The Future of Women in Technology : Challenges and Recommendations

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Abstract: When only women turn up to a panel on challenges for women in technology, how do we then reach out to industry, academia and government to encourage them to listen to the current challenges experienced by women in tech. Technology is rapidly changing and we are seeing women disadvantaged by less training opportunities, lack of role models, perceived penalties for taking time off to have children or discharge caring responsibilities as well as the risk that their jobs are subject to more automation. Multiple workshops at the Institute of Science and Technology highlighted significant challenges for women in tech, the data from our empirical study illustrates these challenges in detail. With the workplace still male dominated and the landscape changing rapidly, women have a significant role to play and we need to ensure that role is not only facilitated but the existing challenges are mitigated. This is a discussion paper with empirical data that illustrates challenges currently experienced by women in tech and how we can move forward to ensure not only equal opportunity but remove some of the challenges currently experienced. In this paper we have not considered the same impact on men who take career breaks for reasons of caring responsibilities.

Keywords Women, Technology, Challenges, Gender Bias, Women in Tech, Gender, Ai, Technology, Challenges, Professionalism

1. Introduction

Over the last few decades, we have seen numerous initiatives put in place to try to ensure women have a fair pathway to success in the workplace. This has included policy generation, spotlights on EDI and sometimes, as in reverse engineering boards, some positive discrimination. However, what has been missed in this landscape is the critical provision of tools to enable women to take up opportunities. The understanding of the specific challenges facing women in the technological workplace has been missed. This is highlighted by Neveen et al. "there is no ambition gap. Roughly the same percentage of women and men—62% and 67% respectively—were trying for a promotion" (Neveen,2021). We can also see that the existing initiatives are not having enough impact as discussed by the Global Gender Gap Report "Overall, the global share of women in leadership roles as illustrated in this data is 31%, although shares vary by industry. In 2022, only select industries have levels near gender parity in leadership, such as Non-Governmental and Membership Organizations (47%), Education (46%), and Personal Services and Wellbeing (45%). At the other end of the range are Energy (20%), Manufacturing (19%) and Infrastructure (16%)" (Global Gender Gap Report 2022). The largest driver for female progression in the workplace being within businesses that were already highly represented "for example, women make up 62% of total workforce share in the Personal Services and Wellbeing industry, but only 45% of leadership share" (Global Gender Gap Report 2022). The biggest step for women, and one where most failure is seen, is the initial promotion step "For every 100 men promoted from entry level to manager, only 87 women are promoted, and only 82 women of colour are promoted" (Women in the Workplace 2022, McKinsey).

One of the main issues we chose to examine in this paper is caring responsibilities. In the Women in Tech group at the Institute of Science and Technology this discussion arose quite often. This is highlighted by Rocha et al. "several researchers report the impact of gender on software development teams, especially in relation to women. In general, women are under-represented on these teams and face challenges and difficulties in their workplaces. When it comes to women who are mothers, these challenges can be amplified and directly impact these women's professional lives, both in industry and academia" (Rocha et al., 2023). In addition, "one analyst said "millions of mums" were being forced to "pay the price" of a less secure career. The new research found that "mums who are employed were more likely to work part-time".('Mothers "paying the Price" for Career Breaks', 2021). This is problematic for continuity and consistency of a career. "This doesn't just take a toll during the early years with young children, but throughout the rest of their working life" ('Mothers "paying the Price" for Career Breaks', 2021). Many websites have sections on how pregnancy and childcare can stall careers, the NCT (UK National Childbirth Trust) states that **"The honest answer is that the evidence suggests becoming a**

mother does affect a woman's career". The NCT also states that if a woman chooses to return to work on reduced hours "it might affect how quickly you make the jump to your dream job. In one large UK study, "26% of men versus 13% of women were promoted or upgraded their jobs within five years of having a child" (Trust, 2022). It is worth noting that no solutions are given to this issue and the advice is to consider one's priorities: "it's worth taking time to consider your priorities to help you make informed, achievable choices about what you want out of your career and family life". (Trust, 2022). This does not seem acceptable in a world where women are known to not have the same opportunities as men due to a larger share of caring responsibilities but yet there is no apparent solution despite knowing teams and innovation suffer without equality and representation (Linked in, 2023). However a contributing factor to this situation is shown in a CIPD study "73% of men surveyed believe there's a stigma attached to taking extended paternity leave" and "95% of men agreed that workplace culture needs to be transformed to normalise men taking extended paternity leave" (CIPD, 2020). To compound this the CIPD founds that "Very few new fathers/partners and mothers have taken up the right to shared parental leave in the last two years, according to our sampled organisations. If we compare our findings with 2016, we see a downward trend in take-up" (CIPD 2022).

