

Career Success Factors of Women Engineers in Leadership Positions

Miriam Schmitt (miriam.schmitt@tu-dortmund.de)

Center for Higher Education, TU Dortmund University, Germany

Summary

- Research questions:** Which factors explain the career success of women engineers in leadership positions?
- Methods:** This study conducted qualitative semi-structured interviews with women engineers in Germany who hold leadership positions in industry. The interview questions focused on these women's career paths into leadership positions, along with any conducive or impeding factors. The interview data was analyzed using qualitative content analysis.
- Results:** The results show that the interdependence of the success factors on the individual and contextual levels contributes to women engineer's career advancement to leadership positions. These women are motivated by an intrinsic interest in technical tasks and career orientations towards responsibility, autonomy, and challenges. Their self-efficacy expectations help them to pursue their career interests, to cope with gender-specific barriers, and to adapt to the work environment. Furthermore, these women are focused on career goal setting and they apply career strategies such as proactive self-marketing and networking. On the contextual level, these women receive social support from their supervisors, colleagues, and husbands, which helps them to manage their careers and achieve leadership positions.
- Structure of the article:** Introduction; Literature review; Method, Empirical results; Conclusions; About the author; Bibliography

Introduction

Women often struggle to build successful careers in the engineering professions and they only rarely reach influential leadership positions. The low number of women engineers in leadership positions is a global phenomenon, which is often explained by the 'leaky pipeline' theory: women rarely decide to study engineering, they have more difficulties in finding a suitable job in engineering fields, and they more frequently drop out of the profession (Fouad et al., 2011; Frome et al., 2006). Finally, only a very few women engineers make their way into higher management levels (DGB, 2013).

Previous research has identified many causes for the difficulties that women engineers face in developing a successful career, such as a hostile male-dominated engineering work culture (Faulkner, 2009), the impermeable organizational structures of engineering workplaces (Hanappi-Egger, 2012), gender-stereotyped assumptions about technology competences (Cardador & Hill, 2018), and problems in balancing the demands of children and career (Herman et al., 2013). These difficulties can lead women engineers to experience a 'glass ceiling' effect, where invisible barriers can prevent them from advancing towards the top of organizations (Evetts, 1993).

The anticipated gender-specific barriers and socially mediated gender-role expectations of careers in engineering can have a negative impact on women's self-confidence, self-efficacy, and motivation to pursue a career in engineering (Cech et al., 2011; Jones et al., 2013). They may even lead many women to change or leave engineering career paths (Buse et al., 2013; Martínez-Léon et al., 2018).

Although the reasons for the under-representation of women engineers have been investigated, scholarly attention has rarely been given to women's career experiences in engineering and to the promoting factors that explain their career success (Cardador & Hill, 2018; Makarem & Wang, 2019).

The present study aims to address this gap by focusing on the careers of women leaders in engineering in Germany. This study aims to contribute insights into the promoting factors of women's leadership careers in the German engineering workforce by using a qualitative research approach. The leading research question is: Which factors explain the career success of women engineers in leadership positions?

To answer this question, qualitative interviews with eight women engineers in leadership positions in industrial companies in Germany have been conducted and analyzed. The focus of this analysis lies on these women's interpretation of their success as leaders in engineering. Based on the Social Cognitive Career Theory (SCCT; Lent et al., 1994), the findings are related to both individual factors (e.g., career goal-making and career interests) and contextual factors (e.g., social support structures that favor women engineer's career advancement).

The results of the present study will help us to understand the factors that can promote women engineer's career advancement into leadership positions. Practical implications for career development and future leadership support programs for women engineers are also discussed.

Literature Review

Women engineers in Germany

This study refers to women engineers in Germany, where the under-representation of women engineers is particularly striking. Paradoxically, although Germany leads in gender-equality rankings (Global Gender Gap Report, 2020), it still has one of the world's highest gender gaps in technical fields (Stoet & Gary, 2018). Despite political efforts to get women interested in the technical profession and to keep them in there after their studies, only a few women in Germany pursue a career in engineering (Ihsen, 2010). In 2019, the proportion of women university graduates with a Master's degree in engineering was 24.8 % (Kompetenzzentrum Technik-Diversity-Chancengleichheit, 2020). The numbers vary depending on the engineering field. For example, in electrical engineering, the proportion of women was 15.3 %, in mechanical engineering 21.1 %, and in civil engineering it was at least 33.1 % (Kompetenzzentrum Technik-Diversity-Chancengleichheit, 2020). Even fewer women subsequently work in engineering. In 2017, the proportion of women employees in mechanical engineering was 18.1 % (Institut für Arbeitsmarktforschung, 2018). Finally, only 9.3 % of all leadership positions in mechanical engineering in Germany are held by women (Statista, 2020).

