

Closing the engineering gender pay gap: Hypotheses and existing literature

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The project

This literature review has been undertaken by WISE to support the Royal Academy of Engineering commissioned project ('the project') on the engineering gender pay gap. The research seeks to:

- quantify the gender pay gap specific to engineering roles in the UK;
- investigate causes of the gap; and
- identify practical recommendations and an action plan on how the gap can be closed.

This literature review is undertaken as part of the investigation of causes of the gap and to validate or challenge a number of hypotheses forming the basis of this project. It has been produced to provide some context for the project steering group as it meets for the first time, so that priorities for the project are fully considered ahead of qualitative and quantitative research being undertaken.

Hypotheses

The project management group, led by WISE, developed the following hypotheses ahead of the production of this literature review, against which the literature reviewed has been tested. These have been proposed based on prior reading, anecdotal evidence, quantitative and qualitative research, and experience.

1. Women attract lower starting salaries than men in engineering roles.
2. Greater female engineer attrition rates are a cause of fewer females progressing to higher-skilled, higher-status engineering roles, and more women than men being in senior roles means a bigger gender pay gap.

3. Women have less access to opportunities to progress in engineering careers than men.
4. After having children, the division of household responsibilities has an impact on female engineers' earnings, and women are relatively unable to access flexible or part-time working.
5. Female discomfort in engineering due to male-dominated culture is a barrier to them achieving higher earnings.
6. Women are more likely to work in engineering roles which attract lower pay and reward than the roles in which men are more likely to work.

Scope of literature reviewed

In order to ensure that this review remains short and is relevant to the project, the focus of this literature review is engineering-related literature.

Literature related to the causes of the engineering pay gap has been considered.

Given that the ultimate purpose of the project is to develop an action plan, the conclusions of this review highlight the key causes of the engineering gender pay gap and recommend areas on which to focus in the development of that plan.

To ensure that this review is sufficiently purposeful, literature has been tested against a number of hypothesized causes of the engineering gender pay gap, as listed above.

Existing reporting of the engineering gender pay gap

The most common method for ascertaining the average pay rates of engineers is salary surveying. In addition to recruitment firms producing their own salary surveys, in which they ask employers to report the salaries paid to different roles, engineering sector organisations produce their own salary surveys of individual engineers.

Recruitment firms generally do not differentiate male and female average salaries, as they receive their information from employers on a per-role basis. However, numerous engineering sector representative organisations¹ produce their own salary benchmarking data and, as these data are self-reported by individual engineers, it is possible for these to be differentiated by gender². As these data are self-reported, however, they are not representative of the whole number of engineers across organisations or across particular engineering roles.

In addition, reported data generally do not include bonus payments, in-kind benefits and other additions to base salary, which may skew the dataset.

Nevertheless, the results of such surveys consistently show female engineers' salaries lagging behind those of their male peers, and where age is reported as well as gender, surveys consistently show the gender pay gap growing as engineers get older. Explaining and ameliorating the causes of this growth has been highlighted as key³ if the engineering gender pay gap is to be closed.

Official datasets and statistics

In addition to surveys of employers and individual engineers which are conducted by recruitment and sectoral organisations, official government datasets provide a helpful basis for comparison of male and female engineers' salaries. Gender pay gap reporting by organisations with 250 or more employees is now mandated by law⁴. This reporting also includes mandated reporting on percentages of male and female employees by earnings quartile. However, as it is collected on a whole-organisation basis, no differentiation by role is possible, and it is not possible to understand definitively what is happening with respect to engineering roles or, indeed, any other specific roles.

However, data from the Office for National Statistics' (ONS) Annual Survey of Hours and Earnings⁵ (ASHE) show, in granular detail, mean salaries by role by four-digit Standard Occupational Classification (SOC) code, plus detail on overtime and bonus pay. These data are separated by gender, with mean and median calculations of gender pay gaps by four-digit SOC code.

Although the official datasets show trends in gender pay gaps over time, they do not explain why such gaps exist and why gaps may be growing or shrinking over time. In the case of engineering sector employers, in addition to gender pay gaps there are also generally large differences in the composition of workforces by gender which can generally be explained by large differences in the numbers of male and female engineers employed⁶. So although we can use official data to understand what is happening with respect to the engineering gender pay gap, we cannot use them to understand why it is happening or to propose solutions to the problem.