In addition to caring responsibilities women still face daily challenges in the workplace. In a survey by Ivanti on challenges faced by women in technology the following was found; "63% of women felt that they were not taken seriously due to gender perceptions. 42% felt that they had no female role model and 40% said they felt there was a gender pay gap" (Ivanti, 2018). However, Ivanti had no actionable recommendations for women.

One of the largest problems can be that the right people aren't listening. At a recent summit in the REAIMS defence conference in the Hague at a panel on challenges faced by women in defence there was poor attendance and no men or high-level decision makers attended. The people required in the room are not there. It must be a discussion between all members of society not just between women and not just perceived as 'targeting' men.

1.1 Studies on the rate of change in disparity between male and female leaders
Over the past five decades, the representation of women in leadership positions within the fields of science, technology, engineering, and business (STEM & Business) has experienced notable shifts (Linked in, 2023). The following examines the evolving landscape, highlights significant research studies, explores predictions for addressing gender disparity, and identifies factors impacting those predictions. An example of where positive action has been taken to address the disparity and how that has impacted on progress is also considered.

2. Key Research Studies
Several influential research studies have shed light on the representation of women in leadership positions:

2.1 The Davies Review (UK):
Launched in 2011, the Davies Review focused on increasing female representation on corporate boards in the UK. It set a target of achieving 25% female representation by 2015, which was successfully achieved and subsequently raised to 33% by 2020. (*Women on Boards*, 2020)

2.2 Catalyst's "Women in STEM" (US):
Catalyst, a research and consulting organisation, has conducted extensive studies on gender diversity in STEM fields. Their research highlights the challenges faced by women in advancing to leadership positions and emphasises the importance of inclusive policies, mentorship, and promoting a supportive work environment. (*Women in Science, Technology, Engineering, and Mathematics (STEM) (Quick Take) | Catalyst*, 2022)

2.3 European Commission "She Figures" (Europe):
"She Figures" is a comprehensive biennial report published by the European Commission. It provides statistical data and analysis of gender equality in research and innovation across Europe, addressing women's representation in leadership roles and the broader research landscape. (*She Figures 2021*)

3. Case Studies: Addressing the Change Factors – an Example of Positive Action
The Nobel Foundation has begun actively supported research and analysis on gender disparities in Nobel laureates. Initiatives taken include the following:

- Expanded Nomination Pool:
- Gender-Sensitive Evaluation Processes

Some of these initiatives, including actively seeking out and considering more female nominees might be viewed as positive discrimination so more detail on this would be required before the initiative could be judged a success. The Nobel Committees have stated that the use of these initiatives has led to diversity increasing within

the Nobel Committees. Actively seeking out women has led to a more comprehensive and inclusive assessment of achievements across various fields. (*Gender Bias in Nobel Prizes | Humanities and Social Sciences Communications*). There has been a subsequent rise in the number of female laureates and role models.

Have any of these initiatives had an impact? We discuss this in the next section.

4. Methodology

Using a survey platform mailchimp, mailing lists and social media posts we surveyed women working in technical disciplines. The survey was conducted to determine how women felt about their experience as a female in the STEM world. 79 responses were received 78 were from women and 1 was a man. We were unable to do branching on this survey so some felt the survey was stereotypical. In the future we would use branching to determine who had childcare and who had general caring responsibilities. However, most respondents did answer from a point of view of any caring responsibilities or not.

5. Demographics:

The respondents were from a global base with the majority being UK based. Most respondents were quite highly qualified (BSc or above) and in technical or managerial roles.

