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## **Risks and motherhood-related uncertainties during PhD studies in engineering**

### **Introduction**

Women are still significantly underrepresented in the field of science, technology, engineering and mathematics (STEM) both in higher education and research and development (R&D). They tend to leave science after obtaining their PhD or have to face slower career advancement compared to their male counterparts. Research already called attention to stereotypes reinforcing the essentialist constructions of science and gender, to the role of early socialisation in women's career orientation and to the different structural barriers in STEM cultures, which can all alienate women from science (Faulkner 2011, Xie & Shauman 2003).

However, the early-stage research career is a special life period where women possibly meet the majority of the obstacles to female career advancement. Firstly, work-life balance can be especially challenging, for they often study, work and (would) raise children at the same time. Secondly, being new incumbents and/or young mothers, they are subject to a high level of labour market uncertainty and risk concerning their employment forms and working conditions. Moreover, occupational characteristics of STEM fields, such as knowledge-intensiveness and laboratory work can lead to further uncertainty and more risk elements.

Using Ulrich Beck's theories (Beck 1992, 2000), this paper will show the uncertainties and risks young female researchers face in engineering in relation to their motherhood, as well as how significantly they influence their family and professional life. Results of 27 semi-structured individual interviews with female PhD students in Hungary will give a more complex understanding of women's constrained careers in a highly male dominated technical field in a post-socialist context.

### **Theoretical background**

Our theoretical framework is based on Ulrich Beck's work on risk society (1992). He argues that in this new risk society there is a growing consciousness towards new types of risks connected to technological, economic and social development. Industrial societies had met their limitation and rigidities and are now experiencing their 'counter-modernistic scenario', including the criticism of science, technology and progress, as well as new modes of work and family life (Beck 1992, 11). In our research we reflect on these two dimensions of risk society.

Science and technology have been demystified in this new reflexive modernity. In risk society, the former security provided by new technologies can no longer be guaranteed: accidents and catastrophes can happen anytime. However, instead of dangers, the “projected dangers of the future” – namely the risks – have become the focus of this new modernity. According to Beck, risk means a “systematic way of dealing with hazards and insecurities induced and introduced by modernization itself” – modernity became its own theme, and in this way, reflexive (Beck 1992, 19–21).

Danger and risk used to be personal and located, while in risk society whole continents face global dangers in the forms of new, invisible physical and chemical formulas, of which side-effects are often latent for the time being and not even calculable. However, there are contradictions in risk society: a) the more security is sought, the more risk we have to undertake and the less security can be achieved, b) we can hardly realize risk or hardly (want to) know its full potential, moreover, when everything becomes hazardous around us we tend to ignore them (Beck 1992, 19-23).

Risk has another essential dimension, for global risk situations overlap with social, biographical and cultural risks and insecurities (Beck 1992, 87). In risk society, former certainties, such as the sanctioning power of classes and norms vanished or weakened due to the process of individualisation. Human biographies have become reflexive, people have more freedom to choose both their individual and labour market biographies (Beck 1992, 87). Meanwhile, in this highly uncertain environment both the recognition of risk, the decision and the responsibility are shifted to individuals (Beck 1992, 143).

In parallel with this, employment systems became less standardised after the ‘70ies. Although there is an increasing demand on behalf of the employers for more flexible, responsible and mobile workers, these requirements are usually opposed to family establishment and long-term career plans (Beck 1992, 142). Beck argues – in his work about the “brazilianization” of work – that labour market uncertainties affect women primarily, for example they are usually employed in atypical, precarious employment forms (Beck 2000).

However, the distribution of risk of flexible employment does not follow the pattern of social stratification. It is a new phenomenon that insecure jobs are spreading at the highest level of the qualification hierarchy affecting – among others – professionals working at universities, or

innovators at high-tech centres, who are also subject to increasing labour insecurity. A significant part of the highly qualified labour force also has to face the disadvantages of the individualised employment systems, where cheap and uncertain jobs demand multi-activity, high levels of flexibility and adaptation to the continuously changing rules (Beck 2000).

### **Hungarian context**

Hungary has undergone quite similar demographic changes like those of Western countries, such as the postponement of motherhood or the decreasing number of marriages (Spéder 2009), however these postponements started before the change in the political system (Tóth 2002). Still, even today women give birth to their first child around the age of 29.6, a year earlier than the EU28 average (Eurostat 2015).

Public attitudes towards family and gender roles are changing slightly but the population is still considered conservative (Molnár 2011). Some social policies, such as three-year parental leave suggest that Hungarians are (still) very family-oriented (Blaskó 2011), meanwhile, the reconciliation of work and family life is still a huge challenge for women and families. Neither recent low fertility rates ([1,4] Eurostat 2015) coupled with gender pay gap ([15.1] She Figures 2015), nor the lack of either sufficient childcare services (KSH 2014) or part time work opportunities (Nagy 2009) support this idea. While the proportion of employed women with children under the age of two in Hungary is the lowest (UNECE 2015), the employment impact on parenthood is the highest in Hungary among the EU member states (She Figure 2015).

