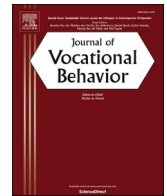




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Women in STEM careers through the lens of career construction theory: A study on females' experiences in persisting in the engineering field[☆]

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ABSTRACT

The persistence of female segregation in many science, technology, engineering, and mathematics (STEM) educational and occupational fields is largely ascribed to gender-specific barriers that women face during their lifespan. Relying on career construction theory, this study aims to increase the understanding of how women in STEM craft and develop their own career over time by attaining leadership positions, in comparison to their male counterparts. In this inductive qualitative research, drawing on career-based interviews on a sample of women and men in engineering, the narrative analysis reveals dynamic changes in women's career adaptability's resources (the 4C's: concern, control, curiosity, and confidence) across specific phases of the lifespan (education, early career, and upper leadership). This study expands our understanding of the role of women's agency in shaping their STEM careers, delineating the specific configurations of career adaptability resources they can deploy to constructively navigate their professional journey. Moreover, because career adaptability changes in response to environmental conditions, this study provides novel insights about the interplay between career adaptability resources and the most relevant contextual factors that support or inhibit women in the pursuit of their career development during each career phase. Overall, our research provides evidence that a lifespan approach to career development is particularly effective in sectors that are still characterized by gender norms. Practical implications are provided for women to help them self-regulate their careers, as well as for educational and organizational policies to help address the underrepresentation of women in the STEM workforce.

1. Introduction

In recent years, the participation of women in the labor market in general has increased, even though they remain underrepresented in certain types of jobs such as in science, technology, engineering, and mathematics (STEM). According to the Global Gender Gap Report, women represent only 28.2 % of the STEM sectors compared with 47.3 % in non-STEM ones. Furthermore, the gap from entry-level to C-suite positions is more pronounced in STEM occupations (42 %) than in non-STEM jobs (46.3 %) ([World Economic Forum, 2024](https://www.weforum.org/publications/global-gender-gap-report-2024)).

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The STEM education sector also presents notable under-representation of gender diversity (Verdugo-Castro et al., 2022). Globally, women make up over half of all students who have enrolled in tertiary education, but data show that in 2018–2023 women made up only 35 % of STEM graduates, and there had been no progress over the past 10 years (UNESCO, 2024). It is worth recognizing the different participation of women across STEM fields (Gao et al., 2024), with a significant underrepresentation in computer science, engineering, and physics compared with biology, chemistry, and mathematics (Cheryan et al., 2017).

The persistence of female segregation in many STEM educational and occupational fields has contributed to the diffusion of the science-is-male stereotype, which claims that men are naturally adapted to technical and math-intensive fields in comparison to women (Deemer et al., 2014; Master & Meltzoff, 2016). Thus, those fields in which women are numerically underrepresented tend to be associated with masculine attributes (Heilman et al., 2024), weakening women's perceived self-efficacy. Because STEM jobs are set to be in demand and well paid in a sustainable future (World Economic Forum, 2023), there is an urgent need to ensure that women are no longer a minority in these fields at all levels.

Recent research has contributed to the understanding of the factors associated with the shortage of women in STEM careers (e.g., Avolio et al., 2020; Meoli et al., 2024), while there has been limited attention devoted to the individual strategies and the contextual factors that enable women to attain their career aspirations in STEM (e.g., Buse et al., 2013; Hatmaker, 2013; Khilji & Pumroy, 2019; Makarem & Wang, 2020; Miller, 2004). Our study aims to increase the understanding of how women in STEM craft and develop their careers. We rely on career construction theory (CCT) (Savickas, 1997), which “elucidates the decision-making and transitional processes individuals undergo in their careers” (Demirtaş-Zorbaz et al., 2024, p. 2). According to CCT, individuals are active creators of their work environments (Savickas & Porfeli, 2012), they connect past experiences with their current situation to make future career plans, and through ongoing adaptation they navigate opportunities and constraints in an attempt to meet situational demands (Savickas, 2005).

Within the CCT framework, career adaptability is defined as self-regulatory capacities that may change over time and situations and that are activated by factors within the person, the environment, and their interaction (Savickas & Porfeli, 2012). Besides predicting positive career outcomes (Rudolph, Lavigne, Katz, & Zacher, 2017), career adaptability may amplify positive career dynamics or buffer against the negative events individuals might encounter in pursuing their career (Johnston, 2018). It encompasses four sub-dimensions—the 4C's of adaptability—that help individuals effectively manage career-related tasks and transitions across the working lifespan, namely career concern, career control, career curiosity, and career confidence (Zhou et al., 2024).

The present study aims to bridge the literature on women in STEM and CCT by adopting a dynamic agentic perspective where women proactively prepare for transitions and thrive in the pursuit of their career aspirations within STEM fields. Moreover, scholars have identified some unanswered research questions that call for further empirical elaboration (Rudolph et al., 2019). First, CCT depicts career development as a dynamic process (Savickas, 2013), during which career adaptability competencies might be activated in different ways. Notwithstanding, researchers neglected the investigation of dynamic changes in its subdimensions across specific phases of the lifespan. Second, Rudolph et al. (2019) called for an extension of the career adaptability theory from quantitative and broad samples to “more specific, underrepresented, or marginalized groups” such as women in STEM professions, to further develop the theory and to identify its boundary conditions.

Building upon these considerations, we aim to answer the following research questions: How do women in STEM fields deploy their career adaptability through the main stages of their career development to attain their aspirations? How do contextual factors interact with career adaptability in supporting or limiting them in attaining career progression? We address these questions through a qualitative study comparing a sample of women and men working in engineering who hold leadership positions. Through a narrative approach, we analyze the career transitions of women across three critical phases, namely education and internships during studies, early career, and upper leadership (Duchek et al., 2022). For each phase, we identify the 4C's mobilization as well as the relationships with the environment in which women operate. We also compare the narratives of women with those of men to validate the findings.

The present research advances the current debate on women in STEM and the literature on career adaptability in several ways. First, differently from research that has primarily investigated the barriers women face in attaining a STEM career or how they respond to systemic gender stereotype threat (Block et al., 2019; Cruz & Nagy, 2024; Khilji & Pumroy, 2019; Kuchumova et al., 2024), we provide evidence of the role of agency in career development, highlighting the importance of career adaptability as a peculiar behavior activated more specifically by women than men in engineering to craft their aspirations and to persist in their STEM careers. Second, we add to the conceptualization of career adaptability by demonstrating how its 4C's differently manifest across the three main career phases. Moreover, this study advances our understanding of the most critical contextual factors peculiar to each phase, that affect and are influenced by career adaptability.

2. Literature background

2.1. Women in STEM

Extensive research has shown that the careers of women tend to display complex patterns of continuity, interruption, and exit attributed to multiple life roles and gender stereotypes (Bonesso & Cortellazzo, 2024; Simosi et al., 2022). Thus, a linear and unidirectional path is likely to be an oversimplification when studying the career development of women, especially in STEM fields where women face gendered workplace structures, which are derived from different forms of gender bias such as masculine defaults (Cheryan & Markus, 2020) and systemic stereotype threat (Block et al., 2019).

Masculine defaults are a form of bias in which characteristics and behaviors associated with the male gender roles are rewarded and valued or viewed as the standard in a given cultural context (Cheryan & Markus, 2020). In STEM professions, these hidden cultural

biases suggest that mathematical abilities are stronger in men than in women. Thus, the stereotype that men have an innate brilliance for science (Bian et al., 2018) may lead women to perceive that they do not have the necessary attributes to succeed as a scientist, demonstrating lower belonging and interest in STEM fields. Even when women's characteristics align with masculine defaults—for example, dressing and behaving in a specific manner—those behaviors may be overlooked or they may experience backlash for acting outside of their expected gender roles. Moreover, because STEM work settings are male dominated, it could be difficult for men to understand that the same environment that fits for them could be aversive to women (Schmader, 2023). In the same vein, male-dominated professions are still permeated by a systemic stereotype threat (Block et al., 2019), which occurs when a system that is characterized by gender disparities applies visible and invisible negative stereotypes about women's performance, potential, and, consequently, career development. Stereotype threat is activated by socially ascribed conceptions, such as the idea that women engineers are less capable of performing field work or that being an engineer limits parenting. These views induce cognitive and physiological responses (Cadaret et al., 2017) that lead women to disengage from the domain where they experience the threat or to express the intention to quit due to the perception that their gender identity is incompatible with a STEM work identity.

Women also face unique challenges to enter STEM professions due to internalization of traditional gender roles, which are shaped since childhood (Shenouda et al., 2024). Consequently, during the educational path, female students may face greater challenges in approaching the science and technology domains and they may show poorer perceived self-efficacy and less autonomy in their studies than male students (Elvira-Zorzo et al., 2025).

In general, compared with other professional fields, women in STEM seem to experience more barriers such as discrimination, inadequate support for dependent care, hostile workplace climates, network exclusion (Kiazad et al., 2024), as well as a lack of role models and of promotion opportunities (Jiang, 2021). They may also experience some forms of unprofessional conduct such as ostracism, hostility, undermining, and sexual incivility (Saxena, 2024; van der Marel et al., 2024). These circumstances can induce women to opt out from STEM professions and enter more suitable sectors (Kiazad et al., 2024). In contrast, men appear to have structural advantages that make their career path in STEM with less barriers. For example, when men are evaluated by male recruiters, they are more likely to be hired because they are expected to be more committed and available to their jobs and careers and less involved with family and domestic responsibilities (Friedmann & Efrat-Treister, 2023). They are also more likely to receive sponsorship and praise from superiors, and, in general, positive recognition and early promotions (O'Connor et al., 2020; van der Marel et al., 2024).

Against this backdrop, STEM professions are a particularly suitable setting in which to investigate how women engage with and succeed in male-dominated fields. The persistence of women in STEM has been widely researched in educational settings, revealing aspects such as the importance of supportive actions for choosing a STEM education path, and the prestige associated with STEM degrees (Kuchumova et al., 2024; Pilotti, 2021; Riegle-Crumb & Peng, 2021). After finishing the education cycle, career decision-making becomes complex and the decision whether to work in a STEM field is influenced by self-beliefs and external factors. Indeed, women's career progression is supported by individual factors, such as high levels of self-efficacy, the ability to adapt to work culture and experiences, an orientation toward others in work environments, and engagement in work (Blaique et al., 2023; Buse et al., 2013; Kuchumova et al., 2024). Moreover, research on women in STEM has considered organizational elements (such as the effect of career counselling and one-on-one mentorship), contextual supportive elements (such as shared parental leave and shared childcare roles between the parents), and the institutional environment as factors that can help women to create a supportive structure and interpersonal relationships (Michaelides et al., 2023; Reilly et al., 2019). Despite these contributions, these studies adopted a static approach, because they isolated the individual and social factors that influence women's persistence in STEM fields during education or a few years after graduation (Kuchumova et al., 2024; Morganson et al., 2015; Sáinz et al., 2020), limiting the understanding on dynamic decision-making. Scholars have called for further research focusing on women's persistence over a long-term period (Kuchumova et al., 2024) and the need for more research on career transitions across the lifespan through an agentic perspective (Akkermans et al., 2024).