6. Results

In response to questions on job security related to AI the majority attitude was positive and many felt their jobs would not be automated. The majority of respondents want decisions made about them by AI to be explained to them. This explanation should explain all of the contributing factors and variables in the decision-making process. However, 44% were worried about subsequent discrimination by AI. Pertinent points were made that a right to review should exist for all decisions and powers should exist to revoke a decision.

When asked if they experience challenges related to your gender in the world of tech, over 40% responded yes and around 5% chose 'prefer not to say'. Below are some key comments to illustrate the challenges faced by respondents.

Some key comments

ID	Comment
14	In my experience, older men do not like to be managed or challenged by a woman of equal or higher rank/experience
17	Anyone understanding what is involved with being the carer for a 90 year old and offering reasonable adjustments - a previous appointment, undermined for 7 years by a senior colleague who resented that I was capable
20	Not directly but as a parent I have restrictions that non-parents and dads who don't do the majority of the childcare, forget about. E.g. organising important meetings close to the end of the working day or during school holidays.
24	When pregnant, I was unable to do certain aspects of my role within the lab as dealing with nasty chemicals. Childcare can be a tricky subject.
25	People attempting to pay me less because of my gender. Far lower investment prospects for start-ups and ventures due to investment gender bias. Bias in offers of publishing deals, wherein men are offered higher fees, and more likely to have 'big ideas' backed, among other things.
68	Male technicians and engineers hear our words and check for themselves anyway, despite us almost always being correct; sometimes even lying and gaslighting to cover themselves.

When asked whether the respondent has experienced discrimination or bullying in the workplace, 51% have reported experiencing some type of discrimination and a similar percentage have reported experiencing some type of bullying.(Fig 2&3)
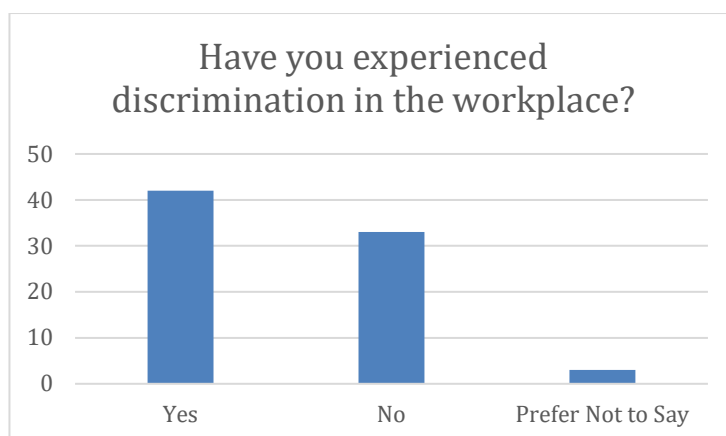
Have you experienced discrimination in the workplace?

Figure 2 : Have you experiences discrimination in the workplace

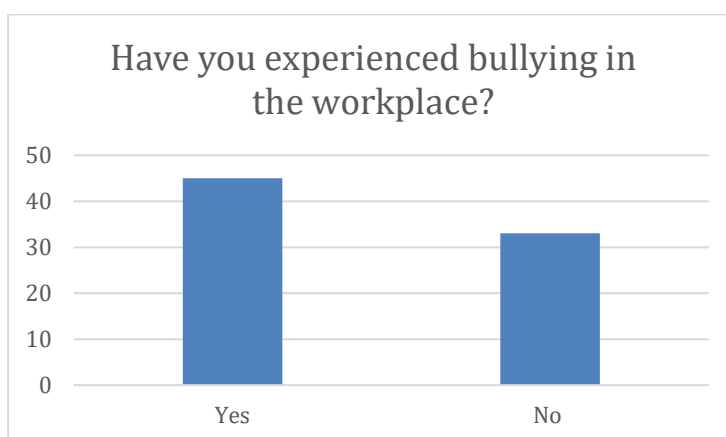**Have you experienced bullying in the workplace?**