The under-representation of women in engineering in Germany has its origins in the historical development of the engineering profession, which systematically excluded women from the very beginning (Ihsen, 2010). In the nineteenth century, the German engineering culture was shaped by the concept of a 'male engineering instinct,' which was exclusively attributed to men and considered necessary for working as an engineer (Paulitz, 2014). This idea is still present today and leads to women being denied technical talent, which also affects the self-image of women (Jones et al., 2013; Hatmaker, 2013). For example, it has been shown that German women who work in a technical profession have a lower technical self-image (Pflugradt & Janneck, 2012).

The low proportion of women engineers in leadership positions is also related to conditions on the German labor market. Compared to other industrialized countries (e.g., European countries or the United States) women, and especially mothers, in Germany are less integrated into the labor market than men (Gangl &

Ziefle, 2015; Scheuer & Dittmann, 2007). This is due to Germany's generous family policy, which subsidizes the non-working housewife (Schober, 2014). Parental leave regulations, which lead to long career interruptions, and the German tax system, which supports single-earner families, contribute to the family concept of the breadwinning father and the mother as a second earner or even full-time mother (Gangl & Ziefle, 2015; Scheuer & Dittmann, 2007; Schober, 2014). In addition, the lack of compatibility between family and career in companies makes it more difficult for women to successfully develop their careers (Wippermann, 2010). Consequently, although women are as highly qualified as men, they are underrepresented in leading positions in the German economy (Allbright, 2020; Wippermann, 2010).

Promoting factors for women engineers' careers

In particular, research in the United States, the United Kingdom and Australia has tended to focus on the factors that contribute to the career success of women engineers, which are summarized below.

Cech et al. (2011) argue that the development of professional-role competence, which is the individual's confidence in their ability to fulfill professional requirements, is essential for women's persistence in the engineering professions. This concept is also related to self-efficacy expectations, which are identified as important factors for women in dealing with gender-specific barriers in the engineering profession (Buse et al., 2013; Fouad et al., 2011; Fouad et al., 2016). In addition, Fouad et al. (2011) highlight women's confidence in engineering tasks, confidence in their ability to control work culture, and confidence in their ability to combine family and work as promoting factors for career persistence.

In their study among women engineers, Ayre et al. (2013) find that engineers who pursue their careers in the engineering profession are self-confident in their engineering identity, feel part of the profession, and actively looked for appropriate work conditions that matched their expectations of interesting, challenging, and enjoyable work. It has also been shown that women engineers are mostly intrinsically motivated to pursue a career in engineering (Blickenstaff, 2005; VanAntwerp & Wilson, 2018).

Coping strategies—including the ability to learn and adapt to the rules of the engineering culture—contribute to the successful development of women's careers (Khilji & Pumroy, 2019). Accordingly, women are forced to adapt to their workplace environment to avoid a conflict between their role as women and their role as engineer (Powell et al., 2009). Wilkins-Yel et al. (2019) conclude that women in engineering use several resilient coping strategies, such as perseverance, assertiveness, or recognition of their strengths.

In addition to women's individual factors, it has been shown that the conditions in their environment also favor their persistence in the engineering profession. In this context, it has been confirmed that engineers who stay differ from engineers who leave the engineering career mainly through workplace support (Buse et al., 2013; Fouad et al., 2016). For example, organizational support, such as developmental opportunities, enhances women's self-efficacy and outcome expectations (Singh et al., 2013). Furthermore, a supportive work-life-balance culture can help to reduce women engineer's work-family conflict (Herman, et al., 2013; Martínez-Léon et al., 2018).

Although these studies have examined the persistence of women in the engineering workforce, there are no comparable investigations that explicitly analyze the promoting factors of women engineers who advanced to leadership positions. Therefore, this study analyzes some of the factors that can support successful women leaders in engineering in Germany.

Social Cognitive Career Theory

This study is based on the Social Cognitive Career Theory (SCCT; Lent et al., 1994), which presents a framework to understand career interest development, career choice-making, and career success in educational and occupational career paths. SCCT is widely used to explain science, technology, engineering, and mathematics (STEM) choices for women (Fouad & Santana, 2017). This theory is mainly applied to examine the decision to pursue a STEM career in high school and colleges; it is also increasingly being used to explain the career success of women in the STEM professions (Bekki et al., 2013; Buse et al., 2013; Fouad et al., 2016; Singh et al., 2013). In this study, SCCT is well-suited to explain the factors behind successful women engineers because it includes both individual and contextual factors to explain career development

processes. The foundation of SCCT is Bandura's (1986) Social Cognitive Theory, which considers the complex reciprocal influence of individuals, their behavior, and their social environments.

SCCT highlights the importance of the individual's capacity to shape their own career behavior, while it also considers the personal and environmental influences on the individual's career development (Lent et al., 1994). Individual factors include self-efficacy and outcome expectations that have an impact on career interest, goal setting, and finally the action that leads to career success. Self-efficacy expectations are defined as the individual's belief that they can achieve what they set out to do with their own competencies (Bandura, 1997). This includes the expectation to be able to control difficult situations autonomously. Persons with high-degree of self-efficacy and belief in positive outcome expectations are expected to develop and achieve more ambitious career goals. Further influencing factors include person inputs (e.g., socialization) and contextual influences (e.g., structural barriers, social support, and discrimination). SCCT assumes that these factors can influence the self-efficacy and outcome expectations, and that they can also impact on the individual's career choices (Lent et al., 1994).