Moreover, few studies have adopted an agentic approach to investigate the coping strategies implemented by women in addressing challenges in the pursuit of their career in the STEM fields. For instance, Khilji and Pumroy (2019) identified three strategies to deal with gender norms: (a) conforming, which means playing by the rules and thus adapting to the dominant, masculine culture (Miller, 2004); (b) compromising, which involves negotiating how to navigate around the rules; and (c) defying to establish their own rules. Similarly, in their literature review on career experiences of women in STEM, Makarem and Wang (2020) delineated the following coping strategies: (a) conforming, characterized by acceptance of the masculine norms; (b) impression management through which women project a competent, gender-neutral engineer professional image of themselves (Hatmaker, 2013), downplaying the conventional feminine behaviors; and (c) proactivity that enables women to challenge gender-imposed expectations. Furthermore, Block et al. (2019) found three response patterns that women in STEM show so that they can work in a stereotype-threatening system: feeding off the threat, confronting the threat, and sustaining the self in the presence of the threat. Although these studies have considered the behavioral response women adopt to face stereotype threat in STEM fields, they devote limited attention to the strategies females implement to make decisions in self-directing their career over time. Furthermore, Duchek et al. (2022) illustrated how women in top leadership positions have developed resilience resources throughout their lifespan during early childhood and early career, and have built resilience behaviors during the upper leadership phase. The findings confirmed that the resources women require to progress and persist in their career can be developed through a dynamic process during different career phases. Considering the barriers that women in STEM face compared to their male counterparts, they are expected to frequently adapt to changes during different career phases. For women, taking responsibility for their own career success through individual proactivity and personal agency is more crucial than for men in order to cope with difficult STEM environments and develop the necessary competencies to pursue their aspirations.

2.2. Theoretical framework

We employ the career construction theory as the guiding theoretical framework to investigate how successful women in STEM have reached their leadership positions. CCT adopts a dynamic approach to explain vocational behavior across the lifespan and maintains that career adaptability plays an important role in sustaining their long-term career development (Savickas, 2005; Savickas et al., 2009) through four dimensions: career concern, career control, career curiosity, and career confidence (Guo et al., 2014; Rudolph, Lavigne, & Zacher, 2017).

Career concern is the primary dimension of career adaptability. It is a future orientation and refers to the belief that it is important to prepare for tomorrow—and for tomorrow's success—with the knowledge that present vocational situations have evolved from past experiences and it is important to connect them to a preferred future (Savickas, 2013). *Career control* over one's vocational future emerges when an individual makes deliberate decisions and takes conscientious action about how their career choices become responsible for shaping themselves and their environments. *Career curiosity* refers to information seeking and exploration of the fit between oneself and the work world, helping to make choices that fit the self to situations. This attitude of exploration leads to experiences that increase competence in self-knowledge and occupational information. Finally, *career confidence* arises from solving difficult situations or complex problems, reinforcing the perception of self-efficacy, self-esteem, and self-acceptance (Savickas, 2013).

According to Bouckennooghe et al. (2022, p. 1), "research on career adaptability has mainly relied on a variable-centered approach, focusing on the average effects of its four resource dimensions in relation to antecedents and outcomes within a given sample." Rudolph et al. (2019) stated that due to its multidimensionality nature (Hirschi & Valero, 2015), there is still a need to overcome the tendency of considering these adaptability resources in an aggregated way, through the analysis of individual strategies related to each dimension and the interrelationship among them. Only few studies have tried to provide a more in-depth qualitative representation of the behaviors related to each subdimension of career adaptability (Luke et al., 2016; McMahan et al., 2012); however, they did not describe how the 4C's of adaptability change across specific phases of the lifespan. Moreover, there has been limited research focused on the role of career adaptability in supporting women in their career development (McMahan et al., 2012; Takawira, 2020) and specifically whether different configurations of career adaptability resources are activated across the career lifespan. The present study aims to address these gaps by investigating how the 4C's of adaptability are deployed by women in STEM, compared with their male counterparts, across the different career phases, starting from their education choice and moving through their early working experiences to the attainment of leadership positions.

Furthermore, career adaptability is malleable, meaning that it changes in response to situational factors (Koen et al., 2012). Consequently, we investigate contextual factors to better understand the relationship with women's career adaptability in navigating their STEM careers, and whether they have a different impact compared with the career experiences of men. Because gender stereotypes emerge in childhood and are reinforced during adolescence and the entrance to the labor market due to socialization of gender roles (McGuire et al., 2020), we investigate the role of different contextual factors in supporting or hampering women's aspirations, intentions, and persistence in STEM. Specifically, we focus on the role of the family environment in influencing women's interests and skills in STEM and the subsequent decisions of their educational path (Tandrayen-Ragoobur & Gokulsing, 2022). Literature has also highlighted the lack or the presence of developmental relationships (e.g., mentoring and networking) as relevant contextual factors in limiting or promoting women's career decisions in STEM (García-Silva et al., 2025; Saffie-Robertson, 2020). Therefore, we consider the possible constraints and opportunities related to the absence or presence of such supporting relationships in the different stages of their career progression. Once women enter the labor market, workplace culture can either inhibit their representation in STEM through discrimination, or support it through inclusive practices (Takawira, 2020). Thus, we analyze the characteristics of the organizational contexts experienced by women and the extent to which such environments interact with career adaptability to retain and support them.

3. Method

3.1. Research design and setting

To answer the two research questions, we adopted a qualitative method to gain a nuanced understanding of the career decision-making and construction dynamics of women in STEM. Specifically, we relied on the narrative approach, which is particularly useful for exploring life and career changes and transitions (Hoyer & Steyaert, 2015). Furthermore, Del Corso and Rehfuess (2011, p. 335) argue that "career construction theory, through the power of narrative, addresses how people construct their careers as they translate their storied identity into work roles."

To explore how women with a master's degree in STEM have gained and developed a leadership position within a male-dominated context, such as engineering, while overcoming contextual obstacles and developing personal resources and adaptability competency at various stages of their careers (education, early career, and leadership roles), we analyzed the career paths of women in leadership positions within the engineering sector in Italy. This country has one of the highest proportions of women graduating in STEM subjects (Eurostat, 2024a), yet it is also one of the European countries with the lowest proportion of women employed in these fields (Eurostat, 2024b). According to the Italian National Institute of Statistics (ISTAT, 2024), there is a significant gender disparity in STEM degrees, with 37 % of male graduates and only 16.8 % of female graduates in these subjects. Despite this lower representation, the graduate profile report (AlmaLaurea Focus Gender Gap, 2024) revealed that, in 2023, women graduating in STEM (natural sciences, mathematics, physics, statistics, information and communication technologies, architecture, and engineering) performed better than their male counterparts. They achieved a higher average degree grade (104.7 out of 110 compared with 102.8 for men) and demonstrated

greater consistency in their studies. Among women, 58.6 % completed their studies on time, compared with 54.2 % of men. However, women are penalized when they enter the labor market. A survey of employment conditions revealed that, 5 years after obtaining a master's degree, the employment rate for STEM graduates is 90.4 % for women and 94.6 % for men, with a significant pay disparity (AlmaLaurea Report, 2024). Within STEM fields, the area with the largest employment rate gap (9.3 percentage points) is "informatics, engineering and architecture" (81.8 % for women and 91.1 % for men) (ISTAT, 2024). Investigating a sample of Italian women who have successfully pursued a career in an extreme field such as engineering could provide valuable insights into the adaptive behaviors that have enabled them to persist in their career path.

Table 1

Personal, educational and professional characteristics of the interviewees.

ID	Age	Parental status (number of children)	Master's degree	Company role	Years of experience in current organization (April 2025)	Interview duration (minutes)
Characteristics of the female sample						
1	46	1	Environmental & Land Planning Engineering	Project Manager and Infrastructure Senior Engineer	2.7	74
2	44	2	Environmental & Civil Engineering	Project Manager	13.4	77
3	50	2	Environmental & Land Planning Engineering	Proposal Director	20.8	84
4	37	2	Environmental & Land Planning Engineering	Project Coordinator	4.2	56
5	39	1	Architecture	Project Manager	7.7	60
6	50	3	Environmental & Land Planning Engineering	Proposal Manager	1.7	66
7	65	2	Construction & Civil Engineering	Technical Leader	26.5	68
8	32	0	Architecture and Construction Engineering	Project Manager	7.1	91
9	42	0	Civil Engineering	Project Manager	10	86
10	39	2	Energy Engineering	Project Technical Leader and Line Coordinator	13.9	97
11	53	2	Civil Engineering	Technical Leader Director and part of the Board of Directors	28	99
12	35	1	Civil Engineering	Project Manager	2	81
13	41	0	Architecture	Project Manager	7.4	75
14	51	0	Environmental & Land Planning Engineering	Chief Operations Officer	8	111
15	45	2	Civil Engineering	Senior Project Manager	2.6	84
16	34	0	Environmental & Land Planning Engineering	Business Development Manager	0.8	141
17	40	2	Chemical Engineering	Energy Market Leader and Senior Project Manager	10.7	88
18	57	2	Civil Engineering	Technical Leader and President of the Board of Directors	33.4	86
19	45	0	Architecture	Project Manager	8	96
20	44	2	Environmental & Land Planning Engineering	Project Technical Leader and Market Leader	5.7	85
21	50	0	Civil Engineering	Senior Project Manager	17.1	85
Characteristics of the male sample						
22	57	2	Geology	Chief Operations Officer and Technical Director	7.6	63
23	45	2	Industrial Engineering (Mechanical Engineering)	Director of Infrastructure	13.1	108
24	57	1	Civil Engineering (structuring)	Senior Project Manager	5.5	72
25	39	0	Civil Engineering + Geotechnical Engineering	Senior Tunnelling Engineer & Company partner	5.3	73
26	52	0	Engineering for the Environment and the Territory	Service and Operations Director	10.1	41
27	49	2	Civil Structural Engineering	Program Manager, Structures Senior Engineer	11	73
28	54	1	Environmental Science	Technical Director environment, Product Owner, Project Manager	21	70
29	38	3	Construction Engineering	Project Manager, Operations Manager	11	47

3.2. Sample and recruitment

To collect data, we involved four Italian companies for whom engineering and architecture professionals represent a strategic role. In particular, they operate in the following sectors: large infrastructure and transport infrastructure design, urban regeneration, sustainable engineering and architecture design, and integrated water and waste management. To achieve geographic representation, these companies are located in different cities in northern and central Italy, where the main engineering firms are based ([Report 2024 on the Italian Architecture, Engineering and Construction Industry, 2024](#)).