Figure 3 : Have you experienced bullying in the workplace

When asked if their workplace has creche or childcare facilities or some support with this the following results were recorded. In fig 4 & 5 it can be seen that 50% had no access to workplace facilities and 32% had no support at work for childcare responsibilities such as, for example, emergency leave, parental/maternity leave or flexi time. This can lead to conflict because a parent would have to leave if there was an issue with the child having to come home from nursery, be taken to medical appointments or similar and this would not be a choice for a parent whether there was a policy on this at work or not. This does show there is more progress to be made and that nearly half have no support or facilities provided at work leaving them to make their own arrangements which may mean that the childcare facility is a distance from the workplace, doesn't have places or is unaffordable. Key comments are below.
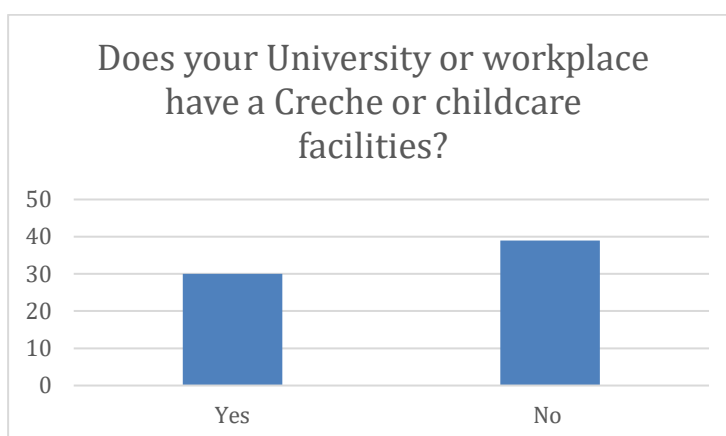
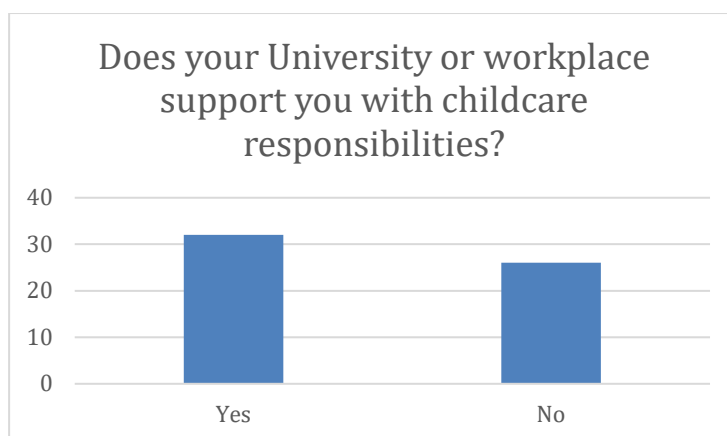**Does your University or workplace have a Creche or childcare facilities?**

Figure 4 : Does your university or workplace have a crèche or childcare facilities

Figure 5 : Does your university or workplace support you with childcare responsibilities

Some key comments

ID	Comment
2	flexible working policy
15	We have domestic leave of 4 days that can be taken at short notice to deal with family emergencies
18	when our children were younger my managers then were supportive, but when my daughter was one (over 20 years ago) I was not permitted to work part time and had to quit my job. When I did come back, they brought me back on a lower grade. I felt doubly cheated
21	I am able to work flexibly if needed. My line manager trusts me to make sure I'm working my contracted hours. I was able to get a jobshare so I can work part time hours.
25	When a child is sick or schools are on strike it is not suggested that we can work from home. Most work is lab based but some admin/PPD/results can be completed at home. When a colleague asked if she could stay home with a sick child she was told to take a day off as she could not use her allocated parental leave days, even though she had days left! Something about parental leave only used in emergency last minute i.e. if child sent home from school.
50	We do have flexi-time so I can set my own working hours to some extent, but still have core hours when I am supposed to be at work, which coincide with school start and finish times.
54	University has a nursery, but it is oversubscribed so I use one closer to home (I have a long commute).