Gendered social norms (e.g., gender-stereotyped assumptions about women's engineering or leadership skills) may have negative effects on women engineer's self-efficacy expectations or career interests, which could lead to lower career success (Buse et al., 2013; Cardador & Hill, 2018; Cech et al., 2011; Jones et al., 2013). Moreover, gender-specific barriers (e.g., a lack of support or incompatibility of career and motherhood) can have a negative impact on women's self-efficacy, career goal setting, and performance (Lent, 2005; Martínez-Léon et al., 2018; Weisgram & Diekman, 2016).

Socialization and environmental work conditions can influence women's ability to manage their careers, and therefore their career progression. The socialization of gender roles distorts the beliefs that men and women have in male- or female-dominated professions, which results in culturally defined career outcomes (Hackett & Betz, 1981). Furthermore, gendered beliefs and gender-specific barriers play a major role in women engineers' career advancement

because they are working in a male-dominated profession (Faulkner, 2009).

This applies in particular to the leadership development of women engineers. According to Ely et al. (2011), women face difficulties in constructing a leader identity because there is a mismatch between the abilities attributed to women and the abilities that are seen as relevant for leadership. Furthermore, gendered career paths, lack of promotion, and the absence of role models can all have an impact on a woman leader's identity work, which is essential for the successful development of leadership roles. The internalization of a leader's identity is an important factor for an individual's self-confidence and motivation to lead, their search for new opportunities to practice leadership, and their capacity for leadership development (Day et al., 2009).

The findings of previous studies on women engineers' careers and the SCCT have been used as guiding assumptions in this research about which factors can explain women engineers' career progression into leadership positions in Germany. In this study, it is expected that women engineers who achieve leading positions have a high-degree of self-

efficacy expectations related to their career development. Based on SCCT, it is assumed that this results in women having ambitious career orientations, career goal setting, and career strategies. Given that the adaptability to their work environment helps women engineers to develop their careers, it is expected that their ability to adapt the rules of the engineering culture also helps them to advance to leadership positions. It can be assumed that the interest in engineering tasks also plays a role here because this is an important factor for women who wish to establish themselves in the engineering profession. From the perspective of the author, these individual factors can help women to successfully develop their careers and achieve leadership positions in engineering professions. Considering that women engineers have to deal with gender-specific barriers, in this study it is also assumed that social support is an important contextual factor for women's career progression. Finally, SCCT is used as a frame to understand how women engineer's leadership development is influenced by individual and environmental factors.

Method

Qualitative research design

This study uses a qualitative approach to explore women's experiences and to reveal the subjective perspectives of their career development (Glaser & Strauss, 1967). The qualitative research procedure allows this study to focus on specific persons and situations, which helps to identify unexpected and implicit influences. The unique characteristic of this approach is that it enables a detailed understanding of the processes that are involved (Patton, 2002). This can also uncover social practices and construction processes of gender, therefore qualitative research is particularly suitable for capturing the experiences of women (Doucet & Mauthner, 2008). Eight semi-structured qualitative interviews have been conducted with women leaders in engineering to explore their experiences on their career paths, and to reconstruct their individual orientations and action strategies.

Participants

Table 1:
The interviewees' engineering degrees, management level, and age

Interviewee	Engineering Degree	Management Level	Age
I1	Chemical engineer	Team management	30
I2	Mechanical engineer	Head of department	51
I3	Electrical engineer	Management board	53
I4	Mechanical engineer	Team management	39
I5	Mechanical engineer	Head of department	61
I6	Mechanical engineer	Head of department (retired)	67
I7	Electrical engineer	Head of department (retired)	66
I8	Civil engineer	Project management	56

Three of the women had one child at the time of the interviews. All of the interviewees were born in Germany. Although these women discussed their career paths in terms of their gender identity, there were no indications of the influence of sexual orientations or cultural background. However, some of the women pointed out that the German work culture, and especially the German engineering culture to which they belong, is particularly male-dominated compared to other countries.

To identify appropriate interviewees, the Internet has been searched for successful German women engineers. The snowball sampling method was then used via the recommendations made by other interviewees. For the aim of the study, it was important to find information-rich individuals who have much experience with this topic. Therefore, an extreme case sampling was used to identify women who are particularly successful engineers (Patton, 2002).

The participants were specifically selected on the basis of their leadership position, age, and area of expertise. Women of different ages and management levels have been interviewed to represent their different perspectives on career development (O'Neil & Bilimoria, 2005). All of the women who participated in this study have completed a degree in an engineering subject and are employed in large companies. Leadership positions are defined as positions with personnel responsibility. The areas of expertise, management level and age of the interviewees are summarized in Table 1.