The companies were also selected for their commitment to achieving gender balance within their organizations. In this regard, the chief executive officers (CEOs) and human resources (HR) managers founded a network in 2022 with the aim of promoting the presence of women in STEM fields, through an orienteering activity in STEM schools and dedicated webinars in their own companies. The nature and recent diffusion of the initiatives promoted by the network can exclude that women's involvement in this project is conceived as a personal strategy for being integrated in their male working context ([Block et al., 2019](#)).

We contacted the CEOs and HR managers of each company and after receiving their commitment to the research, they acted as gatekeepers and supported the research team in selecting a sample of women who had reached and succeeded in leadership positions in their companies. The invitation to participate in the study was sent to all company employees who met the requirements (being female, having a STEM degree, and having a STEM leadership position). The final sample comprised 21 women with a master's degree in STEM, mainly in civil engineering with various specializations, such as geotechnical engineering, hydraulic systems, transport engineering, environmental engineering, chemical engineering, energy engineering, and architecture. The women had an average age of 44.7 years, an average of 11 years of experience at their current company, and an average of 1.2 children. The diversity of the women in terms of different age groups, work experience, and family status widens the range of perspectives, enhancing the credibility and transferability of the findings. [Table 1](#) provides additional details about the participants.

To highlight the unique characteristics of career adaptability among female engineers at different stages in their careers, we expanded our sample to include male engineers working in the same companies. The selection procedure and criteria were the same as those implemented for the sample of women. Indeed, we asked the CEOs and HR managers to involve men with STEM degrees in a leadership position in the company. We reached saturation, or the point at which the same themes started to recur, and no new insights were offered ([Creswell, 2007](#)), after eight participants who had linear career trajectories in this male-dominated sector. Their average age was 48.9 years, they had an average of 11 years of experience at their current company, and an average of 1.4 children. [Table 1](#) also includes the characteristics of the men.

3.3. Data collection

The data were collected and analyzed by a research team that comprises two authors. The first author is a tenured academic with 20 years of research experience in HR management, gender, leadership, and women's careers. She specializes in qualitative research and teaches qualitative methods in doctoral programs. The second author is a postdoctoral researcher with 10 years of consulting experience in leadership, gender, and career development. Both authors are trained in qualitative research methods, including research interviews. To enhance confirmability ([Lincoln & Guba, 1985](#)) and thus ensure that the study's findings are grounded in the data and not influenced by the researchers' biases and interests, the authors familiarized themselves with STEM career trajectories by discussing, prior to data collection, the gender dynamics in the engineering sector with HR managers, CEOs, and consultants operating in this field.

We used in-depth, semi-structured career history interviews in line with our narrative approach to comprehensively examine the career construction behaviors adopted by the women in the sample. The research questions were designed based on themes from existing studies ([Rudolph, Lavigne, & Zacher, 2017](#); [Savickas, 2005](#)) and the purpose of the present study, thus allowing the exploration of emerging themes.

To capture the life stages and career paths of women leaders, we chose a biographical approach that enabled us to understand the participants' development from their choice of secondary school to their present life as a leader. We decided to start investigating their choices from high school due to the characteristics of the Italian context, where after middle school, students are asked to select one of three tracks (academic, technical, and vocational high school) that strongly influence the choice of university. For example, 80 % of graduates from STEM universities in 2015 completed a scientific academic or a technical track during high school ([Carlana, 2019](#)). Further information on the interview process and research protocol used can be found in the [Appendix](#).

Each participant provided informed written consent to take part in the study in accordance with European regulations to ensure compliance and to protect confidentiality. After the participants signed the consent form, the two authors conducted the interviews through an online platform and digitally recorded them. The interviews lasted 90 min on average, excluding the presentation of the researcher's profile, a general introduction to the research, and the sign off. The interviews were transcribed verbatim and checked by the two authors by reviewing the audio-recordings and correcting any inaccuracies. They were conducted in Italian, the language of the interviewees and the researchers. To triangulate and enrich our interview data, we also used secondary data and specifically publicly available materials such as previous interviews released by these women, information gathered by the HR managers and the CEOs of their companies, and their LinkedIn profiles. After data analysis and coding, conducted in Italian to ensure a deeper understanding and elaboration of the information emerged, selected quotations were translated into English by the first author. Given the risk of introducing potential bias during the translation ([Temple & Young, 2004](#)), the second author back-translated the quotations into the original language (Italian) to verify the accuracy of the English translation. If necessary, the translations were adjusted to guarantee that the meaning of the original quotation had been maintained (e.g., [Rogiers et al., 2022](#)).

3.4. Data analysis

Data analysis followed a narrative approach (Josselson, 2011; Riessman, 2008), which is particularly suitable for studying women's intentionality and purposeful efforts in deploying career adaptability in navigating their STEM careers for several reasons. First, the narrative approach allows the investigation of women's meaning-making of the events and related decisions they have made across their career, and consequently it provides opportunities to study their agency in relation to the events narrated. Second, time represents a salient characteristic of narratives and the reconstruction of the chronological order of events allows connecting past and present to create coherence over time. Finally, narratives are always situated in social space, thus women's stories about their relational context are relevant to understand the constraints and opportunities they face as well as to investigate how they mobilize agency in relation to the external environment (Chudzikowski et al., 2020). Thereby, we adopted thematic analysis to identify patterns that were repeated among interviewees across the three main career stages investigated.

Because the interviews used open-ended questions, allowing spontaneous insights from the participants, the narrative presented recurring reference among events that occurred in the different stages of the professional journey. Thus, we restored the narrative to analyze the events in chronological sequences according to the three main stages of the career path: the educational path and internships during studies, early career, and upper leadership. For each career stage, the analysis focused on episodic memories that comprise what happened in a particular "event" in the career construction—for example, the choice of the secondary school or of the university program and the decision to leave a job for another professional opportunity or to accept a promotion.

In the first stage of the coding process, each author read and coded five interviews separately; we regularly wrote memos to capture our thoughts about the data and suggestions of changes in the emerging codes. We utilized open coding and segments of data were labeled as the coders read the transcripts, adopting *in vivo* codes, namely the exact words used by the participants.

In the second phase, the two authors compared the sentences they selected and the corresponding codes created in each phase to indicate specific characteristics related to the key themes under investigation, namely the 4C's of adaptability. Any eventual social or contextual factors emerged as an enabler or constraint was also coded. The discussion helped find any discrepancies on the attribution of the sentence to each code. Next, each author coded four other interviews and repeated the discussion phase. Because we reached an agreement on most codes, each author coded the remaining interviews independently. This iterative process of alternating independent analysis of the interviews and subsequent discussion to solve disagreements led to several additions or fusions of codes.

To ensure the trustworthiness of the research, we actively engaged in reflexivity during the data analysis. We constantly challenged and reviewed our initial expectations and interpretations of the data to provide rich, alternative viewpoints and we reported in a document the reflections on the decisions made during the data interpretation and subthemes identification phase to make the assumptions explicit. We also presented the emerging codes to the HR managers and CEOs of the involved companies and to experienced male and female researchers to seek the views of other scholars and professionals in the field.

In the final stage, we increased the level of abstraction, moving toward theoretical concepts to account for heterogeneity across interviewees. For example, in the educational phase, in the "concern" career adaptability path, the first *in vivo* code highlighted the future work self and the calling of the interviewee, defined separately as personal goals and the desire to have a positive impact on society. These two codes collapsed into a single subtheme, labeled "choosing the educational path based on personal interests and the prospective impact on society."

Consistent with Miles and Huberman (1994), the final coding emerged as the result of an alternation between emerging codes and the literature to identify for each phase of the career development the subthemes pertaining to each main theme. This process resulted in 21 subthemes pertaining to the 4C's of adaptability across the three career stages. We describe them in Tables 2, 3 and 4, which are introduced in Section 4. The tables report exemplary quotes from both men and women in the sample, distinguishing differences between them. Moreover, we elaborated a conceptual framework, illustrated in Fig. 1, which provides a visual representation of the subthemes, together with the relevant contextual factors that interact with career adaptability.

4. Findings

Our inductive analysis revealed how women rely on career adaptability to proactively direct their advancement in STEM fields. In each of three career phases analyzed, women activate the 4C's of career adaptability (concern, control, curiosity, and confidence) through different behaviors to cope with career transitions. Each phase is also characterized by different enabling and constraining factors pertaining to the social environment. We compared the women and men in the sample to highlight the peculiarities related to the gender dynamics in their career construction.

4.1. Phase 1: Early entrance in STEM—education and internships

In the early entrance to STEM, the women in the sample retraced the moments in which they had to make the choice of which high school and university to attend, recalling the decision-making process, including how the choice was made, the people they involved, and the most important moments they remember from that period in which they began to develop awareness of their passions and interests, directing their study choices toward the career they desired. They also described any first approach to the world of work during the educational path where they experienced for the first time the concrete application of what they had studied, such as internships carried out to develop their degree thesis. Table 2 provides illustrative quotes on the career adaptability behaviors manifested during the three main stages of both the female and male samples.

Table 2

- Career adaptability subthemes related to the educational path and internships during studies.