What the ASHE data can show, however, are differences between different engineering roles and, if these are compared with workforce data from the ONS, it is possible to determine whether female engineers are more likely to work in engineering roles which attract lower salaries than men are. Doing so confirms that there is some correlation (table 1).

TABLE 1 – Women as a percentage of the total numbers working in an engineering role, by SOC code, compared with average hourly pay for all workers in that role (ASHE 2018, ONS 2018)

Engineering Role	SOC Code	Women as % of Workforce	Average Hourly Pay
Electrical engineers	2123	1.4%	24.53
Mechanical engineers	2122	2.4%	21.73
Electronics engineers	2124	9.9%	21.45
Civil engineers	2121	10.5%	19.79
Design and development engineers	2126	11.5%	20.59
Production and process engineers	2127	13.9%	20.06
Engineering professionals n.e.c.	2129	21.2%	20.67

Hypothesising the causes of the engineering gender pay gap

'Equal pay for equal work' – so why is there an engineering gender pay gap?

It has been estimated that, on current trends, it will take 24 years to close the UK's overall gender pay gap⁷. However, this is based on an overall gender pay gap of 18.1% and on the gap getting smaller. In the case of engineers, there is evidence to suggest the gap is actually getting bigger⁸.

In theory, there should be no gender pay gap within a given engineering role as defined by SOC code, as equal pay legislation exists to ensure that equal work means equal pay for men and women⁹. In addition, the law determines that women are entitled to equality of terms across all contractual benefits, including overtime pay, in-kind benefits, hours of work and pension rights. However, ONS data shows a consistent lag in women's pay within engineering SOC codes, which means a consistent overall engineering pay gap.

Although 'equal work for equal pay' is a principle enshrined in law, the question of what constitutes 'equality' of work is one which is left to individual employers to interpret with a degree of latitude. Given the sizeable gap between male and female engineers with similar job titles, it is possible that men and women are being paid different rates for doing engineering jobs which are similar in terms of work done and output.¹⁰

The explanation for this could lie in research undertaken in the United States of America¹¹, which has comprehensively demonstrated that the status, and hence financial reward, attached to a given role increases as the proportion of men undertaking that role increases, and vice versa. Evidence also exists to suggest that this is the case for STEM roles specifically¹². Data from the United Kingdom on average salaries supports this, with women overrepresented in roles where average salaries are

lower than roles of an equivalent skill level with greater proportions of men undertaking them¹³.

The starting point, therefore, when hypothesising the cause of the gender pay gap is that women's work *in and of itself* is valued less than men's work. In the case of engineering, this could mean different rates of pay attached to engineering roles within organisations with more male-dominated roles attracting higher pay, and it could also mean different rates of pay for men and women doing substantively similar roles within organisations.

Lower female starting salaries – the genesis of the engineering gender pay gap?

One cause for the growth in the gender pay gap as engineers get older could be how they award starting salaries to incoming engineers. Salary surveys have found that female graduate engineers attract lower starting salaries than male peers on average¹⁴. This means that as engineers are awarded increases each year based on a percentage of their existing salary¹⁵, males attract in absolute terms greater salary increases each year, with the cumulative impact being a widening of the gender pay gap for engineers. The tendency to make salary offers to prospective recruits based on their existing salaries would compound this further, as women not only lag behind within given organisations but then suffer further relative losses of pay when moving to new organisations.

The benefit of transparency in pay and reward in closing the gender pay gap in engineering is uncertain¹⁶, as there is no research available which explores its impact. Although employers are now mandated to be transparent about their overall gender pay gaps, they are not mandated to be transparent about pay gaps between individual engineers, or to have transparent pay and reward processes and procedures. There is evidence from Denmark which suggests that transparency has a positive impact on the gender pay gap¹⁷, although the Danish regulations are different from those introduced in the UK.