Data collection

Potential interviewees were initially contacted by email. All of the women who responded were highly interested in the study and were willing to be interviewed. This enthusiasm can be explained by the fact that, as one of the few women leaders in their profession, the respondents want to share their experiences to draw attention to the under-representation of women in engineering. Some of the interviewees are involved as experts in mentoring programs to support young women.

The aim of the interviews is to enable the women engineers to reflect on their own career path into

leadership positions, along with the conducive and impeding factors. The interviews were conducted on the basis of a semi-structured interview protocol. The questions focused on their career history, motivation to take leadership positions, career strategies to achieve leadership positions, challenges on the career path, and experiences of success and failure during their career development. Due to the explorative character of the study, open-ended questions enabled these women to report freely about their experiences. Face-to-face interviews were held at the interviewee's workplaces between February and April 2018, and each interview lasted between 35 and 66 minutes. All of the interviews were conducted by one researcher. With the women's agreement, the interviews were audio-taped, transcribed, and anonymized.

Coding process

The software program MAXQDA was used to code and analyze the interview data according to qualitative content analysis (Mayring, 2014). Therefore, the insights from the literature review were used as a deductive category assignment and the data material was examined with regard to the research leading assumptions that were developed from the theory. This resulted in a coding structure that includes the following codes: 'interest in engineering,' 'self-efficacy expectations,' 'adaptability to work environment,' 'career orientations,' 'career goal setting,' 'career strategies,' and 'social support.' The interview transcripts were reviewed several times and the data material was assigned to the codes. The content of the codes was developed out of the interview material. The advantage of this method is that there is an opportunity to reveal the content of any promoting career factors that are not included in the theory. The interviews were originally conducted in German and the interview passages cited in this paper have been translated by the author into English.

Empirical results

The data shows career success factors for women leaders in engineering on the individual and contextual level. Individual factors include their interest in engineering tasks, self-efficacy expectations, career orientations, adaptability to work environment, career goal setting, and career strategies. The contextual factors are related to social support structures in the private and work context.

Interest in engineering

Many of the women developed an intrinsic technology-related interest during childhood, which guided them on their adult career paths. Therefore, their passion for engineering themes can be understood as the primary factor motivating their career choice (Table 2).

Table 2:
Exemplary quotes for interest in engineering

Sub-Code and description	Engineer's quote
Reasons for choosing a career in engineering:	
Interest in subjects related to engineering	"I was always very good at mathematics, physics, and chemistry, and I was interested in tools." (I2, mechanical engineer and head of department)
Interest in doing practical work	"I have always been interested in practical work. It wasn't necessarily electro-technics, it was also painting, sculpting, screwing, tinkering, i.e. manual work. [...] That's why I wanted to do an apprenticeship as an electrician, and then study electrical engineering." (I3, electrical engineer on management board)
Influence of others	"My mother is a chemistry teacher and my grandfather was a professor of chemistry at the university. My uncle also works in this field. So, studying chemistry has always been a topic, but it was also my own interest." (I1, chemical engineer with first leading position)

All of the engineers narrate early preferences in subjects such as mathematics, physics, or chemistry as their career choice for engineering. Four of the engineers also refer to their practical and technical abilities (I2, I3, I5, I7) and two engineers even completed a technical apprenticeship before beginning their engineering studies (I2 and I3). These individual technology-related interests have been shaped by the social environment, especially by family members. Accordingly, almost all women report that they have parents, grandparents, or other relatives who have a technology-related profession.

Self-efficacy expectations

The engineers discussed several of their experiences that reflect their personal beliefs about their capabilities to perform in work life. High expectations of their own self-efficacy are expressed in the conviction of the women that they can achieve what they set out to do. For example, as shown in Table 3, they narrate how they control difficult work situations (e.g., conflicts with colleagues). They also explain how they self-manage their career paths to get new assignments and to reach more influential positions.

Table 3:
Exemplary quotes for self-efficacy expectations

Sub-code and description	Engineer's quote
Managing professional conflicts with colleagues:	
Through proactive confrontation	“There was a man who used to insult people in our meetings, me first. After the third meeting, I decided to play along. Then in the next meeting I said to him ‘Oh, you haven't insulted anyone today yet.’ Everyone laughed, I had everyone on my side and he was isolated. You have to endure difficult situations and you have to understand that these are games. That's not my game, but I have to deal with these realities, and I was able to do that.” (I5, mechanical engineer and head of department)
Finding a new job position:	
Through systematically addressing responsible persons	“I knew the chief engineer in the department I wanted to work in. So, I called him and asked him: ‘I heard that there will soon be a new position, I would be interested.’ And he answered: ‘Yes [...] I'll keep you in mind.’ I left my scent marks all over the company and half a year later the chief engineer called me. There were interviews for the positions as PVT manager and he invited me to an interview. It really worked and I got the job.” (I2, mechanical engineer and head of department)
Taking on new professional challenges:	
Through motivating oneself	“When I'm nervous, I always tell myself: I can do it, I can do it, I'm not stupid, I'm actually pretty good, and it has always worked so far. I also make comparisons with others and say to myself: he can't do this, he can't do that, but I am much better.” (I8, mechanical engineer and manager of a huge project)
Through willingness to take risks	“I just try things out. For example, I got an email about a program where you could apply to attend a conference in Colombia. I just applied and I got it. I just try it, even if it becomes a failure. My motto is: Don't ask for permission, ask for forgiveness. That was the same with my application here, because the job description didn't really fit. There were many things that I didn't actually fulfill. But I have tried and succeeded.” (I1, chemical engineer with first leading position)