Career adaptability	Subthemes	Quotes from the women	Differences found in subthemes in the male sample	Quotes from the men
Concern	Thinking about what specific competencies might be required for STEM occupation in the future	<p><i>"I became passionate about these more environmental subjects, because twenty years ago they were more modern, they were still something new, something that had only recently come out. I saw that even at a working level it was a faculty that offered more opportunities than the others."</i> (Interviewee 2)</p> <p><i>"Rationally, I also thought about what I could do after my studies, and I thought that environmental engineering would be the most complete."</i> (Interviewee 14)</p>	Men express more general evaluations on the future job market	<i>"The choice of a scientific high school was influenced by my natural inclination toward scientific subjects. Also, the scientific high school provides a general education that allows me to choose my field of work and slightly more opportunities."</i> (Interviewee 29)
	Choosing the educational path based on personal interests and the prospective impact on society	<p><i>"I wanted something more practical, something that was also not too technical. I wanted to do something that had an impact on the real world I lived in."</i> (Interviewee 10)</p> <p><i>"At the university, the choice was dictated by finding something practical of mathematics, so I didn't want to follow a course that was purely abstract, but I considered something more similar to me, something that was applied to the real world."</i> (Interviewee 12)</p>	Men make their decisions about their educational path based on personal interests and not the prospective impact on society	<i>"I ended up studying geology at university mainly because I love outdoor activities."</i> (Interviewee 22)
Control	Changing the educational path to pursue personal passion or what is perceived as coherent with the person	<p><i>"I remember that he [the high school professor] told my mother in a meeting that maybe engineering wasn't for me, but I didn't listen to him, I was determined enough and so I took that path."</i> (Interviewee 11)</p> <p><i>"When I was a child, I thought architecture could be my way. I wanted to do art in high school, but my parents thought that a scientific high school could give perfect preparation because the willingness of being an architect could disappear. [...] I took the decision of the university on my own and I confirmed my youthful desire."</i> (Interviewee 8)</p>	Men make educational choices that are consistent with their previous scholarly path	<i>"When choosing the university, I found that the technical high school I attended was very focused on civil engineering topics. Many subjects, such as construction sciences and topography, were ones I had already studied."</i> (Interviewee 25)
	Deepening specific skills related to the career idea	<p><i>"I waited for a position in that company because it was a dream of mine to get into it [...], for me it was the best, so I waited for this internship to be activated [...] because it was a path that I liked and that interested me."</i> (Interviewee 10)</p> <p><i>"I met the professional with whom I developed the thesis at a conference. I approached him humbly and asked him to work with him to elaborate my thesis. We completed a very important job. After discussing the thesis, I had a remarkable open path to the world of work."</i> (Interviewee 21)</p>	Men search for a more generic support for identifying a field of specialization	<i>"I was sure I wanted to write my thesis in a specific field, so I contacted the geology professor, which was the field I wanted to write my thesis in, asking her what the possibilities were."</i> (Interviewee 28)
Curiosity	Exploring new disciplines	<p><i>"We have dedicated the entire week to meeting the orientation desks and there was this faculty of Engineering for Environment and Territory that intrigued me."</i> (Interviewee 20)</p> <p><i>"When I saw that there was Technologies & Structures [a master's specialization], I went to its presentation. I liked it, they encouraged me to do a deeper study, even research on everything that revolves around not only how a building is, but how a building lives, how it is used, what are the aspects of comfort, what are the aspects that</i></p>	Men follow the traditional study path and don't explore innovative alternative options	<i>"Initially, the choice of university was somewhat forced, as I felt more aligned with humanities than science. However, I was persuaded that scientific disciplines offered greater career prospects compared to humanities. Consequently, I chose civil engineering as my major, as it was the one that appealed to me the most."</i> (Interviewee 27)

(continued on next page)

Table 2 (continued)

Career adaptability	Subthemes	Quotes from the women	Differences found in subthemes in the male sample	Quotes from the men
	Tacking original study themes and working experiences that are appealing to companies Being aware of STEM capabilities	<p>make it destined to last. [...] It was the first time that this master's specialization was added." (Interviewee 13)</p> <p>"That was also a good experience, we had to create a software for the liquefaction of a slope so it was a mathematical thing linked to a geotechnical aspect [...] It was a nice moment, also the one of developing the thesis, where I afforded a bit of an unknown topic because it was a geotechnical topic compared to mine, in which I had done structures." (Interviewee 11)</p> <p>"[Doing my thesis abroad] I have to say that this is also an experience that I am very happy to have had, partly because writing my thesis in English, working in English and living abroad certainly gives you an extra edge when you have to use this language for work." (Interviewee 16)</p>	Men take study themes and working experiences based mainly on personal interests	"A friend of mine from university asked me if I was interested in going to Mexico to study volcanology. I said, 'Wow, yes, right away!' Volcanology has always been a passion of mine, so I liked the idea of writing my thesis on volcanology. I liked the idea of spending a few months abroad, so..." (Interviewee 22)
Confidence		<p>"I really liked scientific subjects, I really liked mathematics, and I was good at it." (Interviewee 7)</p> <p>"[About the master's degree that lasts 2 years] I said: well, I have to finish it in a year and a half, in order to finish with my colleagues, and in fact I did it [...] I obtained what I wanted with the results that I wanted and finally the satisfaction that I wanted." (Interviewee 8)</p>	Men take their STEM capabilities for granted	"I attended a science high school because I have always been passionate about science, particularly mathematics, as well as the humanities. However, I was more inclined toward the sciences, which is why I went to a high school specializing in science." (Interviewee 23)
	Relying on personal resources to overcome difficulties in STEM disciplines	<p>"[At the university] at the beginning I had some difficult moments, because, despite having solid mathematical foundations thanks to my [high school] teacher, there were subjects that were outside my basic preparation. But I still didn't give up., I said, 'It's okay, let's carry on anyway.'" (Interviewee 21)</p> <p>"I was good. I'm not being modest, but I was good at what I did. But I always had this thing where, for example, if I wasn't able to do a math exercise, I would sit there and think and think to better understand it." (Interviewee 9)</p>	Men overcome difficulties in STEM disciplines relying on external factors rather than personal elements	"I found engineering to be a bit more difficult. I found the first two years to be really sterile: it was just calculations. It certainly wasn't enjoyable, except for a few exams. However, I have to give credit to some of my professors. A good professor who knows how to engage students can completely change your approach to studying." (Interviewee 26)

4.1.1. Career concern

Career concern focuses on a person's future orientation, understanding that it is important to prepare for tomorrow and realizing that the present vocational situation and choices connect to a preferred future (Savickas, 2013). We identified two main career concern subthemes in the educational phase recurrent in the interviews of female engineers: "thinking about what specific competencies might be required for STEM occupations in the future" and "choosing the educational path based on personal interests and the prospective impact on society".

The first subtheme emphasizes that when these women chose their courses of study at university, they focused not only on subjects they liked, but also on how well their studies aligned with STEM job market requirements, evaluating the concrete opportunities they could seize upon finishing their studies. As illustrated by the following quote, Interviewee 21 chose her university course considering not only her personal interests, but also the competencies she could learn and how she could apply them in future STEM workplaces:

[The element of water was] very interesting as a topic, also as a type of future work because, I mean, the hydraulic engineer doesn't just deal with some aspects, it allows one to operate at 360°, enhancing multidisciplinary. This guided me in my choice. (Interviewee 21)

The men rarely mentioned specific evaluations of the future job market. When they discussed this issue, they expressed their reflections in more general terms, not addressing specific STEM specialization, as emerged for the women, for whom preparation for the labor market is a more pressing concern given the initial potential entry barriers. The following quote illustrates this well:

At that time, it was also a choice based on the expectation that professions would evolve toward scientific subjects. That is, because it was expected that scientific subjects would lead to greater job opportunities. (Interviewee 27)

The second subtheme, "choosing the educational path based on personal interests and the prospective impact on society", sheds

Table 3
- Career adaptability subthemes related to early career.

Career adaptability	Subthemes	Quotes from women	Subthemes in the male sample	Quotes from men
Concern	Thinking about the future organizational contexts that support professional growth	<p><i>"I really liked that it was a large company. I didn't like the small working environment of ten people at my previous company for my whole life. What I was looking for the most and I liked most was interacting with different cultures."</i> (Interviewee 6)</p> <p><i>"I work in an engineering company so I like to get into how something is built, how it's made, how to build things with quality. So that's what has characterized me since the beginning."</i> (Interviewee 13)</p>	Men select the organizational contexts based on economic stability and promotion opportunities	<p><i>"I didn't see any growth or prospects, so I felt uninspired. I wasn't acquiring any new skills. I was always doing the same old things. I wasn't very stimulated. But more than anything, I was bored because there were only two or three of us in this branch, so there wasn't much stimulation."</i> (Interviewee 29)</p>
	Identifying the desired job	<p><i>"I have always been particularly fond of my role as a mentor to young individuals. I have been doing this since before I was a technical director. I enjoy keeping in touch with young people and helping them grow by equipping them with the necessary tools, because there is always so much to learn in this work."</i> (Interviewee 7)</p> <p><i>"Over time, I matured and realized what are actually my qualities and main characteristics. I have always recognized myself as a technician who is not precise or fine, but rather substantial and of good quality. Perhaps this lends better to coordinating than calculating and designing. From then on, it's what I've always tried to do."</i> (Interviewee 4)</p>	Men search for progression from operational to managerial responsibilities	<p><i>"At the first company, I experienced the owner-manager's extreme pragmatism. Is there a problem? I'll show you how to solve it. We go to the site, and we do it—no discussion. The second company taught me management skills, such as planning work and workloads, and how to become a manager. They showed me how to organize work in an organic way, which definitely allowed me to make the leap into management."</i> (Interviewee 23)</p>
Control	Being persistent and determined in achieving professional goals	<p><i>"It was a tiring project, partly because the parent company was working against it. They weren't trying to hinder us, but they did point out a whole series of risks, so we had to defend this project. I was really invested in it and put a lot of effort into it. Then we won it, and now it's one of the most important drinking water treatment plants in Italy so I feel like I was doing something right."</i> (Interviewee 3)</p> <p><i>"We were trying to participate in two tenders, which necessitated making some sacrifices like working evenings and weekends and working all night long in the office. It was a challenging situation, and I stated: 'If this continues, we will be in a position to win both tenders.' It was the first time in which I recognized that the effort was truly worthwhile."</i> (Interviewee 8)</p>	Men are fully dedicated to the profession	<p><i>"The beginning was challenging. I would say that I worked eight hours and then studied eight hours in my free time—on weekends and in the evenings—to prepare for new topics. So, yes, I must say that the first few years were interesting and satisfying but also very demanding professionally."</i> (Interviewee 28)</p>
	Making challenging career decisions	<p><i>"I found a new company that had just opened. [...] The nice thing about this firm was the variety of projects we worked on. [...] I learned a lot there. I started as a simple draftsman, but I slowly became head of the drafting department. [...] This was, of course, quite challenging in terms of responsibility and working hours."</i> (Interviewee 5)</p> <p><i>"I made career choices that meant I didn't earn much, but that was my decision. If I had not taken a part-time job to raise my children, I would</i></p>	Men experience a smooth career trajectory	<p><i>"[During the first experience working on a construction site abroad] I enjoyed myself and didn't encounter any particular difficulties. This was partly because I was working for an Italian design company that had been called to Turkey to provide expertise in this area. On the construction site, I never experienced any difficulties or discrimination... perhaps it was quite the opposite."</i> (Interviewee 25)</p>