When asked if your university or workplace provide opportunities for you to attend conferences or events with support for childcare. Nearly 60% had no opportunities or support. Women are clearly disadvantaged here by not receiving help to undertake professional development activities that could aid promotion and be a rich source of information and training for them in their role.
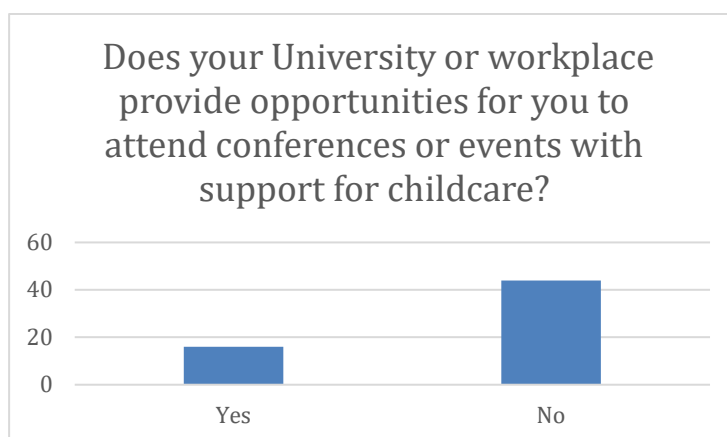

Figure 6 : Does your university or workplace support provide opportunities for you to attend conferences or events with support for childcare

Athena Swan is seen as a new initiative that has brought best practice in equality and diversity to universities with a focus on helping women break down barriers to progressing their careers. However, approximately 25% find it not to be working as envisaged. Some key respondent comments follow. Some respondents believe the initiative to be a good theoretical exercise, but the practical application is either not having the intended results or not working for all people it should work for.
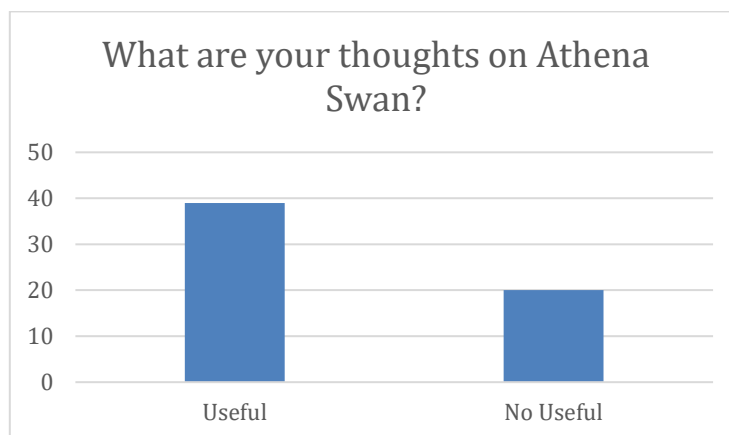

Figure 7 : What are your thoughts on Athena Swan

Some key comments

ID	Comment
7	Useful, seems like box ticking exercise for positive metrics
11	It's a great idea and when I see it I feel hopeful as it signals that the organisation strategy has decided to apply and dedicate resources to equity in the workplace. But it's still more of a compliance exercise. I would love for Athena Swan to be intersectional (I.e. to be about protecting the most vulnerable from harm. Not just women. Women are important, but white women have different needs than black women - and white women can also cause harm, for example. A.S. would pair its baseline care for women with checklists for racism, ableism, homophobia etc.).
15	I have had to miss conferences/networking events due to lack of childcare, and missed meetings scheduled outside of core hours due to school pick up responsibilities
18	Tech staff in my institution have consistently been side-lined, even from the Silver award. Very disappointing.
21	I've seen no difference in the workplaces which have Athena Swan and those that don't. The size of the University has more impact on what childcare options they provide.
48	In my previous position with silver Athena Swan it was still impossible to get maternity leave during a 2-year postdoc and no other postdoc lengths were offered. Brilliant women were not able to contribute without unfair sacrifice.
50	Athena Swan is only useful when it is adhered to by all.
54	One child in nursery 4 days a week costs us half of my take home pay, after commuting costs there isn't much left!
55	Lack of childcare in core hours - hasn't affected me, but I do feel hindered when it comes to networking events as they are all afternoon/evening events. Athena Swan has been good to network and create a community of women who understand the subject specific struggles of navigating work as a woman
70	They have only just started looking at women in particularly in the technical role. It is more of a tick box and takes a great deal of work that isn't easy in these days of grant application or safety and teaching commitments. Fundamental, I think that the training is not evenly applied across all of those who submit and I definitely have worked in institution that can put gold on the door but bully and harass their staff.