The women's self-efficacy develops over the course of a career and is also a result of experiencing uncomfortable situations and failure. The engineers reflect on work situations and control them in such a way that they can achieve advantages for themselves. In this regard outcome expectations (i.e., the belief about the consequences performing particular behaviors results) are of importance. The engineers are prepared to take a risk in this regard, are not afraid of having responsibility, and are optimistic that they can accomplish their tasks.

Therefore, they are constantly facing new challenges, which automatically results in achieving more influential positions.

Adaptability to work environment

All of the engineers narrate how they had faced barriers in the male-dominated workplaces related to gender-stereotyped expectations and discrimination. However, they managed to deal with these challenges in a beneficial way by adapting to the work culture. The interview results

show how the adaptation of the behavior and appearance helps the women to be accepted by their colleagues (see Table 4).

Table 4:
Exemplary quotes for adaptability

Sub-Code and description	Engineer's quote
Adaptation of behavior:	
By taking part in conversations about status symbols	“You have to adapt to the practices of the profession to such an extent that you understand how the power relations are. For me, for example, it doesn't matter at all what kind of official car I drive. But if you sit with your colleagues at lunch and they talk about cars for an hour and you just say ‘I drive the Passat, dark blue,’ then you disqualify yourself from these networks [...] if you want the job, you have to play along. You have to keep an eye on the rules of the game. I have always remained curious and really enjoy my job.” (I3, electrical engineer on management board)
Adaptation of appearance:	
By dressing less feminine	“I'm working in an environment dominated by men [...] that's always a borderline between which I adapt and act like a man or like a woman. You can see that in my outfit. When I work in the factory, I'm very casual. If I'm just among engineers and give a presentation, I usually wear a plain pantsuit. I would never wear a miniskirt, but I always have open hair because it's a bit feminine.” (I2, mechanical engineer and head of department)

These women have the ability to react flexibly and they do not perceive their adaptation to their work environment as something unpleasant. However, they also critically deal with these rules because they are not always part of their self-image.

Career orientation

In addition to their interest in engineering topics, the women report on their career orientations in terms of the responsibility, autonomy, and challenges that have influenced their career choice for a leadership position (see Table 5).

Table 5:
Exemplary quotes for career orientations

Sub-Code and description	Engineer's quote
Responsibility:	
Desire for influence in organizational decisions	“Responsibility, participation, being involved at an early stage in the decision making, having one's own stamp, one's own ideal, and then being involved in shaping the organization. This is my motivation to reach leadership positions.” (I4, mechanical engineer and team manager)
Desire to shape male-dominated engineering work culture	“The higher I moved up in the hierarchy, the more I noticed the pecking order among the men. For example, when the chairman of the board called, everyone had to obey. That is not my leadership style. I had to accept these rules of the game up to a point; otherwise I wouldn't have made a career. But I didn't want to be opportunistic either. Being able to shape things was important to me. [...] And my influence is wider [...]

Autonomy:	when I am higher up in the hierarchy of an organization.” (I6, retired mechanical engineer, had several leading positions in different companies)
Desire for self-determined work	“I absolutely wanted to have a leadership position. And when I see my women colleagues who are so hesitant, then I don't understand it at all. Because it was always clear to me that this gives ME new degrees of freedom. As a leader, I can work the way I want to. In other words, I can work the way people should work together.” (I5, mechanical engineer and head of department)
Challenges:	
Searching for demanding and varied tasks	“I start to get bored when I do something longer, understand it, and the routine sets in. Every three or four years I need new challenges. Then I look for something new and that goes automatically to the top of the company. I think, this is the point by which women can recognize that they are suitable as leaders.” (I3, electrical engineer on management board)

These engineers are motivated to participate in organizational decisions, to coordinate employees and to achieve more discretionary power. Their ambitions also include the motivation to shape organizational conditions to become more independent of the male-dominated engineering work culture. Working at higher levels of management enables women to work autonomously without external restrictions. Moreover, these engineers are motivated to overcome any obstacles, and therefore are constantly searching for challenging and novel tasks. It is these women's

openness and willingness to take risk that helps them to take on new responsibilities and advance in their careers.