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Table 3 (continued)

Career adaptability	Subthemes	Quotes from women	Subthemes in the male sample	Quotes from men
Curiosity	Searching for fields or formal learning opportunities to broaden the repertoire of skills	<p>certainly have become a technical director sooner." (Interviewee 7)</p> <p>"The great thing about my work is that, although the projects are all similar, each one is different. There's always some technical innovation and a bit of a struggle. It's a job where I never get bored." (Interviewee 3)</p> <p>"I decided to work for International Development Cooperation, so I spent about four years in Romania and the Balkans working on development education projects. I moved from strictly engineering and architecture topics to project management. The projects were quite varied." (Interviewee 19)</p>	Men search for fields or formal learning opportunities to broaden the repertoire of skills	"For me, it was fundamental to see the entire design process, especially in the underground area. I wanted to explore and see everything involved, from preliminary design to detailed execution and on-site construction assistance." (Interviewee 25)
Confidence	Recognizing personal qualities to attain professional goals	<p>"I am by nature a very organized and pragmatic person, so I tend to plan everything, from my personal life to my work life. Therefore, I did not find it difficult to transition from an operational role to a coordination one." (Interviewee 4)</p> <p>"Initially, I worked as a project engineer. However, I have always been more inclined toward the relationship with the client and people management. Little by little, I focused on these aspects to transition to a role that was not that of the engineer who does the calculations, but rather, the one who manages them." (Interviewee 10)</p>	Men recognize their abilities from the positive feedback obtained from the work and the social environment	"I think the early years at that company were wonderful. Most of us were around the same age, and it was a great time. We worked well together, worked hard, and built some fantastic plants!" (Interviewee 26)
	Being aware of how work experience has helped to develop skills	<p>"I used to be quite shy, locked in my books and research. I've learned to let myself go sometimes, because it helps. This experience helped me because, at a certain point, I had to interact with the public and learn to engage with everyone." (Interviewee 1)</p> <p>"If you work in a family business, you can see everything. It's in your interest to see everything. There's no one to say: 'This part is not yours. You can't see it.' So, you grow a lot." (Interviewee 6)</p>	Men show self-trust thanks to previous on-site experience	"The interview went very well, and I must say that the induction process also worked well because I found myself doing things that I had already done in my first jobs, so I already had the technical skills." (Interviewee 28)

light on how the women employed long-term reasoning, balancing their personal interests in STEM subjects at university with the activities they aspire to pursue in their future employment. They placed a particular emphasis on concrete contributions to society, such as practical endeavors, leading a group of people, or contributing to environmental protection. The following quote illustrates this combination of personal needs and a positive orientation toward the surrounding social environment:

Therefore, for me the area for which to allocate my efforts of study and work for the next "x" years, I wanted it to be something that interested me, and the protection of the environment and territory is; but also, something that had a somewhat social, ethical, ecological purpose, a basic ethic, the fact of doing things for the right and in some way tangible. (Interviewee 16)

The manifestation of these career concern's features in this phase suggests that women who demonstrate perseverance in their aspirations exhibit intrinsic motivation in science and technological disciplines, along with a sense of purpose in contributing to the enhancement of their social community. A pragmatic and forward-thinking stance regarding the progression of STEM disciplines empowers them to discern the knowledge and competencies that organizations will demand and prioritize.

Concerning this second subtheme, the career concerns of the men did not include deep reflections on their future impact on society. Their selection of an educational trajectory was determined based on their individual aptitudes and interests:

I have always had a huge interest in engines, so when people ask me why I chose engineering, I always respond that it is because I could assemble, disassemble, and reassemble my motorcycle engine in an hour and a half. (Interviewee 23)

4.1.2. Career control

Career control refers to the ability of an individual to take responsibility for their own actions and decisions, keeping a positive outlook and doing what is right for oneself (Savickas, 2013; Savickas & Porfeli, 2012). We identified two career concern subthemes for

Table 4
- Career adaptability subthemes related to upper leadership.

Career adaptability	Subthemes	Quotes from women	Differences found in subthemes in the male sample	Quotes from men
Concern	Reflecting on the leadership responsibilities	<i>[When she was offered the new role]: "I initially experienced some tension. However, I had already established an emotional connection with the incumbent because he told me, 'You can do it.' It felt right to ensure that all the scientific knowledge created would be passed on, providing continuity for my mentor."</i> (Interviewee 18) <i>"When my manager retired, I took over his role. This meant managing the team, organizing everyone's work, assigning projects, following up on projects, and ensuring that deadlines and procedures were met."</i> (Interviewee 3)	Men reflect on the leadership responsibilities	<i>"I also pay attention to personality traits because getting a group to work together is delicate. Teamwork requires balance, and sometimes I reject candidates who are technically well-prepared but lack this balance due to personality traits that do not convince me."</i> (Interviewee 28)
	Identifying salient leadership competencies to learn	<i>"I found a stable group of designers. This allows me to develop my management skills by approaching different personalities. The other skill I'm working on is filtering the information and tensions between the client and project team because not all designers perform well under pressure."</i> (Interviewee 12) <i>"I am developing a skill that I perhaps still don't have: the ability to delegate. I need to make sure that I don't take on responsibilities that aren't mine. I tend to take on things that shouldn't be my responsibility because of my determination to reach the goal."</i> (Interviewee 5)	Men mobilize new behaviors to handle relationships in leadership roles by leveraging existing skills	<i>"I try to have discussions with my team that aren't the institutional ones that I dislike. We have to do them because of the mandatory annual review, so we meet, sit down and chat, but I don't like it. I really enjoy going on missions with them, visiting construction sites and clients, and using those informal moments to talk about ourselves and encourage them."</i> (Interviewee 22)
Control	Showing self-determination in their career advancement	<i>"The role of coordinator was proposed to me by the CEO. It's not an easy role, but I accepted it straight away. I accepted the challenge and took on the role."</i> (Interviewee 21) <i>"I am not afraid to challenge myself with something I don't know. This role was also challenging because I have basically been working on railways my whole life, and now I'm working on bridges and roads."</i> (Interviewee 1)	Men take career progression for granted	<i>"One may decide to leave a place because one is unhappy there, but that's not enough; one must decide to leave with the prospect of improvement. In that case, there was economic and environmental improvement, a project idea [...], so the decision was quite automatic. I worked until Friday and then on Monday I started on the other side."</i> (Interviewee 24)
Curiosity	Nurturing vocational inquisitiveness	<i>"Then there's the contact with young people, which is so enriching because while working with these young people on a project, there's an exchange of skills and perspectives. The beauty lies in passing on knowledge to someone else."</i> (Interviewee 7) <i>"I approached that company precisely because of my curiosity, and desire to explore new topics. One such topic is Scrum [an agile team collaboration framework] on which the company based its structure and organization."</i> (Interviewee 12)	Men experiment through the stimuli offered by organizational contexts and induced by the appointment to new roles	<i>"Perhaps the biggest challenge the organization presented me with was when they asked me to be the project manager for a non-environmental project. I said, 'Okay, I'll give it a try.' I like to experiment and see how far I can go. The company knows that I'll get things done, so they find it quite easy to propose things to me."</i> (Interviewee 28)
Confidence	Being aware of their strengths as leaders	<i>"I think I have a natural inclination toward relationships. Maybe it just comes naturally to me to build a team. Of course, technical competence is necessary. But I have an attitude that involves coordinating people."</i> (Interviewee 20) <i>"In the beginning, I worked as a project engineer, preparing drawings. However, I was always more interested in customer relationships and the 360-degree vision of the project. So then, I slowly transitioned</i>	Men show a willingness to undertake leadership roles regardless of the perceived level of their abilities	<i>"Now I'm the project manager and coordinator. Above all, I enjoy the technical coordination aspect, whereas another colleague prefers the administrative and budgetary side of things. We've therefore found a balance whereby I manage everything related to technical production and he manages the budget."</i> (Interviewee 25)

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Table 4 (continued)

Career adaptability	Subthemes	Quotes from women	Differences found in subthemes in the male sample	Quotes from men
	Creating a reputation as a professional	<p>to a role where I could manage people." (Interviewee 10)</p> <p>"The people I work with gave me positive feedback. They told me that when I joined the team as leader, the situation improved. I'm certainly pleased with that." (Interviewee 15)</p> <p>"I joined the new company because I had designed many products for them, so they knew me professionally. My previous boss always writes me messages of appreciation." (Interviewee 1)</p>	Men use external feedback as a form of validation of the already recognized potential	"I was asked if I would be interested in becoming an operations manager in the construction sector, which has declined somewhat in recent years. They thought that I would be the right person to turn things around. Given my managerial rather than technical skills, I accepted." (Interviewee 29)

women engineers: "changing the educational path to pursue personal passion or what is perceived as coherent with the person" and "deepening specific skills related to the career idea".

For the first subtheme, the women's choices regarding their educational studies demonstrated a high degree of proactivity and decisiveness in selecting a path consistent with their preferences. This is evidenced by their decisions to pursue a field of study despite the suggestion of others as well as their willingness to change their course of study if they find a more fitting area of interest. For example, some women reported shifting from a humanistic high school to an engineering university or changing their current university. Interviewee 1 described the moment she decided to change the focus of her master's degree, without being influenced by her partner with whom she completed her bachelor's degree:

My partner and I did the first two years of university together, then that course wasn't really for me, so I moved to [another city] and completed my studies with a direction that was more fitting to me. (Interviewee 1)

No significant changes in educational paths emerged from the interviews with the men. All opted for a scientific path in high school (either a scientific high school or a technical institute), and the only man who chose a classical high school, was sure to pursue a scientific subject at university:

I chose classical studies because I thought it would provide more opportunities and a broader understanding of different disciplines. [...] Even though I already had a clearly scientific direction in my ideas as a field of study and then of work. (Interviewee 28)

For the second subtheme, "deepening specific skills related to the career idea," we found that the women proactively took responsibility to undertake further specialization that allowed them to delve into a specific topic and better direct their career path. For example, they waited for the opportunity for an internship at the company of their dreams rather than exploring opportunities elsewhere not coherent with their professional goals. In other cases, they proactively sought out external professionals who could assist them in the development of a particular topic of interest or proposed themselves for an internship with an experimental study that allowed them to improve new skills which might contribute to their future career:

One morning I saw an announcement on the bulletin board from a professor who was looking for young people to gain experience on some experimental studies. [...] I swooped in, I called him immediately and I was chosen. (Interviewee 2)

This specific episode highlights an interest in cultivating distinct competencies as well as a readiness to capitalize on emerging opportunities. Therefore, in the educational path, career control seems to be characterized by the understanding that women have the capacity to make decisions by themselves regarding their future careers. Thus, the interviewees showed greater proactivity in identifying specific experts and the experiences for developing the required competencies.

