

What's driving them? A qualitative approach to explore women entrepreneurs' motivations in STEM

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Abstract

Purpose – Entrepreneurship and the disciplines of science, technology, engineering and mathematics (STEM) are considered important drivers of innovation. At the same time, the representation of women entrepreneurs in STEM remains low. Despite this disparity, a number of women still choose to start ventures and persist in pursuing their innovations in STEM. This study aims to examine the motivational factors that drive women entrepreneurs to approach and consistently pursue their innovations and ventures in STEM.

Design/methodology/approach – Drawing on the concept of the heterogeneity of motivational factors (Graham and Bonner, 2022) and Social Cognitive Theory (Bandura, 1986, 2001; Wood and Bandura, 1989), 24 semi-structured interviews were conducted with women entrepreneurs in STEM. This approach allowed for an in-depth exploration of the heterogeneous motivational factors influencing women entrepreneurs in STEM.

Findings – The motivations of women entrepreneurs in STEM are multifaceted, interrelated and dynamic. They encompass personal and cognitive, behavioral and environmental factors and partly change over time. This study reveals two levels of heterogeneity: the heterogeneity of women entrepreneurs' entrepreneurial motivations, and the within-context heterogeneity of women entrepreneurs in STEM themselves.

Originality/value – This study addresses the need for a deeper understanding of women entrepreneurs in STEM. By focusing on nuanced aspects of entrepreneurial motivations that are often overlooked in the existing literature, this research provides valuable insights and discusses implications for theory, policy and education.

Keywords Women entrepreneurship, STEM, Entrepreneurial motivation, Heterogeneity

Paper type Research paper

Introduction

Innovation has the potential to create added value and thereby significantly contribute to a society's well-being (OECD/Eurostat, 2018). Specifically, the disciplines of science,

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technology, engineering and mathematics (STEM) are viewed as major drivers of innovation (Kuschel *et al.*, 2020). However, there is still an underrepresentation of women, and consequently, women entrepreneurs in STEM (de las Mercedes Barrachina Fernández *et al.*, 2021). Increasing the number of women entrepreneurs in STEM is not only important for the sake of equality but also has the potential to drive innovation and is therefore crucial to the economy as a whole (Dai *et al.*, 2019; Madison *et al.*, 2022). Empirical evidence highlights the significant role of women entrepreneurs in innovation processes, as they offer unique perspectives that complement those of their male counterparts (Dai *et al.*, 2019). Moreover, their participation is linked to increased investment in innovation, underscoring their contribution in driving innovation and economic progress (Bauweraerts *et al.*, 2022).

The underrepresentation of women entrepreneurs in STEM has been a major focus of academic research. Studies highlight that the gendered nature of STEM contexts influences women entrepreneurs (Marlow and McAdam, 2012; Ozkazanc-Pan and Muntean, 2018). Building on these findings, recent research has focused on understanding the experiences of women entrepreneurs in STEM, specifically examining decision-making processes, support factors and motivational antecedents (Ármane *et al.*, 2021; Schneider, 2021; Pascher *et al.*, 2015). Despite growing recognition of women's entrepreneurial heterogeneity (Owalla *et al.*, 2021; Henry *et al.*, 2021), a significant proportion of academic research on women's entrepreneurship and their motivations in STEM continues to employ binary male-female comparisons (Iffländer *et al.*, 2018; Pascher *et al.*, 2015). This neglects their nuanced within-group differences (Henry *et al.*, 2021). Furthermore, Welter *et al.* (2017) and Poggesi *et al.* (2020) address a significant shortcoming in the current understanding of (women's) entrepreneurial motivations: They argue that much of the existing research tends to oversimplify the motivations behind (women's) entrepreneurial endeavors, categorizing them into a framework of necessity versus opportunity. This dichotomy, while convenient, obscures the rich heterogeneity of motivational factors that drive individuals to engage in entrepreneurial activities (Douglas *et al.*, 2021; Graham and Bonner, 2022). It is therefore important to further analyze the heterogeneity of women's entrepreneurial motivations, as insufficient knowledge in this regard leads to standardized public policies and programs that do not address specific needs (Henry *et al.*, 2021).

While previous research on the motivations of women entrepreneurs has primarily focused on reasons for starting a business (Ármane *et al.*, 2021; Iffländer *et al.*, 2018; Adikaram and Razik, 2023), entrepreneurship, in general, is increasingly viewed from a process perspective, including all the stages from entry to exit (Burton *et al.*, 2016; Schjoedt and Shaver, 2019). Supporting this perspective, current research shows that entrepreneurial motivation is not static, but evolves across the different stages of entrepreneurship (Murnieks *et al.*, 2020). This evolving motivation is particularly important in the context of women entrepreneurs, as women are more likely than their male counterparts to voluntarily exit their businesses (Justo *et al.*, 2015), revealing gendered challenges. Consequently, Brush *et al.* (2022) call for more research on changes in the motivations of women entrepreneurs over time. Given the gendered context and the challenges faced by women entrepreneurs in STEM, the changing motivations of women entrepreneurs in STEM and the potentially heterogeneous factors that drive them to continue working on their innovations and ventures in highly gendered STEM contexts have not been thoroughly explored (Kuschel *et al.*, 2020). Addressing the identified research gaps is crucial to enhance the academic discourse on motivational heterogeneity and motivational change among women entrepreneurs, particularly in STEM. It is also important to facilitate the development of tailored policies and support mechanisms throughout women's entrepreneurial journeys, acknowledging that "one size (still) does not fit all" (Henry *et al.*, 2021, p. 609). Against this background, we ask:

What are the (heterogeneous) motivational factors that drive women entrepreneurs in STEM to approach their innovations and ventures, and how do these motivations change over time as women

We base our research on the motivations of women entrepreneurs in STEM on Social Cognitive Theory (SCT) (Wood and Bandura, 1989; Bandura, 1986, 2001), while acknowledging motivational heterogeneity (Douglas *et al.*, 2020). According to SCT, an individual's motivation and actions are influenced by a dynamic interplay of personal and cognitive, environmental and behavioral factors. SCT has been employed in numerous studies to examine entrepreneurial engagement (Camelo-Ordaz *et al.*, 2020; Boudreaux *et al.*, 2019). In our study, SCT serves as a lens to explore the motivations that drive women entrepreneurs to approach and consistently pursue their innovations and ventures in STEM. The idea of interweaving this perspective with the concept of motivational heterogeneity for a fine-grained analysis was recently proposed by Graham and Bonner (2022), and guides our analysis, with the aim of uncovering the nuanced dynamics that influence women entrepreneurs in STEM.

Our research contributes to both theory development and a broader understanding of women entrepreneurs' motivations in STEM. Our findings show that motivations of women entrepreneurs in STEM are multifaceted, interrelated and dynamic. Their motivations include personal and cognitive, behavioral and environmental factors. Interestingly, while certain motivations remain stable, others, such as an inner drive or a sense of constraint, change or emerge over time. Additionally, we illustrate both the heterogeneity of women entrepreneurs' motivations and the within-context heterogeneity among women entrepreneurs in STEM themselves. We define this within-context heterogeneity as the differences among the group of women entrepreneurs in STEM, particularly, as a result of the challenges they face. Structural, institutional and sector-specific dynamics and challenges contribute to this within-context heterogeneity, especially between those women entrepreneurs who offer non-software products and those who offer software products. This within-context heterogeneity can also influence the motivation of women entrepreneurs in STEM.

Literature review

Current situation for women entrepreneurs in STEM

Research on the low involvement of women in entrepreneurship and skewed women participation in STEM began in the 1990s (Marlow and Martinez Dy, 2018; Blickenstaff, 2005). Explanations for the underrepresentation of women entrepreneurs in STEM are complex and multifaceted, often related to the masculinized contexts of STEM and entrepreneurship (Wheadon and Duval-Couetil, 2019; Bijedić *et al.*, 2016). Consequently, research has delved into the concepts of gender, technology and entrepreneurship to better understand their interactions (Wheadon and Duval-Couetil, 2019). Findings indicate that apart from facing similar obstacles as other novice entrepreneurs (Treanor, 2022), women entrepreneurs in STEM encounter gender-specific challenges, such as inequality in networking (Ozkazanc-Pan and Muntean, 2018) and struggles with balancing motherhood and entrepreneurship (Marlow and McAdam, 2012). Therefore, entrepreneurship in these contexts remains a gendered phenomenon.

Due to the limited number of women entrepreneurs in STEM and the difficulty of accessing them for research purposes, previous studies on women's entrepreneurship in STEM have primarily been conducted in business incubation contexts and various fields of technology (Treanor, 2022; Poggesi *et al.*, 2020). Other disciplines and industries within STEM are still under-explored (Treanor, 2022). To improve contextualization among women entrepreneurs in STEM, Poggesi *et al.* (2020) suggest that future research differentiate between academic women entrepreneurs who have identified entrepreneurial opportunities within their academic research fields, leading to the establishment of their own STEM ventures, and non-academic women entrepreneurs, who have chosen to start and manage a STEM venture for diverse reasons.