We asked what respondents consider the top three barriers to women in tech. Respondents stated the following:

1. Lack of understanding of women specific challenges
2. Caring responsibilities
3. Childcare Costs

We also asked what other challenges women had faced in their career and used an open text field to let respondents express themselves. The comments below cover areas from poor workplace culture, poor communication, lack of best practise implementation and gender bias.

Some key comments – Other issues which have prevented you progressing in your career

ID	Comment
7	Pay lip service to menopause but no physical space/action
11	A lack of solidarity. Men not being to handle their feelings. Other women pulling the ladder up behind them. A general disinterest in changing the systems, institutions and policies that cause harm in the workplace. Despite better wellbeing outcomes leading to a more effective, and potentially loyal, workforce. Look at the recent Russell Brand allegations - women were removed from the workplace, stripped of opportunities, to keep him in post.
15	I have had to miss conferences/networking events due to lack of childcare, and missed meetings scheduled outside of core hours due to school pick up responsibilities
16	People not thinking outside the box
18	Ongoing culture where predominantly it is women out doing the men with the patriarchal culture who seem to do well. Men don't like to be challenged by women, still.
21	The presumption that women will provide the majority of childcare. Having to take a career break due to having children. The lack of part time jobs at higher levels. Fixed term contracts postdocs.
33	Not children perse, but pregnancy and maternity leave does not help
44	Opportunities that are relevant for career progression
50	All day training courses which don't take into account school times are impossible to attend.
70	I have heard it many times, your female, you can't be dyslexic, dyspraxic or suffer from ADHD or aspergers - oh we do! There weren't many like me but now there are, so something is changing. Sometimes there are less women tech than there are women professors... when is that pointed out
75	Lack of respect - opinions seem less valid because I am a woman. Suggestions I have made being ignored but then if they are repeated by men they are accepted.
76	Gender bias

In order to determine if we had missed any key issues we asked whether there were any other issues you feel have constrained your career because of your gender. The areas covered include poor progression, poor managers, societal based gender discrimination, a resulting lack of confidence and investment in women's continuing professional development.

ID	Comment
2	Menopause
4	How to make a career work with being in a specialist area with family/partner living further away and me having to work away in a week - uncertain how this works when start a family.
7	Unsupportive managers
10	Opportunity for leadership roles: Women are less likely to be perceived reliable and appropriate for playing a leadership role and get involved in decision-making.
11	I love my career and I am very lucky. I see other women facing truly abhorrent treatment and all I can do is be there for them.
15	Discrimination and infantilisation from male colleagues and superiors
18	Teachers who hold the view that girls won't have good careers/results if they do science subjects - no promotion of apprenticeships/alternative science careers other than university
25	I feel that i am lacking in confidence, which may be my personality and the way i was brought up that affected this but i think women in general lack confidence compared to men. We need to ensure we instil confidence in young women to ensure they don't get bustled to the side by male counterparts.
28	There has been little to no encouragement in my career that suggests I could be more until recently. Which ultimately led to me not realising my own potential and therefore staying in the same place and position for almost 12 years. I have only ever seen male colleagues progress into management.
30	Having to take career breaks to have children. The year off each time was amazing personally but it was also a year of lost career development and learning that men don't face.
33	not been take serious
44	Having sexist or misogynistic line managers early on in my career in the early 1990's didn't help.
48	I'm most environments I have been in, women in the workforce still take on the emotional labour in team dynamics. They tend to raise the money for gift collections, recognise struggling team members, support mailing list communications, and organise extracurricular activities. In a gender-equal environment these activities are usually undertaken in addition to an equal or greater distribution of other work duties.
52	Just being overlooked in general.
54	I have encountered some women in academic leadership roles who are not so supportive as technical colleagues.
70	I wasn't allowed to go to diamond light as there wasn't a fund for technician - particularly women - as you are expected to share a bedroom with a colleague. more as I get older, access funds to keep you up to date with your qualification is hard to come by and that is also against less time with caring responsibilities. We should have a fund for make it easier to make adaption in the work place to cut down on manual handling... gas cylinder are 70kg+, hard to push up a slope and they are taller than you.
77	The expectation that women pick up administrative tasks and any 'soft skill'/people related business, advance ED&I, get involved in improvements etc which has no glory attached to it.