For this subtheme, the men clearly showed an interest in performing practical tasks to apply their acquired skills and searched for a more generic support from their thesis supervisors to find a context in which to apply their skills:

After five years of study, I was quite bored; it was always books. I asked my professor to support me with my thesis and to try to find a company interested in an experimental thesis. It was then that I entered this small, medium-sized company. (Interviewee 23)

4.1.3. Career curiosity

During the initial stage, the women expressed their career curiosity by exploring the options offered by STEM fields before making a choice about the learning path they should pursue. Their interest lay in evaluating the emerging educational path and playing an active role in the development of original themes for either the thesis or the internship experience. Our empirical analysis revealed two subthemes regarding career curiosity in the educational path: "exploring new disciplines" and "tacking original study themes and working experiences that are appealing to companies".

The first subtheme emerged from the interest the interviewed women expressed in different topics, demonstrating a multidisciplinary attitude. During the transition from secondary education to university, the women explored a variety of educational programs, often deviating from the conventional path. For example, they participated in university's orientation events to learn more about the program of study offered, including the newest courses, and to determine which ones best suited their interests and expectations:

I looked around and I had also focused my attention on other subjects anyway in the scientific field. [...] I chose this Civil Engineering for Sustainable Development, which was the first year that it was activated at that university. (Interviewee 9)

In contrast, the interviewed men rarely engaged in introspection regarding the potential opportunities presented by the university's academic programs. Notably, they had already delineated their academic trajectory before finishing secondary school, without delving

CAREER STAGES

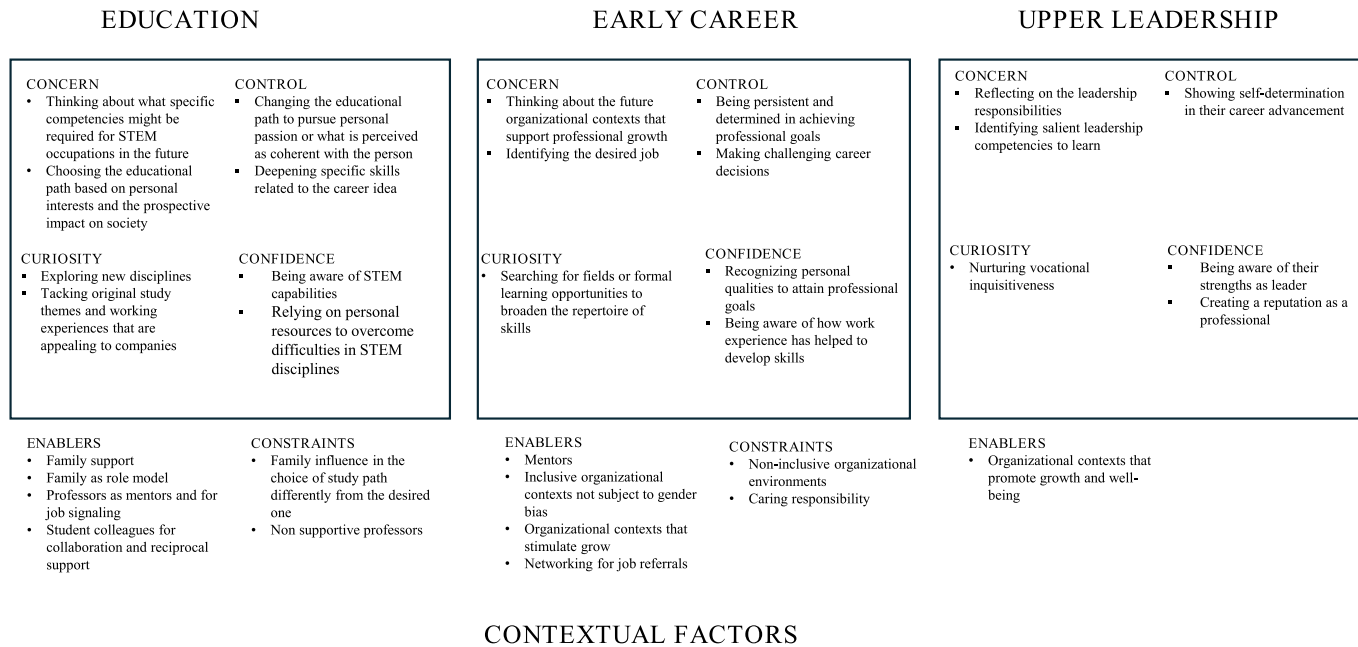


Fig. 1. Conceptual framework illustrating the subthemes pertaining to the 4C's and the contextual factors for each career stage.

deeply into the subjects offered. Rather, they followed a traditional study path, as illustrated by Interviewee 24:

In retrospect, I followed a simple path in choosing a university, although I don't regret it. A more careful choice at that time might have yielded better results. I studied civil engineering because it was the natural progression from high school to university. (Interviewee 24)

The second subtheme, “tacking original study themes and working experiences that are appealing for companies”, emerged when the participants began to have concrete experience of the working context for their thesis or realized that they needed to afford new or different topics compared with the subjects studied during university as the following interviewee narrates:

I had this job interview with a person who grasped my desire to learn. I said: “I don't know anything about land reclamation, but I studied geology, hydrogeology, sanitary engineering, and I'm good at writing. If you want to teach me, I really want to learn”. (Interviewee 20)

Regarding their initial experiences, the men appeared to take companies' requirements for granted, focusing instead on developing their own area of interest. As Interviewee 26 recounted, it was the professor who later proposed him to gain direct experience by taking measurements at a plant:

I chose a professor who specialized in water treatment because it seemed the most interesting topic to me. After five years of studying, going to a plant, seeing how it works, and playing with water seemed the most natural and fun thing in the world, finally applying what was learned. (Interviewee 26)

4.1.4. Career confidence

Career confidence refers to the ability to perform efficiently, overcoming obstacles and learning new skills with a feeling of self-efficacy (Savickas, 2013; Savickas & Porfeli, 2012). Two main subthemes of career confidence emerged based on the educational path: “being aware of STEM capabilities” and “relying on personal resources to overcome difficulties in STEM disciplines”.

Regarding the first subtheme, the interest in and the awareness of performing particularly well in scientific topics emerged from the interviews with the women. Several interviewees openly declared their ability—almost with the fear of appearing pretentious:

I was good in more or less all subjects. I say this without modesty and without boasting, it was like that: it came easy to me. (Interviewee 3)

This awareness of being particularly gifted in scientific disciplines also clearly emerged in women who chose a different main path during high school. For example, Interviewee 17 opted for a classical high school, motivated by the opportunity of undertaking supplementary hours of training in physics and mathematics. Her initial idea regarding her attraction to scientific subjects was subsequently validated by her academic performance in high school. This led to an increased awareness of her self-efficacy in the domain of scientific subjects, which in turn influenced her decision to pursue a career in the sciences:

I was really good at scientific subjects, so mathematics in particular was my passion, while I had to study harder on philosophy and history because they were subjects that I liked but on which I really had to apply myself a lot to obtain satisfactory results. (Interviewee 17)

The confidence of the interviewed men in STEM subjects was expressed as a natural inclination toward the scientific disciplines. They expressed their awareness of their capabilities with less emphasis, taking them for granted:

Studying science was never up for discussion. Perhaps it was because I wasn't very good at humanities subjects, but I was good at science. So, I guess I had no choice but to go to a scientific high school. (Interviewee 22)

For the second subtheme, “relying on personal resources to overcome difficulties in STEM disciplines”, the interviewees expressed that although they were proficient in scientific subjects, moments of difficulty always arose despite their commitment, and they had to face and overcome them. For example, Interviewee 11 narrated how she focused on developing an internal ability to self-motivate and to overcome a moment of difficulty at the beginning of her university experience, reinforcing her confidence in overcoming initial potential obstacles:

I remember moments of discouragement, of exams that I prepared so much but then they didn't go well... There was a test to pass to do the exam and I didn't pass it. It was really disheartening, then I said: “It's okay, now I start again and I'll do it.” I remember this motivation that triggered me and then I passed the exam. (Interviewee 11)

The narratives demonstrated the paramount importance of women identifying and leveraging their personal resources to overcome adversity, also relying on prior personal experiences. It is worth noting the strategies employed by women who attended high schools specializing in humanistic studies when they transitioned to STEM disciplines at the university level:

Mathematics is nothing more and nothing less than a language: It has its symbols, its semantics, its alphabet. If I learn it, I can decrypt it, and then I can understand it. And starting from this point of view, I was not discouraged [to persist]. (Interviewee 16)

Therefore, this dimension of career adaptability was not only expressed by the self-beliefs about math-related abilities but also on a broader awareness of personal resources beyond the STEM domain that could be mobilized and coherently adapted to face obstacles in the science fields.

In their interviews, the men mentioned the difficulties they encountered in tackling STEM subjects as temporary and normal moments that they overcame thanks to elements present in the context, such as studying with peers or meeting a motivating professor, rather than by activating their own internal resources. The following quote exemplifies the influence of the support of university classmates to perform more efficiently:

Studying in a group meant there was more discussion about understanding mathematical proofs and comparing notes, which helped me a lot. I remember studying with both boys and girls, but I found the girls to be much more disciplined, organized, and accurate. I preferred studying with them because I saw that I was improving more quickly. (Interviewee 28)

In other cases, they correlated their difficulties in passing an exam to the characteristics of the professor rather than to personal issues:

Professor X was an absolute genius, but he designed this course that was like a mountain that was very difficult to climb. (Interviewee 24)

4.1.5. Contextual factors

During the educational phase, the women also highlighted the presence of contextual factors that supported or, on the contrary, hindered them in pursuing their STEM studies. The first contextual factor we identified as salient is family, which influenced the women's career choices in contrasting ways. Indeed, families may pose an obstacle when they discourage women from pursuing an education in STEM. However, interviewees, during high school study, developed a greater awareness of their real interests and inclinations, which helped them to reinforce their initial ideas about STEM:

I went to a classical high school, because there were no other high level educational schools nearby according to my family, so these five years have been a bit of a nightmare. [...] When I went to enroll in a Literature University I recognized, let's say, the characters, the personalities of the professors I had met during high school and I ran away. So, I took the engineering entrance test. (Interviewee 2)

Family also emerged as a supportive factor. Family members represented models from which to take inspiration or they recognized the value of the women and helped them in difficult moments (which may be related to personal issues rather than from an economic point of view):

My family had no economic possibilities; even though they supported me beyond belief, even when I said "I give up everything!", they were my first fans, they were very proud of me from the bottom of their hearts. (Interviewee 15)

Family always emerged as a supportive factor for the men. The interviewees referred to parents, siblings, or relatives who worked in specific scientific fields, and who influenced their choice. Family also served as a guide, aiming to ensure a path perceived as safer.