Career goal setting

These women engineers discuss how they choose career goals and actions to advance in their careers. They state that although they did not plan their careers, they regularly reflect on their careers and their future career goals for the next few years (see Table 6).

Table 6:
Exemplary quotes for career goal setting

Sub-Code and description	Engineer's quote
Reflection of career goals:	
With regard to career advancement	“Every two or three years I reflect on my career path so far. Do I want to continue my current job? Do I want to work on a different topic or do I want to advance one career level? Then I take a week, reflect, and write down in which department I would like to work. And then I check who I know in the department so that I can contact them.” (I2, mechanical engineer and head of department)
With regard to balancing conflicts between career goals and private goals	“I participated in an assessment center. It was about moving up to the next management level. The last question was ‘would you move to an international location?’ I did not want to do this to my daughter. So, I denied and for that reason I was downgraded one level. I just lived with less money, but I did not care. I never made that compromise. [...] I am proud that I resisted saying that I want to go to the top of the company right now. [...] Then I would have been on the board eight years earlier. I

did not want that because of my family.” (I3, electrical engineer on management board)

These results show that the engineers' career goals can collide with private goals. As I3 reports, having a young child affected her decision for international mobility and therefore her choice for career advancement. This interviewee preferred meeting the needs of her daughter to her goals of career advancement and higher salary. Due to the requirements for leadership positions (e.g., long work hours, linear career path or mobility), reconciling motherhood and a leadership position can be a challenge for engineers who have or want to have children. These engineers are aware of the conflict between family and career, but nevertheless manage to adapt both life worlds to each other.

Their ability to handle different goals at the same time contributes to these women's career success.

Career strategies

With regard to career strategies, the focus is on the search for new jobs, projects, or other challenges. These women report that they have become active and demanded the jobs or projects that they wanted. In this context, these women report career strategies such as conscious impression management or proactive networking with colleagues (see Table 7).

Table 7:
Exemplary quotes for career strategies

Sub-code and description	Engineer's quote
Impression management:	
In the sense of conscious control of the own image and visibility within the company	“I practice self-marketing. I want to be responsible for people, and I have to communicate and demand that. I have to talk about it, because no one else does that for me. So, I try to be very present. I know that career promotion has a lot to do with how you are perceived by others. In our company, there is an unofficial list of people who are suitable for new responsible positions. I try to get my name on that list.” (I4, mechanical engineer and team manager)
Networking:	
The systematic building and care of influential professional contacts in order to attract attention in the company	“I try to keep in touch with my old colleagues. For example, I'm at the managing director's meeting in my old company every Monday. I take the opportunity to go out for coffee in the cafeteria and see who I meet. At the moment I'm thinking about developing my career. For example, last week I was sitting in the cafeteria, when one of the managing directors came in and sat down. Then I briefly pointed out that I would like to have a new position again. If he had an open position in the future, he would remember me and get back to me.” (I2, mechanical engineer and head of department)

By communicating their career goals, these women attract the attention of potential gatekeepers who can offer them new positions. They also highlight the importance of networks and reciprocal engagement with colleagues. This aspect focuses on increasing the women's own visibility as competent

engineers in the company. This is particularly important for women, who tend to be less trusted with technical competence and leadership skills.

Social support

All of these engineers have experienced gender-specific barriers and discrimination in their work environment during their careers. For example, they were denied technical competence, were not perceived as leaders, were excluded from networks dominated by men, or had difficulties in

combining their motherhood with their career. However, these women recalled individuals in their private and work context who had positively influenced their career decisions and who had helped them to overcome barriers to achieve their career goals, mainly supervisors, colleagues, and husbands (see Table 8).

Table 8:

Exemplary quotes for support of others

Sub-code and description	Engineer's quote
Support of supervisors:	
With strategic career development	"I had a good support, I had in the first three years my boss, who supported me very strongly and also thought about what next steps would be possible for me. He supported me in my move to the first leadership position." (I1, chemical engineer with first leading position)
Support of colleagues:	
For work related questions	"I have three or four persons in my network with whom I reflect on professional problems and decisions. [...] So, we coach us [...] but you have to choose these persons well." (I3, electrical engineer on management board)
For gender-specific challenges	"I have a women's network, because it's different whether I speak to women or men about professional issues. I wouldn't talk to my boss about family planning in terms of career and I don't have a male colleague to talk to about it. So, I tend to discuss with women about it." (I1, chemical engineer with first leading position)
Support of husbands:	
With child care	"The pregnancy was an obstacle, because I didn't know if I still had a chance to get a leading position with a child. I was away from work for a year, which was deliberately not much, because I knew that I had the support of my husband. He then stayed at home for years and took care of our daughter." (I3, electrical engineer on management board)

All of these women report that the support of a person in their work environment (e.g., a supervisor) has been the most important, and even necessary, factor for their career advancement; for example: "Without the support of a sponsor, career advancement is virtually impossible" (I6, retired mechanical engineer). These 'sponsors' mainly help the women to find responsible positions and give them access to networks. These engineers mostly get emotional support from colleagues to deal with professional problems. However, the support of

homogeneous women's networks has a special significance because it allows them to talk about gender-specific challenges, such as the reconciliation of motherhood and career. These women's husbands also played a major role in buffering the challenges of the compatibility of motherhood and career development. All of the engineers who have a child, either have or have had a husband who has taken over a large part of the childcare.

