

Gender differences in early careers of Finnish engineers

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Abstract— Although the employment of graduates has been systematically surveyed in Finland for years, the gender equality aspect has been largely ignored. As early career experiences are likely to affect the retention of female engineers also in Finland, this study aims to understand better the different factors contributing to the vertical gender segregation in engineering careers in order to find ways to enhance women’s qualitative and quantitative employment. A statistical analysis of 3153 responses to a survey about degree and career satisfaction, career progress, factors contributing to employment, competences required in work, and development of competences during university studies revealed several differences in women’s and men’s early career experiences and perceptions. The results indicate that engineering education provides men with a better starting point for an engineering career. Hence, corrective actions are needed already during the engineering studies to smoothen the women’s rockier road in the later working life.

Keywords—gender diversity, early career engineering, employment, career satisfaction

I. INTRODUCTION

The employment of graduates and the early career work quality have been systematically surveyed in Finnish universities for several years [1]. Yet, the gender equality aspect has been largely ignored. Keeping a close eye on the early career experiences of engineers is crucial as exit rates from careers have been noted to be highest in the first ten years after graduation [2]. Although there has been no exhaustive research on the leaky pipeline phenomenon in Finland, there are some indications of women engineers drifting to the sidelines of the core engineering work or to other fields [3]. Hence, early career experiences are likely to affect the retention of female engineers also in Finland.

Upon graduation, Finnish female engineers generally perceive the skills provided in engineering education more important than male engineers and find that education and study-time work experience has developed most of these skills better than their male counterparts do [4]. An exception to this were the entrepreneurial skills, which men perceived to be more important and having developed better [4]. Still, the few studies addressing the gender differences in the employment of engineering graduates discovered that during the first five years of their career, women generally had lower salaries [5], fewer permanent employment contracts, and more unemployment than men [6]. Female engineers in Finland also seem to end up in nontechnical occupations more often than male engineers [3].

Female students in computer science, engineering, mathematics, and physical sciences have been noted to have

stronger people orientation and more interest in people-related jobs than male students in the same disciplines [7]. There is, however, contradictory information regarding the reflection of that in the career satisfaction. Bielefeldt and Canney [8] found no statistically significant differences in the extent to which female and male engineers were satisfied with helping others through their work, whereas VanAntwerp and Wilson [2] suggest that there is a striking gender difference in the aspects of engineering jobs on which men and women focus their passions: men are intrinsically motivated by technology in itself, whereas most women find joy of engineering from the business- and people-related activities or from solving problems and challenges.

Managerial career paths appear to be a double-edged sword to female engineers. Newly graduated engineer women perceive the management skills more important and better developed than men do [4] and increasing women’s representation in managerial roles in male-dominated occupations is suggested as a means to mitigate gender segregation [9]. Simultaneously, engineers with professional identities emphasizing managerial skills are known to be more likely to leave engineering [10], [11] and especially the female engineers on the managerial path are viewed as less technically proficient by other engineers [9]. For women, the managerial path has also been shown to associate with low identification with other engineers, and low perceived intragroup respect, meaningful work, and work satisfaction [11].

A systematic literature review on engineering employability [12] found three kinds of approaches to enhancing the employability in engineering education: focusing on the disciplinary knowledge, on the professional skills needed in the social context, and on the balance between engineering knowledge and professional skills. The authors conclude that for improved employability, both disciplinary knowledge and professional skills as well as the use of problem-oriented pedagogies are needed across engineering curricula [12].

II. METHODS

This study examines the career development and satisfaction with one’s degree and working career five years after graduation of Finnish male and female engineers. The objective of this study is to understand better the different factors contributing to the vertical gender segregation in engineering careers in Finland. This is pursued by seeking answers to two research questions:

1. Are there gender differences in the quantitative and qualitative employment of Finnish university engineering graduates during their early career? What can explain these differences?
2. Are the Finnish female and male early career engineers equally satisfied with their degree and career? What can explain possible differences?

The data consist of 3153 survey responses from engineers graduated between 2013 and 2015 from the seven Finnish universities providing M.Sc. degrees in technology. 73.6% of the respondents were male and 26.4% female. The data were collected five years after graduation, i.e. in years 2018-2020, as part of a nationwide master's degree career monitoring query, which is implemented each autumn jointly by twelve Finnish universities [1]. The exact response rates to the survey are not available, but comparing the number of respondents in the data and the number of engineering graduates in the years of the target groups' graduation shows that the average response rate to the survey has been around 37%.