In most cases, the male interviewees' personal inclination toward scientific subjects persisted, and family support continued to be a constant but more latent element, providing both economic and emotional support. For example, Interviewee 23 remembered the indirect influence of his family:

I was more inclined toward scientific subjects, so I attended a science high school. I come from a family where my father and my siblings are engineers and my mother is a mathematician, so let's say that the scientific field has always hovered in the home. (Interviewee 23)

Another relevant contextual factor is the university environment. In the majority of the women's experiences, professors played the role of mentors, but also, they acted as strategic intermediaries for job signaling to find the first job opportunities. For example, Interviewee 18 remembered:

A key figure for me was Professor "X," who recommended me [to a company after finishing university] and with whom I did many projects together, and for me he has always been a point of reference, truly a guide. (Interviewee 18)

The university professors were also an important figure for the men in building a career by acting as a link to the job opportunities available in STEM.

A few women mentioned that their interactions with professors contrasted with non-supportive behavior from students, culminating in a few instances of isolated situations involving gender discrimination:

The last important factor that emerged as a contextual enabler in the STEM educational path was the role of university colleagues. In fact, the narratives revealed that the creation of a group of students frequently represented a sort of comfort zone. These peer colleagues provided a way to study, to join forces in times of difficulty, and to have moments of leisure:

I was lucky enough to be surrounded by colleagues who later became friends who, to tell the truth, are the best, humanly and professionally, that I have found [...]. They also had this sort of humanity, spirit of collaboration so as not to abandon you. (Interviewee 9)

Some of the interviewed men recalled the small presence of women among their colleagues. However, they emphasized that they perceived it as a neutral fact, without discrimination:

Out of 200–300 students, there were six or seven females, and they tended to be a bit more isolated. This is an unfortunate reality, but it's related to the numbers. (Interviewee 24)

Some men mentioned that their female classmates were also facilitators for their colleagues sharing their personal notes and providing inspiration with their method and consistency.

4.1.6. Discussion of phase 1: Early entrance in STEM

Prior research has primarily concentrated on self-concept of math ability as a significant predictor of study choice in STEM, especially in men (Cuder et al., 2024; Wegemer & Eccles, 2019), whereas limited attention has been devoted to the vocational interests and personal values of female students entering STEM (e.g., Schelfhout et al., 2021; Wegemer & Eccles, 2019).

Evidence from our research demonstrates that women encompass a complex interweaving of components related to career adaptability. In their career concern behaviors, female students devote more time toward self-exploration of their personal values and interests. Moreover, they connect their purpose to a future orientation, with respect to potential interests in the job market, but also trying to match personal interests with the potential contribution they could generate to society at large. On the other hand, male students demonstrate their career concern by choosing their educational path based on their evident propensity toward scientific subjects, without activating particular adaptability efforts.

Women manifest their career control behaviors by formulating independent decisions regarding their academic pursuits based on their eventual discovery of a disciplinary area that aligns with their interests. The proactivity in career decision-making is also evident in their investigation of the specific competencies required to achieve their career aspirations and it is noteworthy their personal investment in identifying opportunities to acquire these competencies. Our analysis of the responses from men revealed no drastic changes in educational path choices, as well as a lower level of proactivity in seeking practical opportunities to apply the theoretical knowledge they acquired in university courses.

Furthermore, the exploratory orientation to STEM cultivates curiosity among female students, transcending traditional academic courses. This approach encourages the exploration of opportunities presented by new disciplines at the beginning of their academic path, and a propensity to experiment with their newly acquired competencies when the opportunity arises, as in the case of internships

for the writing of the final thesis. On the other hand, male students choose traditional university courses and internships based mainly on their own interests. They are confident that these experiences will meet the demands of the companies once they have completed their studies.

Finally, women's confidence in their career path is derived not only from their math skills, but also from their personal resources and mindset beyond the STEM domains that they mobilize to overcome initial obstacles in approaching STEM studies. Male students demonstrate confidence in STEM subjects, but they take this for granted. Any difficulties they encounter during their education do not challenge their perception of themselves.

Overall, this study has contributed to the advancement also of knowledge regarding the interplay between agency and social context. Our findings showed that the educational path is more complex and has more specific nuances for women than for men. For example, the family's role as a model can facilitate the development of career concern in young women. On the other hand, contextual constraints are overcome by proactively activating personal resources and past similar experiences.

4.2. Phase 2: Early career in STEM

Regarding the early career phase, the women narrated their experiences in the labor market as technical professionals in engineering companies. They described the career transitions they experienced when they decided to move to different companies or when they changed roles and responsibilities within the same organizational context. They reported the process through which they progressively became aware of their career aspirations, overcoming obstacles but also benefiting from contextual resources that supported them in defining their vocation. Table 3 presents a selection of illustrative quotes for each subtheme associated with the 4C's of adaptability for both female and male samples.

4.2.1. Career concern

In approaching the engineering sector and imagining their future careers, we identified two subthemes related to career concern: "thinking about the future organizational contexts that support professional growth" and "identifying the desired job."

The first subtheme emphasizes the role of reflection on prior experiences and the assessment of workplace characteristics that predominantly align with women's career aspirations and progression. Indeed, approaching different companies helped the women to appreciate some characteristics of the organizational environment but also to recognize those that they preferred to avoid in their future experiences. Specifically, women search for contexts that allow them to enrich their professional experience, also valuing the positive organizational climate:

I started looking for medium-sized engineering companies, as I found myself drawn to the type of projects undertaken by such firms. So, I moved to a very large, dynamic, international company because I knew it would open the door to the world I wanted to enter. (Interviewee 4)

For the men, economic stability emerged as a key dimension underlying career concern and oriented them in choosing the organization environment in which to work. Many interviewees reported that they moved to other organizational contexts because of the economic uncertainty of their current job. Another reason was to avoid internal dynamics in which they felt limited in their growth by the owner's control or by the absence of career opportunities, typical of small companies with a simple management structure:

I felt stifled at that company. I worked for a family-run business, and I didn't like certain aspects of it, so when the opportunity to work for a major multinational company arose, I jumped at it. In a family-run company, the boss gets angry when things go wrong. In a multinational company, on the contrary, decisions and responsibilities are divided among different departments. In terms of psychological and emotional stress, it's a completely different experience. (Interviewee 26)

In the second subtheme, "identifying the desired job", the women expanded on the desired organizational context by identifying specific characteristics of the job that mostly met their aspirations:

I should have renewed the same contract with the same company in England, but they never offered me anything better. I wanted to do something more, that's all. (Interviewee 14)

A thorough examination of their professional activities and their preferences led the women to identify roles and related tasks they seek to fulfill in the engineering sector and within their respective organizations, whether they were more managerial or operational roles (see Table 3). The awareness activated by career concern regarding the context and the role they aspired to attain has been shown to better orient women in their career planning, thereby preparing them for future career advancement.

Given that the men had no difficulty accessing operational roles on construction sites at the outset of their careers, unlike women, they developed during their early career the desire to limit the operational role in favor of more managerial responsibilities:

In addition to the specialist's abilities, I also have different ones, and I liked the opportunity to try using them. I was able to use them all, including the specialist's competencies, which I was already familiar with, and I had implemented with a few years of experience. I also liked the opportunity to use and expand my relational and organizational skills. (Interviewee 27)

4.2.2. Career control

Two main subthemes emerged from the women's narratives: "being persistent and determined in achieving professional goals" and "making challenging career decisions".

With regard to the first subtheme, the women narrated their difficulties in facing gender stereotypes, which hindered their professional advancement. They demonstrated perseverance, acquiring new competencies, and ultimately achieving their objectives. For example, Interviewee 2 stated that when her company did not allow her to attend the course to become a project manager, she made the decision to pursue a formal certification independently:

They probably thought the project manager (PM) role was more a man's role, so they decided to offer the opportunity to attend the PM

course to another colleague. A few years later, I did a private course for PM at an Engineers' Association. I didn't give up there either. At a later time, I also took the company's course, and I've achieved that goal. (Interviewee 2)

This persistence and determination also emerged from the men's narratives, but it was considered as part of the engineering profession that requires full dedication at the early stage. They also highlighted how they followed a natural career trajectory, starting from the construction site and accumulating the skills for the next steps in their career that enabled them to gain a reputation in the work environment, and to overcome challenges:

I must say that I have been very fortunate. I started working from the bottom—from the geological side and drilling—and as I gained confidence, I climbed the difficulty level. (Interviewee 22)

For women, this career phase was also characterized by various transitions that necessitated challenging choices, that we labeled "making challenging career decisions", for example leaving a secure job for working in a newly founded company composed of young professionals that had great growth potential. In another case, Interviewee 1 accepted a challenging position, becoming the first woman engineer in a company leading a team of male colleagues:

I attended a job interview and the entrepreneur told me: "Let's see, it will be challenging: there are 50 men there in all who I think have never been led by a woman." However, I accepted the challenge. I wasn't afraid to take on the opportunity to start a new chapter in my life. I began this journey, and that's where I discovered my true passion. (Interviewee 1)

For the women, personal agency through career control behaviors allowed them to exercise initiative and perseverance in the face of gender norms that were present in the work environment. It also necessitated the courage to undertake transitions that might be challenging and sometimes initially not aligned with their desired career goals, with the objective of realizing in the future the aspirations associated with their desired profession. In contrast, most of the men described their initial career as a natural transition. They did not remember any specific problems during this phase, nor did they have to make challenging decisions that required particular determination, which highlights their smooth career trajectory. For example, one interviewee said the following when describing his first work experience:

I would say that I did not have any great difficulties. On the contrary, I learned a lot. It was a beautiful environment. We were all very young. (Interviewee 24)

4.2.3. Career curiosity

We found that career curiosity involved each individual exploring their possible future self and opportunities, and thinking about how they might influence different work roles and environments. We identified the subtheme "searching for fields or formal learning opportunities to broaden the repertoire of skills". Specifically, the women reported that they were able to seize learning opportunities during their work experiences. For example, they exhibited a propensity to explore diverse geographical contexts or to engage in challenging and innovative projects, thereby seeking to broaden their skills set and to advance their professional development. In this regard, Interviewee 4 described how she relied on two senior employees to consciously sought to get the best out of them:

I engaged in extensive shadowing with these two managers. They had distinctive soft skills and I attempted to learn something from each of them. I'd say that I've learned primarily by working alongside them, by managing job requirements and making decisions with their support, and therefore they contributed to develop who I am today. (Interviewee 4)

Based on the narratives, during the early stage of their STEM careers, the women manifested curiosity in the form of exploratory behaviors that enabled them to identify and capitalize on learning and skill development opportunities, adopting a growth mindset. They considered experimentation with different tasks and geographic contexts, as well as the selection of knowledgeable references in the field of engineering, to be viable methods for developing the skills that could reinforce their professional identity as engineers.