Motivations of women entrepreneurs in STEM

There is scholarly consensus that entrepreneurial motivation is a crucial driver for the creation and continuation of a company, with a significant impact on its performance (Murnieks *et al.*, 2020; Kuhn and Galloway, 2015). Entrepreneurial motivation has therefore been widely researched (Carsrud and Brännback, 2011; Murnieks *et al.*, 2020). A well-known dichotomy in this context is represented by the so-called entrepreneurial push and pull motives and necessity (push) and opportunity (pull) driven entrepreneurs (Buttner and Moore, 1997; van der Zwan *et al.*, 2016). The former concept implies that individuals are forced into self-employment by adverse life circumstances (O'Donnell *et al.*, 2021). Conversely, the latter concept suggests that individuals are attracted to self-employment through the identification or creation of market opportunities (Hansen *et al.*, 2011). However, this dichotomy is criticized for being overly simplified (Welter *et al.*, 2017; Poggesi *et al.*, 2020). With regard to women entrepreneurs in STEM, initial approaches confirm the co-existence of push motives (such as changing one's own employment conditions) and pull motives (such as social reasons) (Iffländer *et al.*, 2018; Pascher *et al.*, 2015; Ármame *et al.*, 2021). Against this backdrop, Poggesi *et al.* (2020) call for a more in-depth study of women entrepreneurs' motivations in STEM, as the often-mentioned distinction between opportunity and necessity entrepreneurship can be overcome in their case.

Previous research shows that women entrepreneurs in STEM do not necessarily start their ventures with the primary aim of creating wealth (BarNir, 2012; Ármame *et al.*, 2021). Non-monetary factors, such as the idea of making a difference in the common interest and bringing about social change, can sometimes exceed the importance of financial outcomes (Iffländer *et al.*, 2018). However, financial incentives are also perceived as motivating (Ármame *et al.*, 2021). Other drivers include professional growth and cooperation (Amon, 2017), the opportunity to innovate and have a certain leeway (Kovaleva *et al.*, 2023), recognizing opportunities and using one's own know-how (Ármame *et al.*, 2021; Adikaram and Razik, 2023) and the general appeal of entrepreneurship (Ármame *et al.*, 2021; Adikaram and Razik, 2023). Key drivers for entrepreneurial entry in STEM for women also encompass learning experiences and related competencies, as well as entrepreneurial and management experiences (Schneider, 2021). Moreover, an early interest fostered by practical experiences seems to enhance the possibility of a career in STEM (Schnittker and Ettl, 2021). Women entrepreneurs' intentions for starting their ventures in STEM are also influenced by entrepreneurial self-efficacy, a supportive social context and entrepreneurial learning (Barron and Ruiz, 2021; Elliott *et al.*, 2020).

While such motivations are not unique to women in STEM and play a significant role for other entrepreneurial groups as well (Douglas and Prentice, 2019; Douglas *et al.*, 2021), the value placed on these drivers varies across gender and context (Hechavarría *et al.*, 2017). For example, research suggests that men primarily expand new ventures in pursuit of financial prosperity, whereas women have multiple motivations for seeking growth, with financial success being only one of them (Manolova *et al.*, 2012). The complexity of understanding women entrepreneurs' motivations in STEM is compounded by the realization that motivations traditionally considered gender-neutral, such as opportunity recognition and passion, are influenced by gendered expectations and cultural norms (Swail and Marlow, 2018; Hechavarría *et al.*, 2017).

The existing body of literature provides insights into the motivations that drive women entrepreneurs in STEM, but it lacks a comprehensive understanding, especially regarding the motivational heterogeneity and how motivations change over time. This limitation obscures the full range and complexity of factors that drive women entrepreneurs in these fields. Given the gendered contexts that women in STEM face (Treanor, 2022), there is a need for a more in-depth investigation of the potentially heterogeneous motivational factors that drive women entrepreneurs in STEM as they approach their innovations and ventures, and how these motivations change over time as they continue to pursue their endeavors (Poggesi *et al.*, 2020; Kuschel *et al.*, 2020).

Methodology

In order to gain deeper insights into the (changing) motivations of women entrepreneurs in STEM, while acknowledging motivational heterogeneity, we used an inductive qualitative approach in the form of semi-structured interviews. This approach was suggested by [van Burg et al. \(2022\)](#) in their review on advancing qualitative entrepreneurship research, particularly, for exploring heterogeneity. In terms of context, it is important to consider regional specifics ([Welter, 2011](#)). Germany is considered particularly interesting as a reference country for this study because it has an internationally recognized record of innovation, but at the same time, its approaches to improving gender equality have, as of yet, had little effect ([Iffländer et al., 2018](#)).

Sample

To date, “women’s STEM entrepreneurship” has not been uniformly defined ([Kuschel et al., 2020](#), p. 11). We define women entrepreneurs in STEM in accordance with [Martin et al. \(2015, p. 543\)](#), who describe them as women who “have created a business, are actively involved in its management and [...] beyond the initial set-up phase.” Our sample consists of 24 women entrepreneurs from Germany who self-identify as such, have founded a venture in STEM (alone or as part of a team), are still active as board members and have indicated that their venture was at least in the transition from the launch to the post-launch phase ([Baron, 2007](#)).

To account for within-group differences ([Welter et al., 2017](#)), we used purposeful sampling. Accordingly, women entrepreneurs from a variety of industries were recruited: engineering, AI development, software as a service, biotechnology, digital health tech, MedTech, educational tech, deep tech and other tech sectors. We also ensured a diversity of perspectives by selecting women entrepreneurs who varied in age, educational background, maturity of their venture, entrepreneurial experience, and founding team composition. Additionally, we included women entrepreneurs with non-STEM educational backgrounds, but ventures in STEM, as research has shown that complementary knowledge is a key success factor for new business opportunities in STEM co-founding teams ([O’Connor et al., 2006](#)). Therefore, we also considered the motivational factors of these women entrepreneurs in STEM.

Procedure

The sample was identified through online research and recruited via email and professional social networks. In designing the study, we deliberately asked about gendered experiences only at the end of the interview. This approach was implemented to reduce the potential for bias, allowing gender considerations to be subtly integrated into the analysis without overtly influencing interviewees’ responses. The main topics examined included the women entrepreneurs’ career paths, their initial motivations for approaching their innovations and ventures in STEM, current motivations for consistently pursuing their activities and perceived support sources and challenges along the way. The interview guide was pre-tested with three entrepreneurs in STEM. All interviews lasted approximately 1 hour and were recorded and transcribed. In order to consider the limited time available to the interviewees, all interviews except one were conducted online via video conference. One interview was held in person at the request of the interviewee for a face-to-face interaction. To facilitate a personal and open exchange, the interviews were conducted in German. The quotes in this paper were translated into English by the team and verified for accuracy by a professional English native speaker proficient in German.

Data analysis

The interviews were analyzed and coded using MAXQDA Analytics Pro 2022. The analysis process was guided by the methodology outlined by [Gioia et al. \(2013\)](#), which provides a structured yet adaptable framework for analyzing qualitative data in an inductive manner. This

method involves a three-stage process: first, the identification of first-order concepts (informant-centered), the establishment of second-order themes (theory-centered) and the formulation of aggregate dimensions, which are then organized into a data structure. Second, the construction of a theoretical model based on the data structure, and third, the interpretation of the findings, highlighting direct quotations, second-order themes and aggregate dimensions.

At the beginning of the interviews, we initially planned to examine the various motivational factors that arise during pre-launch, launch and post-launch phases (Baron, 2007). However, the interviewees pointed out that a venture's development is not always a straightforward process following these phases and their characteristics. This realization prompted us to shift our approach to a two-part investigation of motivational factors: those that drove our interviewees to approach their innovations and ventures in STEM, and those that drove them to consistently pursue their activities. Additionally, we conducted a detailed analysis of the individual interviews and compared them across cases. This allowed us to delve into the heterogeneous drivers and reasons for changes in motivation. Drawing on SCT (Wood and Bandura, 1989; Bandura, 1986, 2001), we clustered our findings into personal and cognitive, environmental and behavioral factors. According to SCT, personal and cognitive factors include aspects of self-efficacy and personal goal setting. Behavioral factors center on experiences of mastery, while environmental factors highlight the importance of social contexts and their impact on personal agency (Wood and Bandura, 1989). To ensure investigator triangulation (Flick, 2011), all interviews were coded by two team members using the same coding framework. Any differences in coding were then the subject of discussion.

Results

Our analysis procedure, along with the corresponding code formations, is presented in Table 1 (Source: Authors' own work). Figure 1 (Source: Authors' own work) provides a visual summary of our results. The detailed explanation of the visual summary follows in the next section.

Personal factors

Confidence – We found that a deep sense of confidence was an important factor for our interviewees to approach their innovations and ventures in STEM. This confidence was primarily based on entrepreneurial self-efficacy. Our research also shows that this self-efficacy grew over time, motivating women entrepreneurs to consistently pursue their innovations and ventures in STEM. One interviewee stated: “*I trust my abilities more and more and just know that somehow everything has worked out well so far*” (E9:62), showing her increasing confidence from positive past experiences. In addition, nearly all interviewees emphasized the importance of opportunity recognition in their approach to innovations and ventures in STEM. Looking back, some interviewees also acknowledged that a sense of security, such as financial backing or a backup plan, gave them the confidence they needed to start their entrepreneurial journey.