Regarding engineering, women are significantly under-represented in the field. Their participation in postgraduate programmes has always been very low – around 30% – a proportion which is quite equal in chemical engineering, but extremely low (around 7%) in electrical engineering (KSH 2009). Though the duration of PhD programmes was extended from three to four years in 2016, it usually takes 5-6 years on average for students to obtain the degree. The proportion of engineering women in research and development is 21.3% (KSH 2011).

In sum, higher educated women usually face strong conservative social attitudes, insufficient social policy arrangements and labour market conditions that can all significantly hinder the harmonisation of their family and professional life, causing high level uncertainty in their life (Paksi 2014).

## **Methodology**

Our research applies grounded theory to explore how uncertainties and risks described by Beck (1992, 2000) are experienced by PhD students and how they affect their family and professional plans. The approach is based on the constructivist paradigm presupposing that people actively create and shape their social reality according to their subjectively lived realities through their understandings, meanings and practices (Creswell & Clark 2007, 37–43). Based on the considerations we introduced above, we formulated two research questions.

- 1) What kind of uncertainties do PhD students identify in relation to childbearing and how do they affect PhD students' professional and family plans?
- 2) What kind of health risks do PhD students identify in relation to motherhood during PhD studies, and how do they affect PhD students' professional and family plans?

We used qualitative methods and conducted semi-structured individual interviews accordingly. The target group was composed of female chemical engineering (CE) and electrical engineering (EE) PhD students in Hungary. We chose the oldest and largest technical university in Budapest having seven engineering doctoral schools. The sample consists of 27 students, aged between 23 and 33. The majority are married (11) or cohabit (9), are childless (20) and works in the public (14) or in the private sector (6). For the analysis we used template analysis with coding.

## **Results**

### 1) Uncertainty

Analysing the interviews, we identified three dimensions of uncertainty (labour market, negative discrimination, gender-based prejudices and false beliefs) and explored how they affected PhD students' family and professional plans.

The greatest uncertainty these young PhD students reported is related to their labour market participation. The majority of the interviewees work in parallel with their studies and experience uncertainties deriving from their precarious employment form. Firstly, they receive only very short, two to twelve month, fixed term contracts. An electrical engineer student complained about the continuous stress she felt because of the 2-month contracts at a time and seriously considered quitting her job.

Secondly, inflexible working conditions are sources of tension in young researchers' lives. Students working at public research institutes enjoy more flexible working conditions than their counterparts in the private sector. These latter ones face rigid working hours and a less supportive environment regarding their family establishment. The following quotation by an interviewee working at a huge industrial company gives a good insight into the general uncertainty she felt:

*'My future career is uncertain in connection with this (childbearing), because I don't know how I could leave, how I could return, how I could carry on, and who will say what to that.'* (CE, 25, childless)

Thirdly, students' defencelessness is further deepened by the low incomes they receive – if they receive any – in forms of fellowship or salary. The majority of the interviewees had moved to the capital when they enrolled into the PhD programme and now rent an apartment or live in a student hostel. Their low income makes it impossible to establish their own family unless they have a partner who is the breadwinner.

The second dimension of uncertainty we identified derives from the negative discrimination of these young women at their schools and/or workplaces. Although it is forbidden by Hungarian law to inquire into parental status or family plans during the interviewing process, it is a usual phenomenon that employers find their way to this information or it is asked directly. Young mothers are often discriminated against in this way and these students are not exceptions. Discrimination on the basis of gender is also a phenomenon especially among electrical engineers, and the so-called 'Old Boys Network' (Phipps 2008) discriminates women not only during the job applications but during their everyday work as well.

The sources of the third dimension of uncertainty are the gender-based prejudices and false beliefs PhD students, especially electrical engineers experience. Although the students in the sample have a strong researcher identity, the questioning of their competency can cast doubts on their career plans. Religion does not play a significant role in our interviewees' life. However, one of them who graduated from a catholic university shared her experience. Though there is only one university offering engineering education that belongs to the church, it is worth considering that medieval dogmas are still prevalent in higher education:

*'There was a priest when I was an undergraduate who said that women shouldn't learn science because it makes women infertile.'* (EE, 30, childless)

All the above described dimensions of uncertainties permeate PhD students' lives and have significant negative effects both on their professional and family lives. We observed different reactions to these uncertainties. Regarding professional life, some students consider abandoning their science careers because they find childbearing to be incompatible with a career in R&D. *'My fiancé is all enthusiastic about it, but actually he won't have to quit his job. So when I decide that I'm willing to give up my professional career, we can immediately have a baby.'* (CE, 25, childless)

However, – tilting at the windmills – the majority of the students express their aim at harmonising their family and professional lives. Meanwhile, childless students cautiously mention that they should be 'interviewed' again about how their plans were realised after they had established a family. Almost all students state that these uncertainties definitely slow down women's careers, and this opinion is widely shared even among teachers.