Conclusions

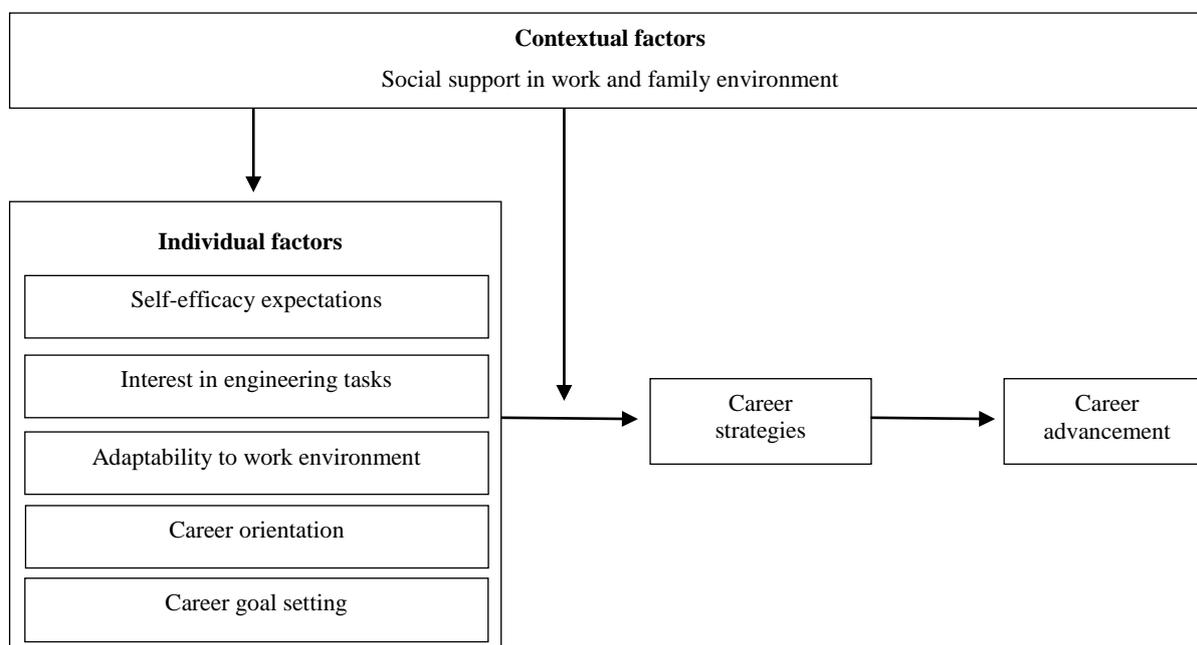
These results show some of the individual and contextual success factors that can have an impact on women engineer's career decisions, career development, and finally on their career advancement to leadership positions.

The women who were interviewed have an intrinsic interest in technical tasks and are orientated towards responsibility, autonomy, and challenges in their careers. They also show high self-efficacy expectations and are able to adapt to the engineering work environment. Furthermore, these engineers distinguish themselves by reflecting on their careers and setting career goals. Finally, these women put their career goals and wishes into action by making use of career strategies such as impression management and networking. These individual success factors are positively influenced by social support structures on the contextual level. Therefore, these women engineers are mostly

supported by their supervisors, colleagues, and in some cases by their husbands. These individuals encourage these women to manage their careers and to achieve their career goals, despite gender-specific barriers such as gender-stereotyped expectations and incompatibility of motherhood. The findings also show that persons in the family environment have already positively influenced the choice of an engineering profession. Overall, the results indicate that the career success of these women cannot be attributed to single aspects, but that several factors on the individual and contextual level facilitate the career advance of women engineers.

Based on the SCCT (Lent et al., 1994), these findings are integrated into a model that explains women engineer's career advancement to leadership positions (see Figure 1).

Figure 1:
Model of career advancement



This model shows the interaction of individual and contextual career success factors. Accordingly, women's individual career interests and their career choice-making are positively influenced by the social support of persons in the work and family environment. In this regard, it is

the social capital that determines these women engineer's career development (Seibert et al., 2001). Therefore, women engineers have the capacity to manage their own career behavior, but the support of others helps them to unfold their interests and to implement them into actions (Lent,