Employers have been increasing engineering rates of pay in order to fill hard-to-fill roles¹⁸, but the impact of this on the gender pay gap is unclear and needs further research. However, given that female engineering graduates are far less likely to go into roles where there are severe skills shortages¹⁹, it seems likely that there is a link between women's choices of 'starting' engineering role and the gender pay gap in engineering, with the impact on women's salaries compounded by how employers structure their salary increases and opacity of pay and reward systems. There is anecdotal evidence that this is the case²⁰, but further research is needed to definitively prove a causal link.

Not only do women attract lower average salaries at the start of their engineering careers, they are also disproportionately likely to 'cluster' in lower-paid, lower-skill engineering roles in their later careers²¹. Indeed, despite the skills shortages which exist in highly-skilled engineering roles²², engineering graduates have some of the most entrenched differential rates of progress by gender.

A female engineer's place is still disproportionately in the home

One likely cause of this differential rate of progress is attrition, with nearly half of female engineering graduates who go on to take engineering roles leaving within five years²³. American research has found that insufficient pay and progression opportunities are a key cause of this²⁴ and it is reasonable to expect that this is the same in the UK. If women remain in the engineering profession in the years after graduating, after the birth of a child, female engineers are then almost twice as likely to switch fields, cut down to part-time hours, or leave engineering entirely²⁵.

The responsibility for caring for a child disproportionately falls upon the mother²⁶, and this remains the case for female engineers who have children too. A lack of family-friendly working patterns is one of the key causes of the attrition rate of female engineers with children. The right to request flexible working is enshrined in UK law²⁷, but despite the business case for flexible working being strong²⁸, engineering roles are amongst those least likely to be advertised as being open to flexible hours²⁹. Over a third of engineers would prefer flexible working to a salary rise³⁰, although further research needs to be undertaken to ascertain whether there is a gender difference in how male and female engineers respond to this.

The UK government has introduced shared parental leave entitlements to encourage more men to take time off work following the birth of a child, but take-up could be as low as 2% of eligible men³¹. In engineering, there is no quantitative research which explores take-up of parental leave responsibilities, although there is some anecdotal evidence which suggests financial implications are a barrier to men doing so³² - in part because male salaries remain higher on average. No research has yet been undertaken on whether having a supportive partner, who is willing and able to take on a greater share of caring responsibilities, enables women to remain within engineering and progress their careers after having a child.

There have been concerted efforts made by the engineering sector in recent years to attract women back to engineering roles after a period of absence taken to care for a child³³. However, further research needs to be undertaken to ascertain how effective such programmes are at helping female engineers to make similar career progress to their male peers.

Although such programmes have been identified as being a good way to ameliorate skills shortages in engineering roles³⁴, not all employers offer such programmes. It's unclear how effective they are proving overall at helping women to pick up their careers where they left off pre-birth.

Perception and reality: opportunities for female engineers to progress in their careers

Whether female engineers choose to have children or not, one common explanation for the engineering gender pay gap is that they do not have equivalent access to career progression opportunities as their male counterparts. Perception is one important cause of this, with two-thirds of young female engineers feeling they do not enjoy the same opportunities to progress as male colleagues and almost two-fifths feeling they are not treated equally by managers³⁵. One explanation of this is that males in senior positions in engineering may not be practicing what they preach, with Australian research finding a big disparity between male support for gender equality in general and their personal willingness to contribute to achieving it³⁶. There is also research which demonstrates that even in the case of scientists, who are trained to be objective, both males and females are more likely to perceive men as more competent and to award them higher salaries³⁷.

The impact on the gender pay gap of this is obvious; if women aren't supported by managers to make progress in their careers, their ability to achieve higher salaries will suffer. Differential access to involvement in high-profile projects and in 'extra credit' work may also help to explain the pay differential for male and female engineers working in ostensibly equivalent roles; evidence suggests that this is the case for women in the UK workforce more widely³⁸, but further research needs to be undertaken to demonstrate or disprove this hypothesis in engineering specifically.

Although there is mixed evidence when it comes to women's preference for male or female sponsors and mentors³⁹, given the preponderance of women reporting cultural factors as a barrier to progression in engineering⁴⁰ and citing cultural factors as reasons for leaving engineering or, in the case of graduates, not entering the field at all⁴¹, it is clear, given they make up the vast majority of engineers, that men have a major role to play in changing the culture of engineering so that it is more accommodating to women.