Inner drive – Most of the interviewees cited an inner drive, rooted in intrinsic motivation and passion, as a fundamental reason for approaching their innovations and ventures in STEM. One interviewee described this as: “*We were so passionate about this idea that I just said – we’re going to do it now*” (E10:28). A certain sense of risk-taking was also highlighted by some of the women entrepreneurs. They explained: “*A bit of that pioneering spirit. Yeah, it’s great, let’s do it. That kind of adventurous approach*” (E22:56). In particular, while intrinsic motivation remained a stable motivator for consistently pursuing their innovations and ventures in STEM, the emphasis on passion and risk-taking seemed to diminish as their ventures matured. Instead, a strong sense of perseverance and hope for success emerged as key motivators. As one interviewee described her perseverance: “*Giving up is not an option and I*

Table 1. Data analysis

Illustrative quotes	Second-order themes	Aggregate dimensions
<i>Personal factors</i>		
<i>Women entrepreneurs' motivations for approaching innovations and ventures in STEM</i>		
I knew what I could do and that I could think analytically. I know the problem and I [...] can also deal well with defeat. That was also a very important aspect for me. I knew that it was possible. (E17:40)	Self-efficacy	Confidence
It really came out of necessity. [...] there was nothing at all at that time. (E9:20)	Opportunity recognition	
I already have a certain amount of experience and a track record that works in my favor, because I said to myself, even if it doesn't work out, if you come back to the company in two years, well, okay, you can still do it. [...] And I think having that comfort or knowing what you can do and knowing that you can bounce back in a lot of areas has at least made this a little bit more comfortable for me from a risk perspective. (E2:38)	Sense of security	
We just wrote a business plan, went to the [pitch], ended up in the interim awards and thought "yeah, it's kind of cool and it's fun". (E19:16)	Intrinsic motivation	Inner drive
I think the very first phase was mainly driven by curiosity. I just wanted to try something out. (E7:28)	Risk taking	
I was very passionate about the subject. (E6:156)	Passion	
<i>Women entrepreneurs' motivations for consistently pursuing innovations and ventures in STEM</i>		
Yes, of course it has grown a lot. I have more experience now and I think I'm in a good position at the moment. (E5:54)	Increased self-efficacy	Confidence
I enjoy it. I've been doing it for a few years now. I think it's great. (E13:72)	Intrinsic motivation	Inner drive
Sometimes you just have to wait. [...] And then sometimes you just have to keep going before it gets better again. Even if you didn't think it would, somehow it always gets better. (E3:78)	Perseverance	
That's what kept us going: Maybe the hope that it would work out, or the belief that it would work out in the end. (E18:46)	Hope for success	
No, I think I can really say that I don't see any other alternative at the moment. (E14:80)	Lack of alternatives	Constraint
And then the fear of failure [...]. Of course, as an achiever, it just drives you to keep going. (E1:42)	Fear of failure	
What has always held me back is my sense of responsibility to the investors. I have always felt that they gave me their money and told me they trusted me [...]. Then I said: "This is their money and this is my job to try everything to make it work". (E2:50)	Entrepreneurial commitment	

(continued)

Table 1. Continued

Illustrative quotes	Second-order themes	Aggregate dimensions
<i>Cognitive factors</i>		
<i>Women entrepreneurs' motivations for approaching innovations and ventures in STEM</i>		
I have to honestly say that my two bosses, who were both male, often made decisions that I couldn't really understand and I really saw all the potential in this area of industrial AI. (E1:6)	"Push"-factors	reconsidered
I found it all very exciting from a technological point of view. (E7:28)	Technological interest	Innovation
We do want to be there when this technology arrives in the industry [...] (E12:8)	Practical orientation	
I immediately saw the purpose of the product and that you could somehow make people happier – just the fact that it makes them laugh again when they are in a really sad phase. (E18:26)	Social value creation	Social impact
I saw the fascination and also the necessity that we just have to change something about the environment. (E19:26)	Environmental value creation	
That also goes back a little bit to the idea of impact that I described at the beginning: to say that you are creating something that solves a problem somewhere and you are helping people with it. So, you have an impact, though not in the classic business sense, but for your own value creation. I think that's the main motivation for me. (E2:40)	Sense of purpose	
You can become a potential employer, you can make everything that you may have found bad at previous employers better. And that has also motivated me to perhaps become a good employer, to build up a company in such a way that it attracts people who want to work for us. (E21:74)	Being a good employer	
I think the biggest motivation was actually being able to do what you want and not having anyone above you. [...] I felt like I already knew what I was doing and I didn't want to be held back anymore [...] (E1:8)	Autonomy	Job empowerment and engagement
On the other hand, of course, it also gives you a certain flexibility in terms of working hours, in terms of the whole set-up, which you don't necessarily have in a normal environment. (E2:26)	Flexibility	
I was well aware that it was also a kind of learning project and a very strong personal development project. (E24:58)	Learning and development	
I'm good at a lot of things, but I'm not excellent at anything. I'm just a total all-rounder and roles like this suit me very, very well. (E24:60)	Personal fulfillment	
Of course, success in some way and maybe financial success. So I would say that played a role, but not an overriding one. (E1:18)	Profit as subordinate motive from the start	Profit

(continued)

Table 1. Continued

Illustrative quotes	Second-order themes	Aggregate dimensions
As this is a venture capital start-up [. . .] I knew from the beginning that the goal was for everybody to make money out of it in the end – that was of course an aspect where you think “Oh cool, I could have a piece of the cake”. That is, of course, very motivating. (E11:24)	Profit orientation	
<i>Women entrepreneurs’ motivations for consistently pursuing innovations and ventures in STEM</i> It’s a continuous desire to drive and shape the technology [. . .] (E12:56)	Technological interest	Innovation
I’m an active part of a meaningful business, at least one that I think is meaningful and does something good for people and society. (E18:66)	Social value creation	Social impact
We have always wanted to make every pump sustainable. No more graveyard pump waste. That still motivates me today. (E6:280)	Environmental value creation	
Meaningful in the sense that the answer is of real interest to someone, that it relates to an industrial problem and could not have been done on another computer. (E12:68)	Sense of purpose	
Last but not least, I realize that many people have a home, a professional home, through the way I work, through my foundation. In other words, I am actually someone who has created structures here where people can think and make decisions and have meetings and think about things. And of course, I think that’s great. (E17:50)	Being a good employer	
Also to set an example for women and to say “you can do it” and be more than just the person who does the housework. (E16:30)	Women empowerment	
I’ve always been very independent. I’m happy to be able to decide for myself what I want to do every day or where we want to go. (E5:30)	Autonomy	Job empowerment and engagement
Like I said, it’s all the freedom you have. I don’t have to worry about, for example, if it’s my grandmother’s birthday. [. . .] You can go to the doctor if you want, or take a week off if you want. (E1:54)	Flexibility	
I would say that the last two years have been the most amazing time of my life, just because I have learnt so much about my own personality. And that’s just super, super valuable I would say. (E19:24)	Learning and development	
That’s where I am now and that’s where I feel at home. That’s where I found what I call my founder personality. (E6:180)	Personal fulfillment	
I don’t feel like I’m getting into a rut. Yeah, well, sometimes I wish a week this would be a bit more predictable or similar to the week before. But on the other hand, it’s something that really motivates me because I don’t feel like I’m doing the same activities over and over again [. . .] (E22:74)	Variety of tasks	

(continued)

Table 1. Continued

Illustrative quotes	Second-order themes	Aggregate dimensions
Yeah, I actually liked the idea of profit sufficiency, because [...] it's not that I wouldn't do it now if it wasn't like that, as long as you just get a decent salary. I also don't want anyone who works for us to have to do it for a pittance. I don't want to do it for a pittance either. As long as you don't have to give up anything, I think it's OK, and if the company ends up with zero, but everyone gets paid and everyone is happy and has a good life, then it's great. (E3:100)	Decreased profit motivation	Profit
First of all, I love thinking with people, developing new things and that's what enriches me. (E17:46)	Interpersonal relationships	Leadership and organizational development
[...] it's also cool when I see the development of the employees. That always makes me very happy. (E24:88)	Empowerment of employees	
So no matter what challenges you have in everyday start-up life, it's always about solving problems, putting out fires and sort of approaching them with a certain naivety. Like, well, it'll work out, let's make a plan anyway. (E24:62)	Daily management activities	
I think really the most important thing is to make sure that we are much, much more stable as a company. So number one is to really get out of this crisis, but number two is to put the structures in place so that everything runs more smoothly. Diversify [our products]. (E14:112)	Venture growth and development	
<i>Behavioral factors</i>		
<i>Women entrepreneurs' motivations for approaching innovations and ventures in STEM</i>		
I'd been working on it for about two years, I had a good overview of the market, I knew the players and, well, you know what you know. (E8:62)	Area of expertise	Professional mastery
At one point there was a course called the Funpreneur Competition. It was a challenge where you set up a company and I thought it was really funny. [...] you try something out and then somehow actually found a serious company and you're a GbR [special business form] right away. (E23:12)	Entrepreneurial education	
What definitely helped me at that time was that my father had already started a company and had already had his own business, because otherwise [...] as a normal person you don't know how to start a company or anything like that. (E14:58)	Family involvement in entrepreneurship	
<i>Women entrepreneurs' motivations for consistently pursuing innovations and ventures in STEM</i>		
I really just pushed my feelings away and disconnected from my body because I knew that this was the only way I could survive and pull off this foundation. But yes, there was a real numbness at times. (E23:40)	Emotion regulation	Professional mastery