The query targets all persons who have five years earlier graduated with either a second cycle university degree or a concluding first cycle university degree [1]. The respondents are asked about the satisfaction with their degree, their overall career progress, a perception about the factors contributing to their employment, the competences required in their work, and the development of those competences during their university studies [1]. The query process follows the common ethical principles of Finnish universities' feedback surveys [13], which have been established by the Finnish Council of University Rectors.

The questions used for this study consisted mostly of closed questions, with alternatives to choose from or statements to be evaluated with a 6-point Likert scale. For those questions, the statistical significance of gender differences was examined by viewing the differences between response distributions. For the Likert scale questions, also the means of the responses by gender were compared. For the questions with simple numeral answers, like questions regarding the salary, number of employers since graduation, or duration of different leaves, the group mean was used as the basis of comparison. As most of the responses did not follow a normal distribution, nonparametric statistical tests were used. The gender differences of the distributions were

inspected with the Pearson Chi2 test and the difference between means with the Mann-Whitney test. The effect size for the difference between means was calculated using Cohen's delta. All the analyses were conducted with the statistical software Stata

III. RESULTS

A. Income, employment, and absence from working life

Statistical analyses revealed several significant gender differences, albeit most with only small effect sizes. Previous findings regarding women's lower salaries and fewer permanent contracts were confirmed. No statistically significant difference in unemployment was observed, although women were noted to have more often gaps in their employment history. Women also had substantially more often and longer family leaves during their first five years of engineering career. The differences in the salaries and duration of leaves are collected in Table 1.

The one-year difference in the age upon graduation is mainly explained by the military service, which in Finland is compulsory for men and needs to be completed by the age of thirty. The much greater standard deviation of the average gross salary of men reflects the significant difference in the top salaries (44 000 euros/month for male respondents and 10 800 euros/month for female respondents). 30% of women and 26% of men had been unemployed within the five-year period from graduation, but the difference was not statistically significant ($p=0.07$). Neither were there statistically significant differences in the number or duration of unemployment periods. Women had, however, had significantly longer leaves due to family or other reasons.

Figs. 1 and 2 illustrate well the gender differences in the quality of employment. The profile of current employment is statistically significantly different ($p=0.000$) for men and women with men being more often employed in permanent full-time jobs or as entrepreneurs and women holding other type of status more often than men. The greater stability of men's employment situation also shows in the overall career path (Fig. 2), which indicates that women have had more breaks and interruptions within the first five years of their career. The difference is statistically significant ($p=0.000$).

TABLE I. RESPONDENTS' AGE UPON GRADUATION, CURRENT SALARY, NUMBER OF EMPLOYERS SINCE GRADUATION, AND DURATION OF LEAVES FROM WORK DURING THE FIRST FIVE YEARS OF THEIR CAREER

	Mean		Standard deviation		M-W sig.	Cohen's d
	Male	Female	Male	Female		
Age upon graduation	28.6	27.7	5.060	4.628	0.000	0.197
Current average gross salary or monthly income (including allowances, benefits etc.) / Eur	4726.27	4248.611	2020.38	1172.70	0.000	0.258
Number of employers since graduation	1.932	2.054	1.017	1.149	0.030	-0.116
Duration of unemployment since graduation / years	0.734	0.701	0.950	0.754	0.216	0.037
Duration of family leaves since graduation / years	0.278	1.194	0.391	0.684	0.000	-1.837
Duration of leaves (excl. Family leaves, unemployment, layoffs) since graduation / years	0.778	1.107	1.082	1.102	0.001	-0.311