Existing solutions to the gender pay gap

When considering what action could be taken to close the engineering gender pay gap, it is worth looking at examples from other, similar occupational groups and sectors which have had some success. In addition, it is important to consider what engineering employers are currently doing, and what level of effectiveness existing action is showing.

The UK government has produced an evidence-based guide for employers⁴² which lists a number of effective, promising and mixed results actions, and these provide a useful basis for consideration of which activities might work best in an engineering context. This is especially useful in the case of actions which have mixed results, given their widespread usage in engineering and wider STEM fields; for example, research exists which shows that men’s attitudes towards stereotypes about women do not change following unconscious bias training⁴³.

An examination of 25 engineering employers’ gender pay gap narrative reports, undertaken as part of the background research to this project, has found that a minority of employers are currently using those interventions which have been proven to have positive impacts (see tables 2-4). Of those, the most popular is the appointment of diversity managers and/or a diversity task force, with ten of the 25 having done so. Uptake of promising actions is more widespread, with 16/25 having improved workplace flexibility for men and women, 15/25 offering mentoring and sponsorship, and 15/25 offering women’s networking programmes.

However, the uptake of actions with mixed results is even more widespread, with 17/25 using unconscious bias training and 18/25 introducing leadership development training for women. In the case of leadership development training, it has been flagged as one intervention which is failing employers globally⁴⁴.

TABLE 2 – Take-up by engineering employers of interventions to close the gender pay gap which have been found to have a positive impact

Intervention	Take-up
Include women in shortlists for recruitment and promotions	3/25 recruitment, 1/25 promotions
Skills-based assessment in recruitment	4/25
Structured interviews for recruitment and promotions	0/25
Encourage salary negotiation by showing salary ranges	0/25
Introduce transparency to promotion, pay and reward processes	4/25 promotion, 2/25 pay and reward
Appoint diversity managers and/or a diversity taskforce	10/25

TABLE 3 - Take-up by engineering employers of interventions to close the gender pay gap which are promising, but require more research into their effectiveness

Intervention	Take-up
Improve workplace flexibility for men and women	16/25
Encourage the uptake of shared parental leave	2/25
Recruit returners	6/25
Offer mentoring and sponsorship	15/25
Offer networking programmes	15/25
Set internal targets	10/25

TABLE 4 – Take-up by engineering employers of interventions to close the gender pay gap with mixed results

Intervention	Take-up
Unconscious bias training	17/25
Diversity training	10/25
Leadership development training for women	18/25
Abandon performance self-assessment	0/25
Diverse selection panels for recruitment and promotion	5/25 recruitment, 3/25 promotion

The Equality and Human Rights Commission has also produced a guide to reducing gender pay gaps⁴⁵ and, although it does not detail which interventions have mixed results, its recommended actions are also evidence-based. They include greater flexible working, greater sharing of parenting between men and women, and reduction of bias in promotion and hiring – all recommendations which engineering-specific literature suggest would translate well to an engineering context.

Other sectors with male-weighted workforce profiles are making progress in narrowing their gender pay gaps, such as construction⁴⁶ and tech⁴⁷. In the case of construction, examples of actions which have had a beneficial impact include the introduction of diverse recruitment shortlists⁴⁸ and tying managers' bonus payments to improved female representation in their teams⁴⁹. Greater personal accountability, and personal reward for success, is one way to encourage predominantly male engineering managers to consider the balance of their own teams.

In tech, one employer has achieved what it terms 'pay equity' worldwide by statistically modelling all employees' pay and awarding salary increases to those who were deemed to have been underpaid⁵⁰. If applied to engineering, this would counteract any imbalance caused as a result of

percentage of salary-based pay increases. This could, in turn, help to stop the gender pay gap growing as female engineers get older.

Conclusions and areas for further consideration

Returning to the hypotheses listed at the start of this review, it is reasonable to conclude that there is credible evidence for the following.

1. *Women attract lower starting salaries than men in engineering roles.*

However, the evidence available is self-reported by engineers themselves, and analysis of primary data gathered from employers would provide a more robust evidence base.