(continued)

Table 1. Continued

Illustrative quotes	Second-order themes	Aggregate dimensions
<p>You have to be really careful not to overwork, to make sure that you take breaks. I do that now – meditation, for example, is really important to me. [...] And I really do take a ten- or fifteen-minute break every day [...] (E19:28)</p> <p>Of course, I also realized that it's very different when you're talking to potential customers, when you can talk to them at eye level and say, "Hey, listen, I understand your problem. I have had that too and I have thought about this and that solution. Would this work for you?" And that helps. (E2:42)</p>	<p>Practical coping actions</p> <p>Previous professional experience</p>	
<i>Environmental factors</i>		
<p>These are just moments or small situations where we were asked to speak at some event and then they said, yes, they would like to have me as a speaker, simply because I'm a woman. It wasn't because they liked me [...]. And they are just saying, "Yes, you're a woman, we want more women on stage". (E11:78)</p> <p>First of all, I've always, always been mistaken for my own secretary. On every pitch, at every event. (E7:72)</p> <p>I always feel guilty. There are three small children who are, to a certain degree, not being looked after properly. Then there are the professional challenges, so to speak. So it's a constant balancing act, and you have to be able to justify it to yourself and, especially, to your children. And then there are the high costs that every hour of work costs me. (E4:16)</p> <p>[...] There's how much of an outsider you are, let's say, in an environment and as a woman in her early 40s in the medical technology sector, as the CEO of a tech start-up. It's not that everyone is saying "Hurray, we've been waiting for you", but the expectations are obviously very different. (E7:68)</p> <p>Now that I'm here in the [area], I realize that I just have to explain it a lot more often. And in Berlin I don't have to explain anything. I have to say, I think more often now, is this really still the right place? Why am I not in Berlin if I have to explain so much less there? (E23:14)</p> <p>I think it was a good thing that we didn't have that knowledge, because if I had known how highly regulated the healthcare market would be and what problems we would have to deal with, I think I would probably have just shied away and said "Oh no, we'll never make it. (E18:30)</p> <p>Of course, the fact that engineering is not an investment theme makes things even more difficult. What is popular with people is that</p>	<p>Belonging and (hyper) visibility</p> <p>Gender stereotyping</p> <p>Balancing motherhood and business</p> <p>Intersectionality</p> <p>Location disadvantages</p> <p>Sector-specific hurdles</p> <p>Investor's focus on software and monetary aspects</p>	<p>Gender dynamics</p> <p>Structural, institutional and sectoral dynamics</p>

(continued)

Table 1. Continued

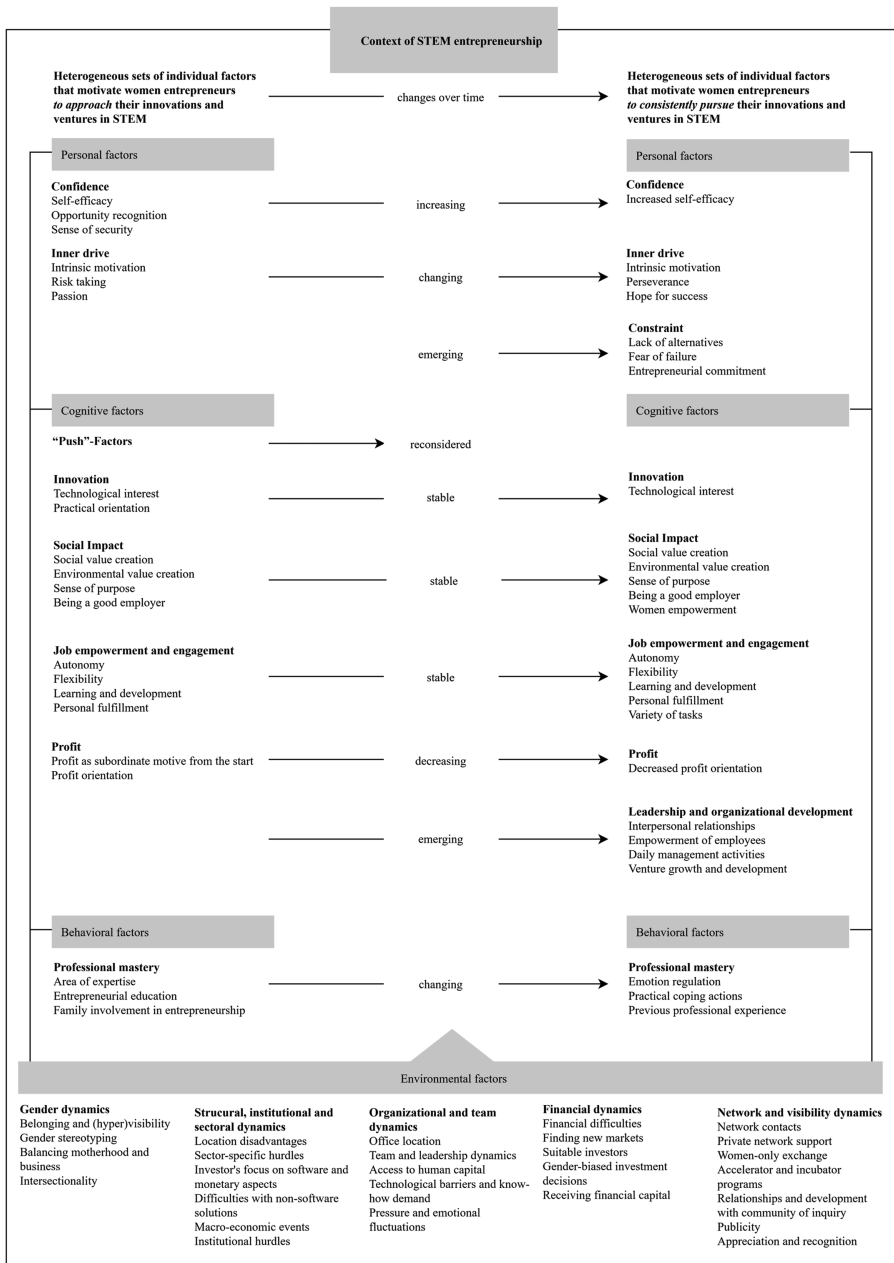
Illustrative quotes	Second-order themes	Aggregate dimensions
they want digitization. [. . .]. Something that's somehow sustainable, software, exactly. Because you can exit after 3–5 years. (E6:176–178)		
We pitched together with some programmers who wanted to write some applications and wanted €10,000. I can't buy lab equipment with €10,000, I can rent a lab for two months, I can't hire anybody. I wouldn't get very far with €10,000 [. . .] (E15:50)	Difficulties with non-software solutions	
Of course, Corona meant two years that didn't play into our hands, despite the digitalized startup. (E10:60)	Macro-economic events	
Starting a business in Germany is not made easy and I am fascinated by how many people have been able to start a business without having the best academic degree. (E22:66)	Institutional hurdles	
Yeah, it definitely motivated me and actually having that support made it a lot easier, as well as hearing that we have a workplace that we can go to, and we don't always have to meet in somebody's living room. (E13:60)	Office location	Organizational and team dynamics
I would say it's just our team spirit and our intrinsic motivation. (E19:60)	Team and leadership dynamics	
It helps us when we find the right people [. . .]. And we often get people from outside who bring some good input and really help us in terms of content and expertise. (E7:116)	Access to human capital	
I think the problem in our field is that the scalable product obviously depends on a quantum computer, and the hardware of the quantum computer is not necessarily in our hands. (E12:10)	Technological barriers and know-how demand	
Sometimes we both get down and think, "Shit, what are we going to do now?". Then it's important that you do it yourself. Nobody's going to stand there and cheer you on. (E11:60)	Pressure and emotional fluctuations	
I was extremely frustrated by venture capital discussions. Business angels weren't any better. They wanted 30% of the shares in a start-up company for €30,000, for a project that we had already pre-funded to the tune of half a million. It just didn't add up. (E6:178)	Financial difficulties	Financial dynamics
Now, with the war in Ukraine, we've suddenly got a new target group that we didn't even know we had. [. . .] And the exciting thing is that it has just become a really big target group for us. (E16:36)	Finding new markets	
We have great investors. We also have a great supervisory board that works with us in a very solution-oriented way. We have a great investor who said, "Hey, you're short of money right now. I can give you some more in the short term." (E14:110)	Suitable investors	

(continued)