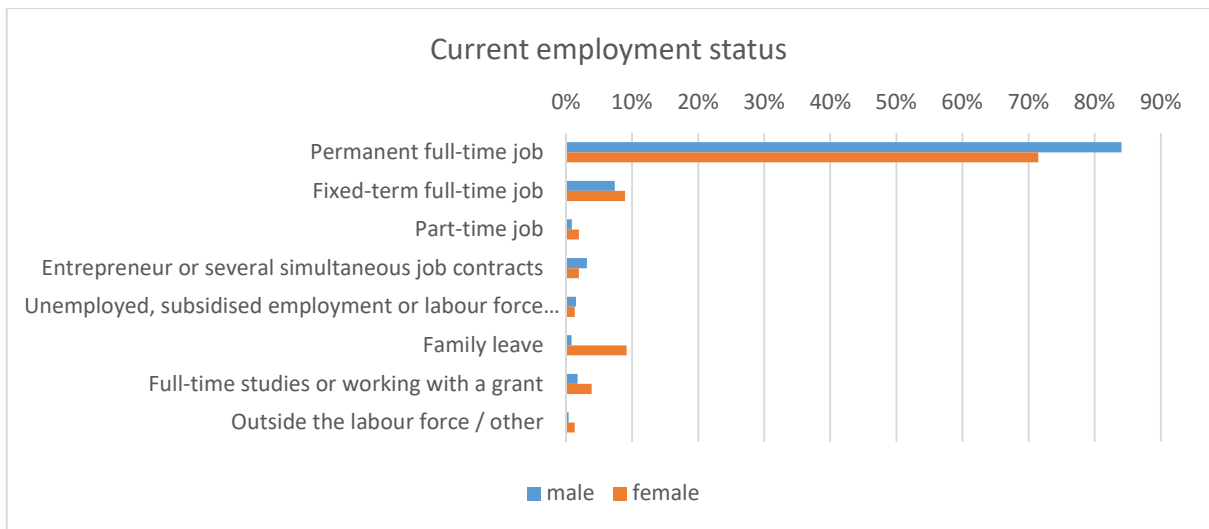


Fig. 1. Employment status of the respondents five years after graduation

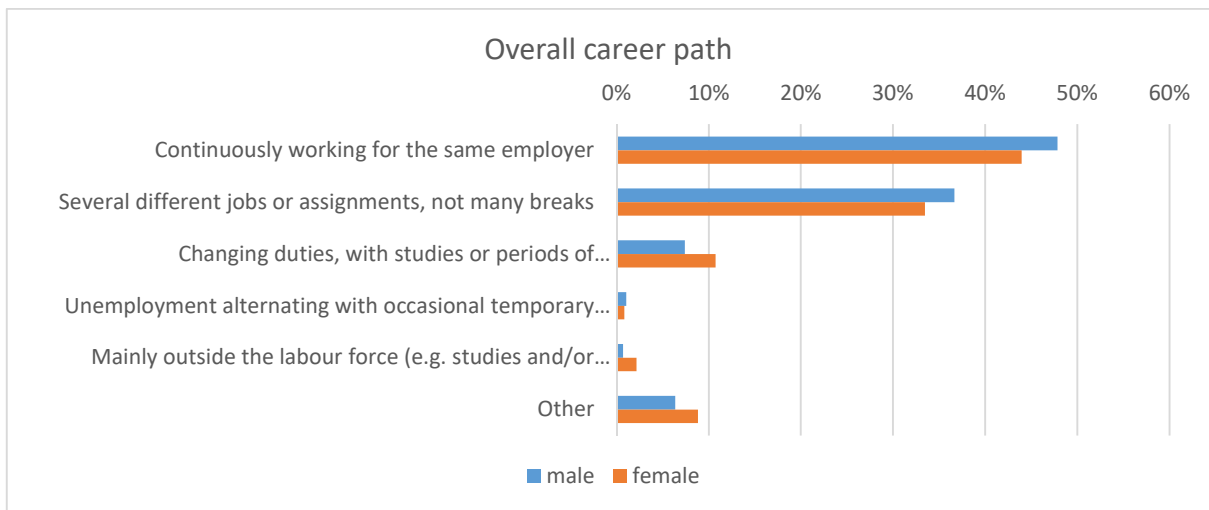


Fig. 2. Characterization of the overall career path of the respondents during the first five years of the career