2005). Furthermore, women can influence the male-dominated structures in the engineering profession in the long term by pursuing their career goals. These results demonstrate that the success of women's career strategies (e.g., impression management and networking) depends on the support of colleagues, supervisors, and gatekeepers. The support of others is an important success factor in the engineering work environment because they can buffer the negative effects of gender-specific challenges on women's careers. These findings are consistent with previous studies on women's persistence in engineering professions, which highlight the relevance of workplace support to enhance women's self-efficacy (Fouad et al., 2016; Singh et al., 2013), and possibilities to combine work and family and career (Herman, et al., 2013). Support in child care is especially important for women leaders in Germany because there is a lack of organizational support for working mothers (Schober, 2014). Greensbank

Self-efficacy expectations also play a central role in women engineer's career development because it helps them to cope with difficult work situations, to adapt to the engineering work culture, and to pursue their career interests, orientations, and goals. Self-efficacy expectations also contribute to the women engineers' belief that they have a chance to control their work environment. While these findings agree with the previous results on women's persistence in engineering professions (Ayre et al., 2013; Buse et al., 2013; Cech et al., 2011; Fouad et al., 2011; Fouad et al., 2016), the present study goes further and argues that high self-efficacy expectations are especially decisive for women engineers who wish to achieve influential leadership positions in industrial companies. Furthermore, high self-efficacy expectations could help women in Germany to assert themselves against the widespread prejudice that women have no technical talent (Pflugradt & Janneck, 2012).

There are two aspects that especially explain these women's success in leadership careers. First, the requirements of a leadership position meet these women's career orientations towards responsible, autonomous, and challenging tasks. Schein (1996) argues that conformity between career orientations and work environment

results in employee's stable career development and positive career outcomes. In this respect, it can be assumed that women leaders realize personal values in work activities, thus building a sense of meaningfulness and finding fulfillment in their professional careers. Moreover, the intrinsic interests in engineering and the intrinsic motivation to achieve leadership positions contribute to women's career ambitions, and finally career success (Ryan & Deci, 2000; VanAntwerp & Wilson, 2015).

Second, the proactive career behavior that includes career planning, career goal setting, and developing an appropriate career strategy helps these women to achieve leadership positions (Crant, 2000). In this respect, networking is the volition to build and maintain social networks that could provide access to career-related resources, such as information or support (Wolff & Moser, 2009). Given that women in engineering often have less access to influential male-dominated networks, proactive networking is particularly important for them because it helps them to successfully become established in their profession.

Practical implications

This study's results indicate implications that could promote women's career advancement towards leadership positions in engineering professions. Based on the SCCT (Lent et al., 1994), it is important that the implications include both individual and contextual factors to enable women engineers to progress to leadership positions.

On the individual level, the promotion of self-efficacy might be an important factor to enhance women's capacity to self-manage their careers. One possible approach for increasing self-efficacy could be to offer women developmental opportunities. Women engineers should be encouraged to follow their career orientations and ambitions, and to seek for opportunities to continuously improve their technical and management skills (Schein, 1996). Therefore, women in engineering should be empowered to become aware of their career orientations and to achieve their career goals, despite gender-specific barriers. Career counselors could help women in reflecting on their careers, setting career goals, and

developing appropriate career strategies to achieve their goals.

It is expected that individuals are more likely to follow their career goals if they perceive career autonomy and supportive environmental conditions (Lent, 2005). Therefore, in addition to promoting women in their career development, it is also important to create work environments that meet these women's needs. For example, autonomy-supportive work environments that include the possibility for self-determined work could enhance women's career motivation (Gagné & Deci, 2005), and supportive work-life-balance cultures could help to reduce women engineer's work-family conflict (Herman, et al., 2013; Martínez-Léon et al., 2018).

As the results of the present study show, the social support of others has a considerable impact on women's ability to achieve leadership positions. Therefore, leadership development programs could help women engineers to build and use strong networks (Ely et al., 2011). Furthermore, colleagues and supervisors could also be included in the leadership development of women. One possibility is a 360-Degree Feedback and Coaching program, which allows peers and bosses to give feedback to a manager (Ely et al., 2011). This program could increase the women's self-knowledge as leaders and their colleague's

awareness of their impact on women's career chances. Therefore, it would be beneficial to critically reflect on gender-stereotypes concerning engineering and leadership competences.

Limitations and further research

The present study provides an overview of the career success factors for women engineers in leadership positions. Because of its explorative character, the small number of participants, and the extreme case sampling, the findings cannot be generalized for all women engineers. Furthermore, because the research results only concern women from Germany, they are not easily transferable to other countries. However, the results do indicate further research possibilities. For example, in further investigations women engineers in leadership positions could be compared to women engineers who do not have leadership positions. This could help to specify the factors that contribute to leadership careers in engineering. Additionally, quantitative studies could analyze the influence of self-efficacy, intrinsic interest in engineering, career orientations, career goal setting, adaptability, career strategies, and social support on women's career advancement to leadership positions in engineering in more detail.

About the author

Miriam Schmitt is a research assistant at the Center for Higher Education at the TU Dortmund University. She holds a Master's degree in Educational Science and Gender Studies, and is

currently researching the careers of women in the STEM (science, technology, engineering, mathematics) professions.

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