Table 1. Continued

Illustrative quotes	Second-order themes	Aggregate dimensions
I also wonder about how the investments are made. They think: [...] Do we trust this person? And then, when they find out, oh, she also has children can she manage this? I think that often causes them to say no, to reject the application. Of course, it's never communicated openly, but that's my feeling. (E2:72)	Gender-biased investment decisions	
What helped a lot was that one of the members of the [name] forum was on the local council and he was in favor of us doing a project with the city. We got €120,000 over two years, even though we couldn't really do anything yet. And that almost completely financed our development. During that time, when we didn't have any staff costs or anything like that, we didn't pay ourselves, so we had a lot of money. (E3:48)	Receiving financial capital	
That has actually helped me time and time again. Building a network and trusting the network. (E8:66)	Network contacts	Network and visibility dynamics
There weren't really any obstacles (...) because everyone was behind our idea and our friends and family just said try it out, we are behind you, no matter how crazy the idea might seem! (E16:62)	Private network support	
I thought that was very good too. It really is just a women's network, which is another very interesting point. (E5:58)	Women-only exchange	
In the accelerator program you actually learned how to pitch, not an invention or a technique, a technology, but how do I translate my technology into a product and a business plan that I can pitch? And that was incredibly helpful for me personally because I really didn't know anything about that. (E8:40)	Accelerator and incubator programs	
We actually met our first customer at that very first start-up fair. He was in product development himself and had come from university and was interested in what his product did and why his product worked. And then we sort of built our toolbox with him. What does he need? What can we deliver? We sold our first customer trial in a very experimental way and we are still working with them five years later. (E15:28)	Relationships and development with community of inquiry	
Our company was founded in January 2020, and in December 2020 I got a request from [magazine], asking if they could do an article about me. That gave me a huge boost, because they were so supportive. I was so happy about it, because I knew it would be good for us, and it turned out to be. (E1:34)	Publicity	
Of course, when we get positive feedback from women saying the app has really helped them or has done something, that's super nice. (E20:62)	Appreciation and recognition	

Source(s): Authors' own work



Source(s): Authors' own work

Figure 1. Multifaceted, interrelated and dynamic motivations of women entrepreneurs in STEM

can only say that when I have really tried everything [...] I can end it. But you always have to keep going” (E5:64). This shift suggests that while passion and risk-taking may initially facilitate the entrepreneurial journey, sustained motivation may be more rooted in ongoing intrinsic motivation, perseverance and a hopeful outlook for the future. This change reflects the maturation process of a venture. In the beginning, passion and a willingness to take risks are essential to turn the idea from paper into reality (“Then there was a really crazy phase [...] the manic phase, [...] in which I didn’t actually sleep because I was thinking about [...] designs day and night. I was just so enthusiastic,” E3:20). Later, when the realities of the market and day-to-day business become more noticeable, perseverance and an optimistic but realistic hope for success are more important in order to manage and grow the venture sustainably (“So when you get a rejection like that from an investor, it’s always hard to pick yourself up and stand up and say, ‘No, my company is great and the idea we have has great potential,’” E1:40).

Constraint – Women entrepreneurs described emerging feelings of constraint as reasons for consistently pursuing their innovations and ventures. They experienced a lack of adequate alternatives as well as a fear of failure (“There’s always a little bit of fear ‘Okay, maybe it’s not going to work and it’s all going to go down the drain [...] and then it is going to come out how bad we really are,’” E9:20). This fear stemmed from personal insecurities, avoidance of negative judgments from others and a focus on avoiding undesirable outcomes. The majority of the interviewees also cited entrepreneurial commitment as a driving factor. This entrepreneurial commitment was defined as a sense of obligation to investors, other venture members and the venture as a whole. Contractual obligations, as well as previous financial and time investments, were mentioned as reinforcing aspects of feelings of entrepreneurial commitment. One woman reflected: “I always had the feeling that I couldn’t go back now, because there are contracts, there are agreements, there is money that has been paid out. That was my impression. Now I can’t get out of here. At a certain point, you are contractually bound in such a way that you can’t get out without really big losses” (E7:56), showing her feeling of being trapped in the situation. The partial intertwining of entrepreneurial commitment, economic obligations, social responsibility and personal insecurities culminates in feelings of constraint that lead some women entrepreneurs to consistently pursue their ventures.

Cognitive factors

“Push”-factors – Our study also reconsiders the traditional distinction between “push” and “pull” factors, as well as necessity and opportunity entrepreneurship (Buttner and Moore, 1997; Poggesi et al., 2020). Among the aspects traditionally considered as “push”-factors – negative conditions that favor the creation of a business – the desire to improve one’s own working conditions was most often highlighted by our interviewees. A lack of other adequate employment alternatives, a practical orientation, a desire to avoid boredom and the incompatibility of a permanent job with entrepreneurial activities were also mentioned as “push” motives. These push motives can be linked to different goals, such as generating profit, having a social impact, contributing to innovation and achieving job empowerment and engagement, that can be pursued through entrepreneurship and are described in the following sections. Dissatisfaction with previous working conditions, the desire to avoid boredom and the incompatibility of a permanent job with entrepreneurial activity can be seen as both: an escape from an unfavorable situation (“push”) or a motivation toward an attractive job alternative (“pull”). These three aspects can therefore be linked to the goal of achieving job empowerment and engagement. A practical orientation can be linked to the goal of contributing to innovation and a lack of adequate alternatives can be linked to the desire to generate profit or achieve job empowerment and engagement. The distinction between “pull” and “push” can therefore be overcome. We also found intertwined goals driving women entrepreneurs in STEM to approach their innovations and ventures in STEM. One interviewee

described this as follows: “When you do [. . .] applied research, at some point you reach a certain [. . .] level of frustration, because you push research or development to a certain point and then it goes into application and then you start again with another topic. [. . .] And that was the point where I said that I don’t want to do that again. I want to go into application” (E22:42). This quote illustrates the desire to achieve job empowerment and engagement as well as contribute to innovation through her entrepreneurial endeavors, indicating that multiple goals can drive the approach to innovations and ventures in STEM. For the reasons outlined above, the distinction between push and pull motivations was reconsidered for the remainder of the analysis of women entrepreneurs’ motivations in STEM, as the dichotomy does not capture the complex, interrelated and multifaceted motivations that drive women entrepreneurs in STEM. Instead, we focused more on the goals that can be pursued through entrepreneurship, hereafter referred to as cognitive expectations (e.g. generating profit or contributing to innovation).

Innovation – Several women entrepreneurs have expressed their cognitive expectation to contribute to innovation as a reason for approaching their innovations and ventures in STEM. They expressed this in particular through a strong interest in technology or a practical orientation. One of the interviewees stated: “I find software development in general, or solving difficult problems, interesting [. . .] That’s what fascinated me” (E13:62), highlighting her passion for technological advancements. A keen interest in technology has been a consistent and strong driving force for many women entrepreneurs, motivating them to consistently pursue their activities.

Social impact – A deep desire for having a social impact emerged as a significant motivation for our interviewees when approaching their innovations and ventures in STEM. This motivation was rooted in a cognitive expectation of social or environmental value creation. One interviewee explained: “It was about the vision of freeing up a lot of resources to really spend time with people. The amount of administrative work in society, and therefore in medicine, has increased enormously. We have very little time for patients. That was my vision” (E17:38), highlighting the use of STEM innovations for social improvement. In addition, many interviewees also recognized the importance of having a sense of purpose in their work and the opportunity to be a good employer. The desire to have a social impact remained a strong driver for the majority of the interviewees in consistently pursuing their activities. One entrepreneur expressed her motivation to be a good employer by saying: “When I think about what is going wrong, I think of, for example, the gender pay gap. As a female entrepreneur, I have the opportunity to say that things may be fundamentally wrong, but I can behave differently in my limited area and simply help shape them” (E14:46). The motivation to empower women was particularly evident in the later stages of their innovations and ventures, with women entrepreneurs seeing their work as setting an example for others. One interviewee explained: “They [young women] sat there with their eyes open and I told them that it is really possible: You can have children and be an entrepreneur, you can do two things at the same time without much money [. . .]. So basically, motivating them. I think that’s super good, super important” (E17:68), revealing her desire to share her experience, inspire other women and act as a role model.

Job empowerment and engagement – Our research found that achieving job empowerment and engagement was also a crucial factor that drove women entrepreneurs in STEM to approach their innovations and ventures in STEM. The interviewees valued certain entrepreneurship characteristics such as gaining autonomy, increasing flexibility and finding personal fulfillment in their work. One woman mentioned: “I personally think it’s just so cool to be a CEO because [. . .] I’ve just created a role for myself that fits my personality perfectly” (E1:20), expressing her motivation for achieving a role that brings her personal satisfaction. In addition, women entrepreneurs’ approach to their innovations and ventures in STEM was often linked to learning and development opportunities. The same aspects were also mentioned as motivational drivers for consistently pursuing their innovations and ventures.

However, personal learning and development was more strongly emphasized as motivating in the later stages. One interviewee expressed: *“I would say that you never stop learning [. . .], but I think that’s also the beauty of it, that when you really get into this entrepreneurial life, you kind of see something new every day”* (E19:54), emphasizing the intellectual stimulation derived from entrepreneurial activities. This is also consistent with our findings that a wide variety and diversity of tasks is important in encouraging women entrepreneurs to consistently pursue their innovations and ventures in STEM.

