age and gender. These variations highlight the complexity of the engineering workplace culture. Future work can further investigate factors related to engineering workplace culture to help create inclusive change that makes the engineering workplace a better place for all.

VIII. Acknowledgements

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Appendix

A. Factor Loadings

Item Number	Factor 1	Factor 2	Factor 3	Factor 4
1	.419	.251	-.097	.190
2	.677	-.051	-.139	-.009
4	.673	-.038	.065	-.039
5	.869	-.110	.045	-.033
11	.337	.103	.431	.128
12	.014	.024	-.084	.900
14	.221	.441	.025	-.022
15	.119	.666	.043	-.256
17	.190	.595	-.051	-.199
19	-.163	.747	-.013	.094
20	-.236	.635	.028	.261
22	.646	.062	.020	.220
24	.086	-.078	.090	.648
25	-.044	.002	.750	-.078
26	-.065	-.023	.914	.028

B. Survey Instrument

	Consider your current job, or your previous position if you have changed jobs recently. Please rate how often you experience (or experienced) the following within that role. Please rate how often you feel (or felt) the following within that role.
1	A lack of personal growth opportunity
2	Risk taking is discouraged
3	Your work is boring
4	A lack of flexibility
5	Creativity is discouraged
6	You are stuck in your current position within the company
7	Management is poor
8	Your working environment is physically uncomfortable
9	Your working environment is unpredictable
10	A lack of job security
11	Unfair treatment by fellow employees
12	An unmanageable workload
13	Procedures are not followed by employees within the company
14	You are underutilized
15	The pace of work is slow
16	A lack of cutting-edge work
17	Your work lacks urgency
18	Your job is not impactful to your field
19	You are unproductive
20	Isolation from other people
21	A lack of professional support
22	Your ideas are ignored
23	Your work conflicts with your personal values
24	You have a lack of work life balance
25	You have experienced sexual or physical harassment by someone at work
26	You have experienced discrimination by someone at work
27	Do you work in the engineering and technology industry?
28	What is closest to your specific field? - Selected Choice
29	What is closest to your specific field? - Other
30	What is the size of your company?
31	What region of the US is your company located in?
32	What is closest to your job title? - Selected Choice
33	What is closest to your job title? - Other
34	What is your gender?

35	What is your ethnicity? - Selected Choice
36	What is your ethnicity? - Other (Please Clarify)
37	Are you Hispanic or Latinx?
38	What is your age? - Years
39	Approximately what percentage of your immediate work group is like you in terms of: - Your gender
40	Approximately what percentage of your immediate work group is like you in terms of: - Your race/ethnicity
41	Approximately what percentage of your immediate work group is like you in terms of: - Your age
42	Approximately what percentage of your work department is like you in terms of: - Your gender
43	Approximately what percentage of your work department is like you in terms of: - Your race/ethnicity
44	Approximately what percentage of your work department is like you in terms of: - Your age
45	Approximately how often do you work remotely? - Percentage of Time