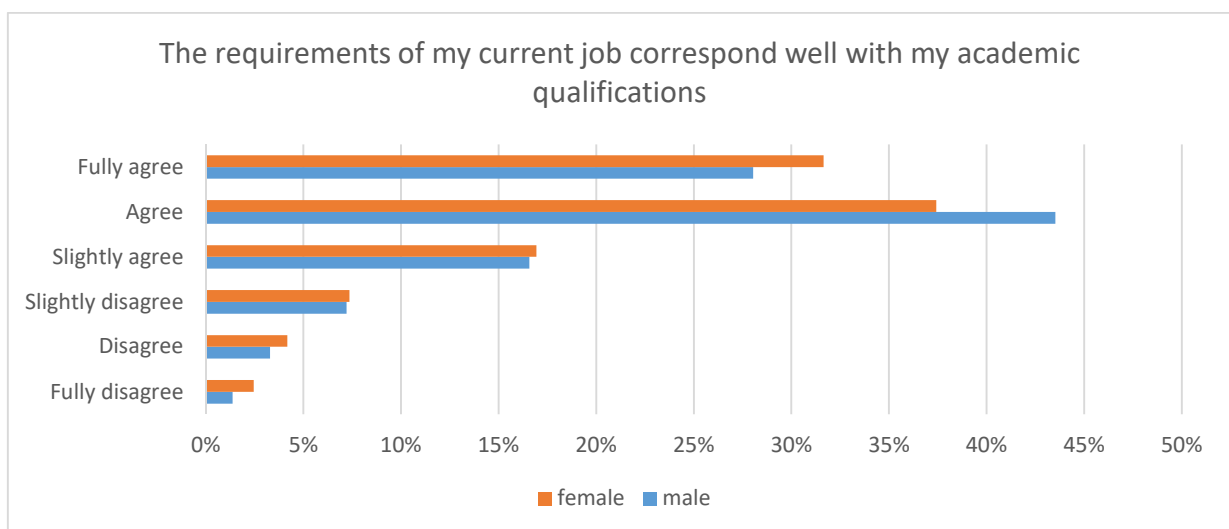


Fig. 3. Correspondence between respondents' current job requirements and academic qualifications

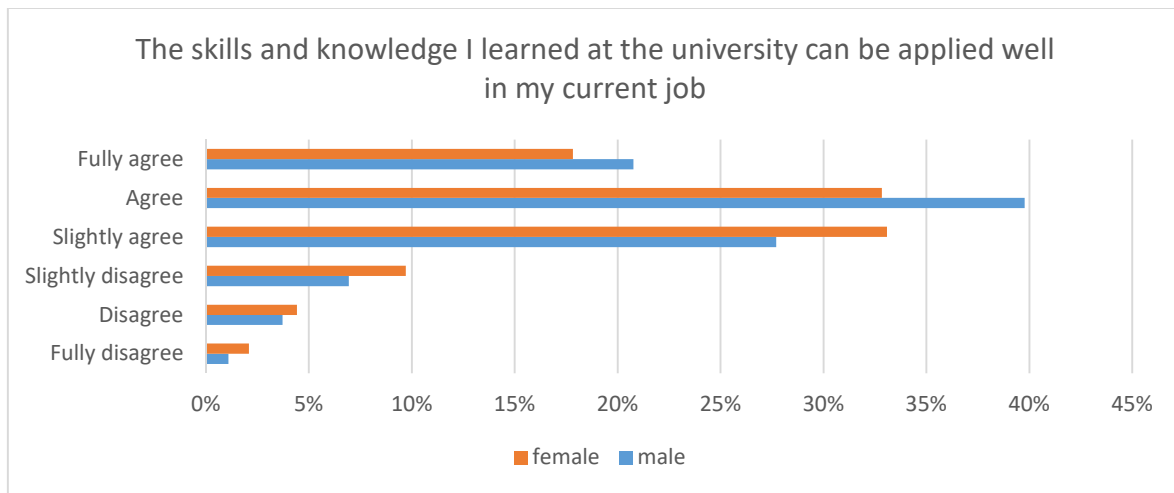


Fig. 4. Applicability of respondents' skills and knowledge acquired from university in their current job