Profit – Our analysis reveals significant differences among women entrepreneurs in STEM in terms of their profit expectations. Approximately half of the interviewees admitted to being motivated by financial gain and profit-seeking when approaching their innovations and ventures in STEM. However, there was considerable variation in the extent of this profit motivation. Some of the women entrepreneurs identified profit as their primary motivator. Others, however, viewed it as a secondary motive from the beginning (*“I didn’t start the company to make a huge profit. To put it bluntly, it’s a necessary evil,”* E6:282). It is noteworthy that for some of them, the drive for generating profit also diminished over time. This change can be observed in the reflection of one woman: *“I would say that in the beginning it was a little bit more financially successful than it is now. In the beginning you thought, [. . .] at some point it [the company] will be bought for millions of euros and then I’ll make a glorious exit. And now I’m thinking to myself [. . .], what would I do with so much money? [. . .] Somehow, I can buy everything I want. I don’t have to fly to the Maldives for €10,000 euros. So, funnily enough, maybe the financial motivation has decreased a little”* (E1:18). This narrative indicates a shift in the perception of profit among women entrepreneurs in STEM, suggesting that for some, profit changes from being a major motivator to being seen as a means to a decent living. The shift is attributed to a growing emphasis on social relationships and impact over financial success and an adjustment to the realities of the entrepreneurial journey (*“In retrospect, [. . .] the interpersonal part really caught me the most. Sure, the financial part, that’s all exciting and cool, but I think you get a little blinded by that in the beginning,”* E11:44).

Leadership and organizational development – Another driver, summarized as leadership and organizational development, emerged as a key aspect for women entrepreneurs to consistently pursue their innovations and ventures in the later stages. Daily management activities, such as solving challenges, were a driving force for women entrepreneurs in STEM. Planning for the growth and development of ventures, including reaching milestones, product development and market diversification, also motivated them. One interviewee stated: *“We would continue to [. . .] help this product, or as we always say, this child that we have created, to become really big”* (E10:32), showing a personal connection and dedication to nurturing the venture. Furthermore, the importance of interpersonal relationships with their team and empowering employees was recognized as a driving force for the majority of the interviewees. One woman elaborated: *“I don’t need to do it alone. I’d rather have a team around me who know what they’re doing, who can implement it and then make it a success together”* (E10:48), emphasizing the fundamental role of leadership and connection with the team in sustaining motivation.

Behavioral factors

Professional mastery – The interviews revealed that family involvement in entrepreneurship and access to entrepreneurial education opportunities positively influenced women entrepreneurs in their approach to innovations and ventures in STEM, as they gained early experience. In addition, having industry-specific experience also had a significant impact on their entrepreneurial aspirations. One interviewee explained: *“I was able to pass on and recycle all the expertise I had built up over the years on a one-to-one basis”* (E4:16), highlighting how her accumulated knowledge and experience contributed to her sense of professional mastery and entrepreneurial intention. As these women continue to

pursue their innovations and ventures in STEM, their sense of professional mastery evolves. They identify resilience developed from past work experiences, emotion regulation and practical coping strategies as crucial to their ongoing entrepreneurial motivation. While the practical coping strategies included well-being activities, such as sleep or counterbalancing activities, one woman reflected on her emotion regulation as follows: *"It's still important to have some kind of distance [from the venture]. Because if you don't have that distance, you won't be able to sustain it in the long run"* (E1:56), demonstrating her emotional detachment as a resilience strategy that enabled her to consistently pursue her innovation and venture in STEM. This change in professional mastery is explained by a shift in perspective over time. As one entrepreneur noted: *"After the first two years, you also realize that you are not the business, that you have another life and that you should also do things outside of your business, not just work"* (E3:70). This highlights a shift from an exclusive focus on the venture to a broader recognition of personal well-being and demonstrates a realization that self-sacrifice does not make for a sustainable venture.

Environmental factors

In our analysis of the environmental factors influencing women entrepreneurs' motivations, we identified five main themes that are highlighted either as challenges or support sources. These themes contribute to within-context heterogeneity: gender dynamics; structural, institutional and sectoral dynamics; organizational and team dynamics; financial dynamics; and network and visibility dynamics.

Gender dynamics – The most dominant themes among the interviewees in terms of gender dynamics were their sense of non-belonging, (hyper)visibility and gender stereotyping in STEM. Women entrepreneurs reported feeling excluded from male-dominated networks with one saying: *"There are – especially when I'm at conferences – many older men who accept that you're there as a woman and they may also accept the competence that you have. But they are really a clique, the men"* (E22:123). Aspects of intersectionality reinforced these feelings of non-belonging. One interviewee explained: *"When you are almost 40 and have a family, it's different from starting a business when you're 23 and your dad has just paid for private school"* (E7:32), expressing the additional layers of complexity that gender, age and family responsibilities add to the broader challenges in STEM entrepreneurship. Furthermore, half of the interviewees reported experiencing hyper-visibility. They explained that, though they receive a lot of positive attention, *"People don't even look at whether [...] what we're doing is somehow relevant, but rather, 'Ah, there are two women founders, we definitely need them for the photo and the stage'"* (E23:26), and that they receive this attention simply because of their gender. While the majority refused to be reduced to their gender, some women entrepreneurs mentioned using this visibility as a differentiator and a strategic advantage. Almost half of the women entrepreneurs also reported that the challenges of balancing motherhood and business affected their ongoing motivation. One pregnant interviewee reflected: *"When you realize that, for example, maternity leave doesn't exist, it sucks. Then I started to question myself: Would this be the right time to quit?"* (E24:94). One childless entrepreneur reported some concerns about starting a family while running her venture, stating: *"I'm not planning to have a family right now, but I know for sure that it wouldn't be compatible. [...] I don't know what would happen. But the way it is now, it definitely couldn't go on"* (E3:80), acknowledging the personal conflicts and incompatibility between the roles of mother and entrepreneur.

Structural, institutional and sectoral dynamics – Structural, institutional and sectoral dynamics were discussed, with location disadvantages and sector-specific hurdles being highlighted. Women entrepreneurs in the medical device sector faced challenges due to strict regulatory requirements, while women academic entrepreneurs struggled with legally

detaching their start-ups from the universities. Institutional hurdles, such as complex policies and bureaucracy, were also frequently mentioned. A lack of government support and systems was noted as particularly detrimental to women entrepreneurs. They explained: “*The education system doesn’t work, the pension system doesn’t work, childcare doesn’t work*” (E3:98). Additionally, obstacles due to macro-economic events, such as crises and government interventions, were described as difficult to navigate. Our results also point to an important difference between women entrepreneurs according to the nature of their ventures (non-software products vs. software products). Several interviewees mentioned how investors favored software products, focusing on monetary and scaling aspects, while neglecting societal impact and other forms of technology. One interviewee expressed: “*This focus on it being technical and scalable. That annoys me [. . .]. We’ve got huge problems in this world and most tech business models that scale don’t help at all*” (E3:66). Women entrepreneurs offering non-software products also faced challenges related to laboratory resources, development time, production, supply chain difficulties and high capital requirements. One interviewee highlighted the difference between non-software and software products, and the unique challenges faced by the non-software entrepreneurs, as follows: “*We make hardware [. . .]. And that’s pretty much the rockiest road you can choose. [. . .] It’s not just like software, where you program it and if it doesn’t work, you program it again, but you have to hire engineers for a lot of money. They have to create a design, then you have to start production. You have to build prototypes, you have to deal with manufacturers, you have to buy silicon, you have to do 3D printing. So suddenly everything becomes very, very physical and very, very expensive*” (E7:52). This illustrates the within-context heterogeneity of women entrepreneurs in STEM, depending on the nature of their ventures. The different challenges of developing and bringing non-software versus software products to market have different impacts on women entrepreneurs in STEM and their motivations.

Organizational and team dynamics – The well-known difficulties of emotional fluctuations, high workloads and pressures were highlighted as common organizational difficulties. The challenges of team dynamics and leadership, especially in the face of societal stereotypes of women as humble and relationship-oriented (Gupta et al., 2013), were also frequently mentioned. One interviewee shared a troubling experience with her co-founder, stating: “*I have a mega-pedantic [. . .] co-founder [. . .]. He just has a problem with strong women. [. . .]. He can’t deal with me saying ‘Hey, can you please do that?’. ‘You can’t give me instructions’*” (E4:60). This situation underscores the interpersonal and leadership challenges faced by women entrepreneurs, and points to bias in professional settings. In line with these challenges, interviewees reported positive co-founder and team dynamics as particularly beneficial. Accessing human capital was identified as a significant obstacle, but recruiting qualified employees and securing an office location were seen as helpful. Technological barriers and the need for technological know-how were also cited as important factors of insecurity. One interviewee explained this difficulty as follows: “*I had the idea, but then I convinced a friend of mine to get involved. And then he brought a friend along to cover the technical side, because I’m not a developer myself [. . .]. That’s always the problem when [. . .] you cover the business side, but you don’t have a technical background. You’re always dependent on somebody who can ultimately implement it*” (E2:26).