2. *Greater female engineer attrition rates are a cause of fewer females progressing to higher-skilled, higher-status engineering roles, and more women than men being in senior roles means a bigger gender pay gap.*

The tendency of female engineers to 'cluster' in relatively lower-skilled, lower-status roles is evident, and it is reported by female engineers that lack of sufficient opportunities to develop are a cause of their unhappiness in their roles and of them leaving the profession. The research available is US-based, so further UK-based research would be useful to provide a more credible local source. A majority of employers whose narrative reports were analysed (17/25) reported this as a cause of their own gender pay gaps.

3. *Women have less access to opportunities to progress in engineering careers than men.*

This is self-evident from workforce data on the numbers of male and female engineers in senior roles, supported by what female engineers themselves say. It is also clear that female engineers perceive a gender opportunity gap.

4. *Women are more likely to work in engineering roles which attract lower pay and reward than the roles in which men are more likely to work.*

Comparing official datasets demonstrates that there is a correlation, even if relatively few employers whose narrative reports were analysed (6/25) reported this as a cause of their own gender pay gaps.

The evidence assessed implies the following, but further research could be undertaken through the project to provide an evidence base.

5. *Female discomfort in engineering due to male-dominated culture is a barrier to them achieving higher earnings.*

That there is female discomfort with this culture is evident, but the link between this discomfort and women's lower earnings as engineers needs further exploration to make it more robust.

6. *After having children, the division of household responsibilities has an impact on female engineers' earnings, and women are relatively unable to access flexible or part-time working.*

This is implied by data on women reducing their hours or responsibilities following the birth of a child, but it is not proven that having a partner who takes on more domestic responsibilities means women achieve higher earnings as engineers. Given the relatively small proportion of employers which initial analysis found to be promoting shared parental leave, this should be a key consideration for this project.

When considering which interventions would solve these problems, a useful starting point is the government's own evidence-based guide. Initial analysis of employers' narrative reports has found that in engineering there is a relative lack of use of actions which have been proven to work. Further research could be undertaken to examine a wider range of employers' narrative reports to strengthen this evidence base.

Either way, a question for consideration should be: **Why are engineering employers using interventions which aren't effective, and how can they be encouraged to take up those which are?**

¹ https://www.icheme.org/media/8667/lc-0151_18-salary-survey-poster-2018-v5-final.pdf

² <https://www.theengineer.co.uk/2018-salary-survey-gender-gap/>

³ <https://angel.co/blog/why-the-gender-pay-gap-gets-worse-not-better-among-senior-engineers>

⁴ <https://www.gov.uk/guidance/gender-pay-gap-reporting-overview>

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<https://www.ons.gov.uk/employmentandlabourmarket/peopleinwork/earningsandworkinghours/datasets/occupation4digitsoc2010ashtable14>

⁶ <https://www.wisecampaign.org.uk/statistics/2018-workforce-statistics/>

⁷ <https://www.ft.com/content/0107f2fa-f75c-11e6-9516-2d969e0d3b65>

⁸ <https://www.theengineer.co.uk/2018-salary-survey-gender-gap/>

⁹ <https://www.equalityhumanrights.com/en/advice-and-guidance/equal-pay-equal-work-what-law-says>

¹⁰ <https://www.imeche.org/news/news-article/'shock'-survey-shows-women-earn-up-to-30-less-than-male-engineers-in-same-roles>

¹¹ <https://academic.oup.com/sf/article-abstract/88/2/865/2235342>

¹² <https://www.naceweb.org/job-market/compensation/exploring-gender-bias-in-starting-salary-offers-among-stem-majors/>

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<https://www.ons.gov.uk/employmentandlabourmarket/peopleinwork/earningsandworkinghours/articles/understandingthegenderpaygapintheuk/2018-01-17>

¹⁴ <https://www.theengineer.co.uk/2018-salary-survey-gender-gap/>

¹⁵ <http://www.imeche.org/news/news-article/engineers-see-pay-rise-2-year-on-year>

¹⁶ <https://theconversation.com/could-knowing-how-much-your-coworker-earns-help-close-the-gender-pay-gap-58570>

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