Regarding family life, students' utmost concern is the timing of their motherhood. They feel a continuous tension about it, because, on the one hand, they intend to finish their PhD before becoming a mother, while on the other hand they would consider themselves too old if they were to wait until they obtain the degree. In the latter case they are fully aware of the health risk of both becoming a mother at later ages and the cumulated effects of laboratory work.

Summarising the answers to the first research question we can conclude that PhD students in our sample experience different types of uncertainties. Young mothers are in a disadvantageous position in the labour market and the chilly climate further exposes these women to these uncertainties. Neither the precarious employment forms described by Beck, nor the strong conservative attitudes in Hungary foster these students' career advancement in science. Uncertainties make any long-term planning and decision making impossible, causing continuous stress in PhD students' lives.

## 2) Health risk

Although students in our sample do not work with especially hazardous materials, such as radioisotopes, they regularly use other, 'less' hazardous substances that also present health risks. Interview questions about the health risks of laboratory work revealed a contradiction in students' narratives.

On the one hand, the majority of the students are aware of the fact that working with hazardous chemicals involves certain health risks in researchers' lives. Even those student whose PhD research does not involve laboratory work, are exposed to its risks, since PhD students are required to teach and supervise the laboratory work of BSc and MSc students.

On the other hand, the health risks of laboratory work are often mentioned by the students in connection with the way safety regulations are broken. This allows the conclusion that they underestimate or neglect the health risks they are subject to. Regulations are sometimes broken by pregnant students, but we found examples of offences by the institution itself. Finally, no matter how cautious students are, accidents can always happen:

*'As for me I learned about my pregnancy rather late, and I accidentally knocked over some carcinogenic solvent in the lab before I even knew. Well, the baby was affected a bit, but it was only for one or two days.'* (CE, 28, pregnant)

As uncertainties, health risks also affect PhD students' family and professional lives. The interviewees shared the opinion that although men are affected as well, women are more endangered by the side effects of laboratory work. The younger ones are exposed to a greater health risk due to their childbearing, the older ones are subject to the cumulative effects, which often cause gynaecological problems at later ages.

Health risks are definitely high before, during and after childbearing. We saw above that accidents can easily happen before being aware of pregnancy; during pregnancy risks are officially acknowledged, because entering the laboratory is forbidden by the regulation; and lab work also presents risks to young mothers' breastfeeding. The timing of childbearing and the schedule of the laboratory work are therefore strongly interconnected and require thorough family and career planning. On the one hand, students usually do not want to postpone their motherhood until after the age of 30, on the other hand, engineering students are usually already engaged to work with industrial partners through fixed-termed contracts, which hardly allow any career break.

*'Women had better have children as soon as possible, because no matter how careful we are about health and safety, these chemicals do not make childbearing any easier.'* (CE, 28, childless)

Summarising the results of the second research question we can conclude that PhD students working in laboratories are exposed to health risks, as well as their older counterparts due to the cumulative side-effects of the hazardous substances. Results support Beck's theory that health damage is often invisible for an indefinite time, side-effects cannot be estimated; and risk is often neglected. Risk and uncertainty are intertwined in our interviewees' lives, for the timing of childbearing is a crucial life event both in their family and professional lives.

### **Summary and conclusion**

Young women in our research experience high level and multi-faceted labour market uncertainty. Precarious employment forms, such as short and fixed-term contracts, inflexible working conditions and low incomes already exist during PhD education, making students' family and professional life insecure and incalculable. The negative discrimination of these young researchers both in their schools and workplaces, as well as the prejudices and false beliefs in relation to women's knowledge competency further deepen PhD students' uncertain positions in this masculine profession. These experiences are significant sources of tensions in their lives, which highly influence their family and career decisions.

Both the younger and older researcher generation in engineering, whose work demand laboratory work, are subject to health risks. The side-effects of chemicals are often invisible and are not calculable. Nevertheless, health risks are often underestimated or neglected both by the students and their supervisors. As uncertainty and risk, family and career planning definitely are linked, for the timing of motherhood require – besides other conditions – a thorough schedule of laboratory work.

Our results show that uncertainty and health risk strongly present as early as PhD education and pervade PhD students' life. Uncertainty and risk are often intertwined and significantly influence these young engineers' career choices. Even our higher educated interviewees face high level labour market uncertainty and the invisible, cumulative side-effects of modern technology, as Beck described them in his works (1992, 2010). The negative effects of both the chilly climate and the laboratory work are additional factors to how professional life courses are gendered in research and development, as well as how life courses can differ according to the field of science and sectors. Meanwhile, students' control over these uncertainties and risks are limited. Their elimination or minimisation are needed in order to offer a more certain and calculable career model and retain women in research and development. Our results have a

limited generalisation, however, the chilly climate and the laboratory work may also play the same role in PhD student's lives in other disciplines.

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