Financial dynamics – Women entrepreneurs often emphasized the well-documented challenges of financial difficulties, such as obstacles to meeting market and customer demands, covering living and business expenses, and securing necessary financing. Reflecting on these challenges, one interviewee stated: “*A lot of things are quite frustrating and difficult at the moment, [. . .] we can’t get the prices we want, we can’t get the sales, we don’t have the growth and we don’t have the funding at the moment for next year to continue to do all that*” (E20:64). This quote demonstrates the impact of external factors, such as funding, on motivation. In line with this, finding suitable investors and obtaining financial capital were

identified as crucial sources of motivation. Some interviewees also mentioned that finding new markets was helpful. In terms of financial capital, our interviews revealed the challenge of gender-biased investment decisions: “No investor wants a woman. So even women investors don’t want a woman. Women investors come from the e-commerce sector. They come from the cosmetics industry and they can’t do anything with technology” (E6:174). This quote highlights the non-conformity of women entrepreneurs in STEM with the stereotypes of the male founder, showing how industry-specific biases limit women entrepreneurs’ access to financial capital and influence their motivations.

Network and visibility dynamics – In their pursuit of credible visibility, women entrepreneurs highlighted the importance of publicity, such as awards, media coverage, and word-of-mouth, as being helpful and motivating. Credible visibility was also positively reinforced by appreciation and recognition. Feedback and attention from employees, social networks, and the market were seen as crucial sources of motivation, along with the ability to witness the results of their own work. One interviewee vividly recalled: “The brand partners and also the press reacted very strongly and positively, and there was just a total hype. Of course, that was an extreme boost because you feel like you’re working on a hot topic. You get a lot of positive feedback, which of course is extremely motivating and makes it easier to develop that ‘sky’s the limit’ mentality when everyone is pushing you at that moment” (E11:26). This demonstrates how publicity, appreciation and recognition can enhance women entrepreneurs’ motivation. In addition to visibility, support from private networks, network contacts and collaboration in product development within a community of inquiry were also seen as beneficial. Most interviewees also spoke positively about strategic institutional support through accelerator, incubator and scale-up programs. Some women entrepreneurs mentioned the importance of creating women-only networking opportunities to foster a sense of belonging: “You have role models, you see how other women do it. I think there are just problems that are very specific to women” (E14:94).

Discussion

We used qualitative empirical data to uncover new insights into the motivational factors that drive women entrepreneurs in STEM to approach their innovations and ventures and how these motivations change over time as women entrepreneurs consistently pursue their activities (Brush *et al.*, 2022; Poggesi *et al.*, 2020). Our findings illustrate the multifaceted, interrelated and dynamic nature of women entrepreneurs’ motivational factors in STEM, emphasizing both the heterogeneity of women entrepreneurs’ motivations and the within-context heterogeneity of women entrepreneurs themselves.

Heterogeneity of motivations

In terms of personal and cognitive factors, we find that women entrepreneurs’ motivations to approach their innovations and ventures include confidence, an inner drive and cognitive expectations such as generating profit, having a social impact, contributing to innovation, achieving job empowerment and engagement to varying degrees of intensity. Thus, firstly, our findings challenge and reconsider the traditional dichotomy of push and pull motivations (Ármane *et al.*, 2021; Iffländer *et al.*, 2018; Pascher *et al.*, 2015), offering a more nuanced understanding that embraces the interdependence of different entrepreneurial cognitive expectations (such as improving their working conditions to achieve job empowerment and engagement and recognizing an opportunity to contribute to innovation simultaneously). This improved understanding allows us to better understand the different motivational pathways of women entrepreneurs that drive them to approach their innovations and ventures in STEM (Poggesi *et al.*, 2020). This enables the development of theoretical frameworks in entrepreneurship research that more accurately reflect the

realities of women entrepreneurs. Most of the cognitive expectations illustrated, such as generating profit or having a social impact, as well as the importance of self-efficacy that lead women entrepreneurs to approach their innovations and ventures are also evident in the broader literature on entrepreneurial motivation (Murnieks *et al.*, 2020; Ármann *et al.*, 2021). However, there has been a lack of a holistic and interrelated view of these motivational aspects for women entrepreneurs (in STEM) that also recognizes behavioral and environmental aspects. We are addressing this gap. Our findings align with Douglas (2020) and Douglas *et al.* (2021), who also emphasize, e.g. innovation and profit as important for entrepreneurial intention in general. An examination of the patterns that lead to entrepreneurial intention among our interviewed women entrepreneurs in STEM reveals a wide variety of motivational pathways, ranging from the (non-)significance of profit to varying levels of technological interest, among others. This is consistent with the results of Graham and Bonner (2022) and Douglas *et al.* (2021), who suggest that there is not a uniform group of factors that drive entrepreneurial intention, but entrepreneurial motivation is influenced by a diverse array of elements that vary widely among individuals and situations. Therefore, our findings underscore that there is considerable heterogeneity in the motivational factors that drive women entrepreneurs to approach their innovations and ventures in STEM, undermining the idea of a single, dominant pathway to entrepreneurship. This motivational heterogeneity defies the traditional categorization of push and pull motivations and requires a more nuanced, multifaceted and interrelated approach. This also underlines that “one size (still) does not fit all” and programs need to account for women entrepreneurs’ motivational heterogeneity (Henry *et al.*, 2021, p. 609).

Change in motivations

To the best of our knowledge, our study is the first to focus on exploring the motivations that drive women entrepreneurs in STEM to consistently pursue their activities and to consider changes in their motivations. The motivational pathways that drive women entrepreneurs to consistently pursue their innovations and ventures may change as their innovations and ventures evolve. For example, our research indicates that as innovations and ventures evolve, individuals’ confidence increases and their inner drive also changes.

While the intrinsic cognitive expectations of having a social impact, contributing to innovation and achieving job empowerment and engagement remain constant driving forces, the appeal of extrinsic motivations, particularly of generating profit, tends to diminish over time. This finding challenges the traditional belief that profit maximization is a primary entrepreneurial motive (McCaffrey, 2014) and instead supports Murnieks *et al.* (2020)’s call for a deeper examination of the interplay between intrinsic, prosocial and extrinsic motivations. Previous studies indicate that the desire to benefit society is a significant motivator for women entrepreneurs (Solesvik *et al.*, 2019; Barkema *et al.*, 2023). Our interviewees indicated that the cognitive expectation of having a social impact – the idealistic desire to protect the environment or help specific social groups – was a stronger driving force than generating profit. Based on these findings, we conclude that for women entrepreneurs in STEM, intrinsic cognitive expectations like having a social impact, contributing to innovation, and achieving empowerment and engagement in their work are consistent motivators throughout different stages of their ventures, while extrinsic motivators such as generating profit, vary and diminish over time. Therefore, women entrepreneurs’ motivations change as their innovations and ventures evolve.

We have also uncovered that the cognitive expectation of leadership and organizational development is an important motivational factor for many women entrepreneurs to consistently pursue their innovations and ventures. This includes a desire for the growth and development of the venture, as well as broader, more inclusive goals such as fostering positive interpersonal relationships and empowering employees. This challenges traditional masculinity-associated leadership norms. Previous research has mainly focused on examining

the business expansion of women entrepreneurs, often adopting a male-dominant normative lens when studying entrepreneurial leadership (Darnihamedani and Terjesen, 2022; Dean *et al.*, 2019; Hsieh *et al.*, 2019; Aparisi-Torrijo and Ribes-Giner, 2022). However, there has been a shift in focus towards examining the relationship between leadership theories, gender and entrepreneurship more closely (Galloway *et al.*, 2015; Lewis, 2015). Our findings suggest that as women entrepreneurs' ventures and innovations evolve, they are embracing social responsibility and cultivating a transformational leadership style that goes beyond traditional measures of business success. The cognitive expectation of leadership and organizational development not only enhances our understanding of the multifaceted factors driving women entrepreneurs but also underscores a shift towards a more other-oriented and collective approach in the later stages of the venture.

This shift towards a more other-oriented and collective orientation is also evident in the feelings of constraint stemming from a lack of alternatives, fear of failure and entrepreneurial commitment, which arise in the later stages of the venture. This sense of constraint is a strong motivator for women entrepreneurs in STEM to consistently pursue their activities and also includes a sense of social responsibility. Despite being closely related to motivation, entrepreneurial commitment has received little attention in research on women's entrepreneurship. It includes an additional aspect of obligation and can lead to actions that contradict initial intentions (Gabay-Mariani and Adam, 2020). McDowell *et al.* (2019) provided the first empirical evidence of the duality of entrepreneurial commitment. While entrepreneurial commitment can lead to job satisfaction, it can also have negative consequences, such as conflicts between job and family or emotional exhaustion. Women entrepreneurs in our interviews and in previous research (Armane *et al.*, 2021) indicated that they found it challenging to balance motherhood and business and struggled with role expectations. Therefore, emotions of constraint, especially entrepreneurial commitment, seem highly relevant to women entrepreneurs in STEM and warrant further investigation to develop better support mechanisms. Overall, our results suggest that women entrepreneurs' motivations to persist in their activities are multifaceted and interrelated. They include not only primarily individual-oriented cognitive expectations and positive emotions, but also cognitive expectations of leadership and organizational development, as well as feelings of constraint. This indicates that in the later stages of the venture, feelings of social responsibility and collective and other-oriented aspirations come to the fore.