7.   Discussion

Over the last 50 years, the representation of women in leadership positions within STEM & Business sectors in the UK, US, and Europe has witnessed notable changes. Research studies have illuminated the progress made, identified challenges, and proposed strategies to address gender disparity. Sustained efforts to foster inclusive cultures, improve education and skills development, and implement supportive policies are crucial for achieving gender equality in STEM & Business leadership in the future. Whilst some examples can be cited (eg. the Nobel Foundation) where the disparity is being successfully addressed there are still many environments where progress is painfully slow and where many barriers to women still not only exist but cause harm to women. Athena Swan was heralded as a ground-breaking policy designed to further equality within the HE sectors but the implementation seems to be sporadic and disparate. Some respondents found that it made no difference, and some found that, despite its implementation, they were still treated poorly even when the institution advertised they were Athena Swan compliant. EDI washing is similar to greenwashing in that committees or institutions advertise the implementation of best practice but make few changes to accomplish equal working practices. This shows that good ideas are hard to implement, especially in the field of equal opportunities. Holding institutions to account might encourage them to implement policy more thoroughly and robustly.

Ongoing challenges for women in the workplace, specifically women in tech are still very much present and holding hardworking women back from the career they deserve. Some challenges detailed by the respondents of this study relate to societal barriers and preconceptions, treatment at work, lack of understanding of their specific challenges, lack of workplace flexibility and lack of policy implementation. In addition, men are disadvantaged by cultures of presenteeism and lack of awareness towards shared parental leave. This means they are sometimes unable to support women even where they would like to. This leads to further sexist issues towards men. The sheer cost of childcare or caring for someone can be too much and can lead to resignations.

Sexism and misogyny, even despite movements like 'metoo' continues to exist as does the expectation that women take on administrative roles or 'caring roles' in the workplace. One interesting aspect is mentioned by a respondent that when some women do manage to break the ceiling they continue on their upward trajectory and ignore those trying to accomplish the same. Women supporting women has historically been poor due to societal pressures to encourage competition between women so this is something that has to change from within society itself in addition to the sexist and misogynistic issues discussed above. Overall women have been neglected in terms of research into women's health, women's lived experience and their challenges. This lack of investment, research or even willingness to discuss women has left society unable to fully understand or integrate with women. Too many aspects of women's lives are either taboo or not discussed. This impacts on women themselves where a lack of research impacts many challenges women face such as childbirth, childcare, menopause and menstruation. This then leads to a lack of communication and understanding that almost sidelines women and leads to so-called easier solutions such as positive discrimination. Instead of creating new policies and forcing equality perhaps the way forward is to open the discussion, get to know women and integrate them into society and the workplace as fellow human beings with a right to equal conditions.

8.   Recommendations

There are many recommendations that could be made but the most significant for the results of this paper are as follows:

- Challenges around returning continuing professional development can be mitigated with welcoming facilities at conferences such as childcare provision, breastfeeding rooms, chairs at the back so parents can bring their children but leave if required and many other small adjustments. This needs a cultural shift to achieve.
- Board level data has to be actionable in order to recruit and establish female role models, recruit fairly in promotional opportunities for women and to understand the unique challenges women face to determine the blockers.
- Societal language and narrative around women needs a cultural shift to change. This includes aspects such as unconscious bias, faulty assumptions and bias.
- Create more female role models and give them recognition. "Female role models will play a key role in gender diversity, especially in male-dominated sectors like technology. They inspire other women and create pathways for women to break into the industry" ('How to Support Women in the Tech Sector in 2022', 2022).
- Debunk myths around male and female career paths ('How to Stop IT Being a Boys Club', 2020).
  Ensure policy is implemented and used as it should be and within the originating spirit, holding those to account who claim to uphold the policy but, in practise, do not.

Listen to women discuss their specific challenges and lived experience in order to mitigate barriers.
- Caring responsibilities and their impact on the careers of carers needs more actionable research that is then formed into policy and implemented.

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