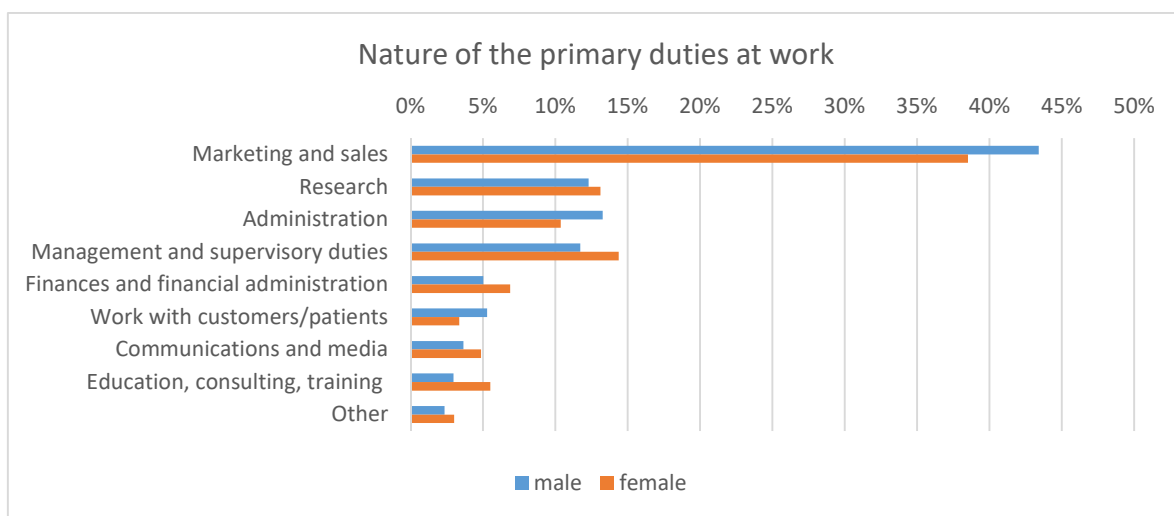


Fig. 5. Nature of respondents' primary duties at work five years after graduation

B. Nature and demands of duties

When the respondents were asked whether the master's degree was an eligibility requirement for their current job, 56% of women and 51% of men responded "yes," 31% of women and 38% of men "no," and 13% of women and 11% of men "I do not know." The difference was statistically significant ($p=0.002$). However, when the respondents were asked if the requirements of their current job correspond with their academic qualifications, there were no statistical differences ($p=0.881$). The detailed distribution of responses to the latter question is presented in Fig. 3. Asking respondents to reflect upon the usability of the takeaways from their engineering degree revealed that men evaluated the applicability of the gained skills and knowledge more favorably than women ($p=0.000$) as illustrated in Fig. 4.

There also seems to be some gender difference ($p=0.000$) in the nature of primary duties at work five years after graduation (Fig. 5). When respondents were asked to choose one line of duties that describes best the work that they do,

marketing and sales was the area with most mentions for men and women. Perhaps somewhat surprisingly, women hold management and supervisory duties as their main responsibility more often than men, whereas men are more often engaged in marketing and sales or administration. Since the survey is common to all educational disciplines, it is slightly difficult to connect the areas of duty to engineering work. Based on the distribution in Fig. 5, one could suspect that the typical engineering tasks in the private sector would fall into the category of marketing and sales.

C. Satisfaction with degree and career

In order to get information about the respondents' satisfaction with their degree, they were asked to evaluate five statements concerning it on a scale from 1 to 6 (1=fully disagree, 6= fully agree) as well as to state their overall satisfaction with the degree in terms of career (1=very dissatisfied, 6= very satisfied). Along the same lines, they were also asked about their overall satisfaction with their work career. The key figures regarding the satisfaction are collected in Table II.

TABLE II. RESPONDENTS' SATISFACTION WITH THEIR DEGREE AND CAREER

Assess the degree you completed	Mean		Standard deviation		Chi2 sig.	M-W sig.	Cohen's d
	Male	Female	Male	Female			
Employers value my degree.	5.013	5.052	0.930	0.982	0.111	0.078	-0.041
I would recommend my studies to others.	4.974	4.897	0.989	1.067	0.015	0.153	0.076
The learning objectives were made clear during the studies.	4.043	3.938	1.033	1.060	0.184	0.012	0.100
The studies equipped me sufficiently for the working life.	4.356	4.173	1.091	1.075	0.000	0.000	0.168
Entrepreneurship was presented as a career option during the studies.	3.082	2.777	1.359	1.351	0.000	0.000	0.225
Overall satisfaction with the degree in terms of career	4.823	4.663	0.995	1.021	0.000	0.000	0.159
Overall satisfaction with the career	4.778	4.621	0.992	1.076	0.001	0.000	0.155

The results indicate that women are slightly but significantly less satisfied with their degree and career than men. The most significant gender difference can be seen in the extent to which entrepreneurship was presented as a career option during studies. Women also agreed less with the statement about studies having equipped the respondent sufficiently for working life, but the effect size of the difference was smaller than in the case of entrepreneurship.