In terms of behavioral factors and in line with the existing literature, we found that a sense of professional mastery gained through entrepreneurial education, family involvement in entrepreneurship and an area of expertise increased women entrepreneurs' motivations to approach their innovations and ventures in STEM. This is consistent with the general concept of mastery outlined in SCT (Bandura, 1986, 2001; Wood and Bandura, 1989). In addition, our research shows that as women entrepreneurs consistently pursue their innovations and ventures in STEM, their sense of professional mastery also changes. Both practical and emotional dimensions of resilience emerge as important sources of motivational support, enabling them to overcome challenges. The role of resilience in entrepreneurs is receiving increasing attention (Hartmann *et al.*, 2022). While existing research emphasizes a strong connection between entrepreneurs and their ventures (Radu-Lefebvre *et al.*, 2021), some interviewees in our study adopted a strategy of deliberately distancing themselves from their ventures as a means of resilience. Interviewees suggest that a strong attachment to the venture can lead to significant emotional disturbance, which can prevent sustained motivation. This observation partly challenges previous findings indicating that resilience and a commitment to the entrepreneurial role are connected (Hundera *et al.*, 2019). Future research should therefore explore the diverse and potentially gendered strategies that women entrepreneurs use to maintain their motivation and cope with the mainstream and gender-related challenges they face in STEM contexts.

Within-context heterogeneity

In their discussions of the environmental factors influencing women entrepreneurs' motivation, our interviewees highlighted several challenges and support sources. These can be categorized into different dynamics, including gender, structural, institutional and sectoral, organizational and team, financial and network and visibility. These dynamics not only shape the motivations of women entrepreneurs, but also lead to a wide variety of experiences and outcomes across individuals, ventures, sectors and social environments. They contribute to a high degree of within-context heterogeneity. Ettl *et al.* (2021) emphasized that these dimensions contribute to entrepreneurial heterogeneity and diversity in general.

However, we specifically focus on the structural, institutional and sectoral dynamics. We prioritize these aspects because Poggesi *et al.* (2020) highlight a significant gap in research on women entrepreneurs in STEM fields, noting that existing studies have often been based in mainstream literature on women's entrepreneurship and do not adequately address the unique characteristics, complexities and specific contexts of STEM industries. This oversight results in the specific influence of structural, institutional and sectoral dynamics on women's entrepreneurship within STEM being under-explored.

Our research indicates that structural, institutional and sectoral dynamics significantly influence the motivations of women entrepreneurs in STEM, leading to within-context heterogeneity, especially considering the nature of their ventures. For future research, Poggesi *et al.* (2020) suggest distinguishing between academic and non-academic women entrepreneurs. While there are minor differences between academic and non-academic women entrepreneurs, our interviews reveal a significant distinction based on the nature of their ventures. Specifically, women entrepreneurs offering non-software products (engineering, MedTech, biotechnology and deep tech) differ from those offering software products (software as a service, AI development, digital health tech, EdTech and other technology sectors). Women entrepreneurs offering non-software products often encounter barriers such as supply chain difficulties, lack of laboratory resources, or higher financial requirements, which impact their entrepreneurial motivation. Oakey (2012) suggests a similar distinction among entrepreneurs in general, especially in high-technology areas (like biotechnology), which present unique challenges (such as long development times and high risks). Our findings also align with Brush *et al.* (2017), who observe a financial bias toward software products favored by investors for their smaller upfront investments and quicker returns. Consequently, there is significant within-context heterogeneity among women entrepreneurs in STEM, largely driven by the different challenges associated with the nature of their ventures. Our research suggests that it is more important to differentiate women entrepreneurs based on the nature of their ventures (non-software and software products) rather than their academic or non-academic status. This underscores the necessity for tailored support programs that address the distinct needs and within-context heterogeneity of women entrepreneurs across various STEM industries.

In summary, our findings demonstrate how structural, institutional and sectoral dynamics, in conjunction with other environmental dynamics, reinforce each other. For example, gender-biased investment decisions have been identified, particularly affecting women in the non-software sector who face even greater investment difficulties. This illustrates the varying experiences of women entrepreneurs and shows how environmental factors can compound, increasing the within-context heterogeneity of women entrepreneurs in STEM and influencing their motivations.

Limitations and future directions

As our research was conducted in Germany, cultural norms, values and laws may have influenced the answers of the interviewees. Due to the qualitative approach, the responses could also have been influenced by social desirability. Furthermore, the motivations for approaching the innovations and ventures were based on memories and constructed

retrospectively. Therefore, it is possible that the narratives were influenced by hindsight or memory bias, aligning the stories and motivations with the actions taken. Our study serves as a starting point for exploring the heterogeneous motivations of women entrepreneurs in STEM and their changes in motivations. It was therefore only conducted at a single point in time. In future studies, longitudinal and potentially quantitative research could provide valuable information on recurring events that contribute to changes in motivation. Our approach has also highlighted under-researched topics. Based on our findings, we identified some areas for future research and practical implications:

First, in order to avoid the limitations of survivor bias and gain a more comprehensive understanding of the entrepreneurial process, it is crucial to examine resilience strategies and the reasons behind women entrepreneurs' exit decisions in STEM. This analysis can illuminate the challenges faced by women entrepreneurs in STEM and further highlight the motivational heterogeneity and within-context heterogeneity within this group. Such an approach complements our research and opens avenues for identifying targeted support mechanisms and interventions aimed at promoting successful women's entrepreneurship in STEM.

Second, more research is needed on the factors that drive women entrepreneurs in STEM to consistently pursue their activities, such as their collective and other-oriented aspirations. Entrepreneurial commitment is increasingly being studied (Gabay-Mariani *et al.*, 2023; Gabay-Mariani and Adam, 2020). Longitudinal research on (changes in) entrepreneurial commitment, psychological consequences and the link to gender and STEM can further explain why some women entrepreneurs continue their activities and others do not (Kuschel *et al.*, 2020). This research can also contribute to a better understanding of (women) entrepreneurial behavior (Gabay-Mariani *et al.*, 2023).

Finally, the proposed distinction between women entrepreneurs who offer non-software and software products would provide more detailed insights into how to increase and sustain women's entrepreneurial activity in STEM. Given the uneven distribution of women entrepreneurs across STEM disciplines and the sector-dependent and gender-biased nature of investment (Brush *et al.*, 2017; Cheryan *et al.*, 2017), a closer look at each sector could reveal further interactions between women's entrepreneurship, sector-specific determinants and investment-related aspects. We therefore emphasize the call of Treanor (2022) for a more detailed examination and analysis of the individual STEM sectors to improve contextualization.

In terms of practical implications, some women entrepreneurs have expressed their desire for societal impact but have emphasized challenges in finding financial capital due to investors focusing on monetary aspects and software products. Institutional support could be provided by improving the matching process between women entrepreneurs and investors (Polzin *et al.*, 2018). Sharpening investors' understanding of non-software products such as those from the engineering or deep tech areas, could also make a positive contribution.

Women entrepreneurs' self-efficacy was found to be fundamentally important in their approach to and consistent pursuit of innovations and ventures in STEM. Therefore, we recall Wieland *et al.* (2019) in reducing the perceived risk by improving government systems related to education, pensions and childcare. Factors influencing entrepreneurial self-efficacy include work experience, education and training, role models and mentors (Newman *et al.*, 2019). Therefore, we also recommend the implementation of gender-open and gender-closed programs focusing on STEM and entrepreneurship. This could lead to improved networking opportunities. These programs should also address entrepreneurial diversity and intersectional aspects, thereby challenging the stereotype of the male entrepreneur.

As women entrepreneurs reported the cognitive expectation of leadership and organizational development as their venture progressed, the issue of management could also be supported by institutions. This underlines the need for specialized programs tailored to different stages and sectors of a venture, rather than one-size-fits-all solutions. Specifically, in the scale-up phase and the transition from a start-up to a medium-sized venture, such support

can assist women entrepreneurs in navigating conflicting gender roles and expectations, bringing them closer to achieving their future venture goals.

Conclusion

The purpose of this article was to provide insights into the motivational factors that drive women entrepreneurs in STEM to approach their innovations and ventures, as well as how these motivations change over time as women entrepreneurs consistently pursue their activities. Our findings illustrate both: the heterogeneity of women entrepreneurs' entrepreneurial motivations and the within-context heterogeneity of women entrepreneurs in STEM themselves. Their motivations are multifaceted, interrelated and dynamic. They include personal and cognitive, behavioral and environmental factors. Interestingly, while some motivations remain stable over time, others, such as an inner drive or a sense of constraint, may change or emerge. In addition, among other environmental dynamics, structural, institutional and sectoral dynamics, in particular, contribute to within-context heterogeneity within this group. In summary, a more detailed and process-related understanding of women entrepreneurs' motivations in STEM provides theoretically grounded explanations for behavior and support opportunities. However, more research is needed in this area.

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