D. Factors promoting employability

Both female and male engineers rated the same three factors as the most important factors affecting their employment. Ability to explicate one's competence was regarded the most important, work experience (excluding internships for the degree) the second, and content of the degree as the third important factor. The ratings of the different factors by gender are collected in Table III.

There were, however, some differences in the strength of the perceptions. Men rated the effect of degree content higher than women, whereas women perceived training outside degree studies, other work experience, international experience, ability to explicate their know-how, and activity in social media to be more important than men did. Based on the effect size, the training outside the degree studies seems to be the factor where the gender difference is the largest. Looking at the trainings the respondents had attended since graduation reveals no statistical differences in participating in short training programs, professional qualifications programs or conducting doctoral studies. However, women had significantly more often either completed another degree ($X^2(1)=8.16$, $p=0.004$) or were studying towards it ($X^2(1)=7.12$, $p=0.008$).

TABLE III. RESPONDENTS' VIEWS OF FACTORS THAT HAVE AFFECTED THEIR EMPLOYMENT AFTER GRADUATION ON A 6-POINT LIKERT SCALE (1=NOT IMPORTANT AT ALL, 6=VERY IMPORTANT)

How have the following factors affected your employment after graduation?	Mean		Standard deviation		Chi2 sig.	M-W sig.	Cohen's d
	Male	Female	Male	Female			
Combination of subjects in your degree	4.183	4.032	1.351	1.430	0.025	0.015	0.109
Practical training	3.583	3.579	1.731	1.830	0.079	0.960	0.002
Other work experience	4.329	4.538	1.512	1.456	0.013	0.001	-0.140
Other studies or training (not part of the degree you completed in 201x)	3.080	3.357	1.691	1.759	0.003	0.001	-0.162
Experience relating to organizational work or hobbies	2.519	2.576	1.529	1.511	0.220	0.228	-0.038
International experience	3.178	3.407	1.621	1.630	0.018	0.004	-0.141
Contacts/networks	3.625	3.584	1.675	1.697	0.802	0.577	0.024
Ability to tell people about your skills	4.799	4.932	1.079	1.092	0.005	0.000	-0.124
Activity and profiling in social media	2.075	2.179	1.285	1.319	0.244	0.038	-0.080

IV. DISCUSSION AND CONCLUSIONS

The results suggest that also in Finland women's early career in engineering is a slightly rockier road than men's. Despite no differences in the likelihood of unemployment or the length of the unemployment periods, women's careers are more fragmented with a greater number of employers and contracts and longer periods of absence due to family leaves or other reasons. Women also earn less than men in the early years of their career. Although men and women perceive the level of demand of their duties quite similarly, men express better applicability of the skills provided by university training to their current job.

The gender segregation of different types of duties appears to begin very early in the career, and the likelihood of a managerial path seems to be greater for women than men already within the first five years from graduation. This may not be solely a good thing for women, as the research has shown that this poses women many challenges in terms of staying in an engineering career [9] [10] [11] as well as career progress [14].

Women are less satisfied with their degree and career and feel weaker than men that university studies have equipped them sufficiently for working life. In the moment of graduation, Finnish female engineering graduates evaluated the development of their skills in education generally more favorably than males [4]. Hence, it appears that the five years after graduation in working life change the perception that the female graduates hold regarding the match between the educational outcomes of the engineering degree and the requirements of engineering work.

Men perceive the effect of the content of their degree more important for their employability than women, whereas women emphasize the outside-studies experiences and competences more than men. This confirms that integrating disciplinary knowledge and professional skills throughout the engineering curriculum to enhance employability as suggested by [12] is important also in order to guarantee the equal employability of men and women. Women also start studying new degree in another field after graduation as engineers more often than men. The motives behind that cannot be deducted from this study, but it may signal of some degree of dissatisfaction towards the engineering degree or its employability. This issue needs to be studied further in the future.

Altogether, the results indicate that engineering education provides men with a slightly better starting point for an engineering career. From the viewpoint of engineering education, it is essential to recognize the differences possibly

produced by education and find ways to mitigate them. Likewise, it is important to consider what kinds of tools and means, like career counseling, could already be provided during study years to smoothen the women's career paths. The actions are crucial, not just to retain the women in the engineering path, but also to develop the engineering education and working life in a direction that is more appealing for generations to come.

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