Career curiosity manifested similarly for the interviewed women and men. The men described their approach to experimenting with the competencies acquired during their educational training in various contexts and they undertook organizational transitions motivated by their desire to get involved in diversified experiences, such as working abroad and experimenting with different job contexts (small design studios, large companies, university research centers). The quote from Interviewee 23 exemplifies his curiosity to take on new challenges after he became confident in his performance:

I realized that I could have continued doing what I was doing for another ten years, but it was time to try something new. I had proven that I could succeed here, and I no longer had anything to prove. I was ready for a change. (Interviewee 23)

4.2.4. Career confidence

In the early phase of their professional journeys, the women cultivated optimistic beliefs regarding their capabilities and the feasibility of attaining their career aspirations through two distinct behaviors: "recognizing personal qualities to attain professional goals" and "being aware of how work experience has helped to develop skills."

For the first subtheme, the women identified specific qualities that enabled them to achieve important work milestones during their early careers. Leveraging these personal characteristics, they overcame obstacles and managed complex projects, increasing their confidence in themselves and preparing them for their subsequent career advancement. For example, Interviewee 6 paused to reflect on those qualities that allowed her to be recruited by the current company:

They recognized my ability both on the client side to captivate them, but also my willingness to solve problems. Problems have to be faced and solved, and I think these skills have been the keys to my success in my career path and have given me confidence in myself. (Interviewee 6)

Differently from the women, the men became aware of their strengths mainly from the outcomes attained, and the feedback received in the organizational context, which motivated them to aspire to progress in their careers:

My manager always gave me positive feedback. Although he never said so explicitly, I sensed that I might become an active member of the company in the future. (Interviewee 29)

Regarding the second subtheme, “being aware of how work experience has helped to develop skills,” during their early careers, the women demonstrated a clear understanding of how specific experiences can serve to reinforce their areas of improvement, thereby getting closer to their overarching career goals. For example, Interviewee 20 emphasized the importance of first-hand experience of visiting work sites, along with the ability to handle male-dominated contexts and earn respect:

The field experience was useful to me in two ways. Firstly, I got to practice with lots of different things, which helps me now to understand the data I receive. I've also learned how to earn respect from men by being on the field — in that kind of field. I know the dynamics [...]. For example, I never use my title of engineer in the field. I only use it when I want to say: “Wait, you're exaggerating!” (Interviewee 20)

For the men, working at construction sites provided particularly enriching and formative experiences that allowed them to apply the theoretical knowledge they had acquired during their studies. Therefore, they represent an ideal place to grow professionally and develop confidence in one's abilities:

Looking back now, the idea of me managing three teams on the construction site makes me laugh, but at the time it was a huge task. I struggled to keep up with one team, so having three was completely overwhelming. I had moments of enormous discouragement, as I'm sure everyone does. In the end, though, you get through it, and it helps you grow. (Interviewee 22)

It is interesting to note that some male respondents recognized construction sites as a place where gender stereotypes persist despite their gradual decline over time:

Working on a construction site, for example, was mainly a man's job. [...] Many construction sites were environments that did not welcome women. (Interviewee 22)

4.2.5. Contextual factors

Based on the women's narratives of their early career transitions, the social environment emerged as a catalyst for achieving their career aspirations. However, it also impeded their progress and rendered their career trajectory more intricate.

Concerning the contextual enabling factors, a recurrent theme that emerged from the women is the possibility of relying on mentors, professionals who are prepared and available to provide them the support they require when they enter the STEM field. For example, these senior professionals consider young female engineers as a resource, thus sharing with them their knowledge on technical issues, and providing support for relational aspects. A quote from Interviewee 1 that narrates the importance of a mentor for her professional journey, exemplifies this concept:

A colleague of mine who was an expert on railroad armament gave me an introduction to all the issues related to railroad switches because they aren't studied in university. This person had reached his working peak, become an executive, and retired. Now he wanted to share his knowledge with people he was comfortable with. I owe everything I learned at the beginning to him. (Interviewee 1).

Another factor that supported women in their STEM career is the presence of an inclusive organizational contexts not subject to gender bias that stimulate their growth, as the following interviewee narrates:

I landed at this company, which has a large female workforce. Shortly thereafter, the new CEO elected was a woman. Women were already represented in managerial roles and internally I have always had a linear path, without obstacles. (Interviewee 4)

Finally, the women took advantage of networking for job referrals. They relied on their network of contacts to find new job opportunities:

The interview with this company went well because the person who signaled me, already knew me. So, it was an interview where there was someone who had already worked with me, and vouched for me. (Interviewee 20)

The contextual factors that acted as constraints for the women are primarily related to non-inclusive organizational environments and the caring responsibilities that were perceived as limitations for the pursuit of their aspirations. In their early approach to the engineering field, they encountered a male-dominated culture that made their acceptance in the organizational environment more difficult:

However, the sector is very masculine. When I went to the workshop, the foreman said: “Ah, but you are a woman. You are married. You have children. What are you doing here?” (Interviewee 6)

Caring responsibility (e.g., coping with parents' illness and maternity) was another contextual factor that for some women in the sample represented the cause for postponing entry into certain roles or organizational contexts or for deciding to change jobs:

In those days, I realized I was pregnant with my first child, so I told them, “Look, I'm not coming.” They said they were very sorry because all that was missing was the CEO's signature and that they'd be in touch later. (Interviewee 7)

On the contrary, the predominantly male nature of the engineering field favored the integration of the interviewed men. Interviewee 26, for example, described his perception of the organizational context when he entered a new job as follows:

When I arrived, there was a male predominance. There were a few female technicians and engineers, but not many. Above all, they were seen as process engineers rather than construction site workers or operational staff. (Interviewee 22)

Similarly to the women, the men emphasized the importance of having a competent manager who is willing to share knowledge and act as a mentor, especially regarding technical skills:

My direct supervisor, with whom I remain in good relationship, had a despotic attitude at times, but I think it was more due to his insecurities about his role than his actual attitude. He taught me a great deal about what I know now from a technical point of view. (Interviewee 22)

Finally, networking and maintaining good relationships with colleagues and professors are strategic elements for men in supporting career development as the following quote exemplifies:

The professor said to me, “I just spoke with this company. Would you be interested in working for them?”. I knew the company because it specialized in exactly what interested me, so I replied, “Wow, absolutely!” (Interviewee 25)

Regarding work–life balance, the men acknowledged difficulties managing family commitments, particularly those involving children. However, they did not allow these difficulties to influence their career development. Instead, they drew on third-party

assistance, such as involving grandparents or hiring domestic helpers:

Having children changes the way things are organized, but thanks to someone helping us around the house every day, neither my wife nor I experienced any significant impact on our work. (Interviewee 24)

In summary, contextual factors also influence men's career development. However, because this environment is traditionally male oriented, the interviewees primarily revealed supportive factors rather than constraints.

4.2.6. Discussion of phase 2: Early career in STEM

In the early career phase, instead of conforming to the gender norms or confronting the threat as suggested in prior research (Block et al., 2019; Khilji & Pumroy, 2019), our findings showed that women rely on career adaptability to engage in a conscious construction of the meaning ascribed to the engineering profession, aspiring to organizations that may facilitate the fulfillment of their expectations. This process of continuous self-development is supported by the ongoing monitoring of the competencies acquired and job requirements achieved through learning experiences, reinforcing their permanence in the field.

In this phase, career concern in the female sample is expressed by the willingness to identify their desired job, enriching their professional growth in a positive work environment, while men positively evaluate organizational environments that allow them to demonstrate autonomy and offer economic stability and career growth opportunities, in line with a prior study (van der Marel et al., 2024). Through career control, women make deliberate decisions that lead them to pursue future career opportunities in different organizational settings, while men are not asked to make challenging decisions and perceive it as normal to fully dedicate themselves to the profession, coherently with prior research (Friedmann & Efrat-Treister, 2023). Career curiosity appears in a similar manner in both women and men, cultivating their curiosity regarding future career trajectories and their confidence in problem-solving and professional success by leveraging the support of mentors and gaining experience in companies that valued their expertise. Focusing on career confidence, men exhibit a natural confidence in their skills matured progressively from the work performed in the construction sites and the opportunities offered by the organizational contexts to enrich their job with more technical and managerial responsibilities. In contrast, women engage in continuous self-evaluation, identifying the strengths they rely on in their work, as well as reflecting deeply on areas they believe need improvement to achieve their professional goals.

Moreover, the analysis of the interaction between agency and external factors revealed a process of mutual influence, whereby, for example, a contextual constraint activates career adaptability, which positively influences the environment in turn, as the following quote exemplifies:

I was the first woman hired in the technical and armament sector. The president of the company said that until that moment, he had thought women would never be able to work at his company. After meeting me, he wrote to me: "You made me change my mind. I realized that this is possible. I consider you a great woman and a great professional." Since I left, about ten women have joined the technical and armament sector. Before, it was an all-male company. (Interviewee 1).

4.3. Phase 3: Upper leadership in STEM

In the last phase, the women described their progression to leadership roles, explaining how they have been promoted within their organizations and have attained the responsibility of entire departments or teams. According to the specific career stage, women described their approach to different managerial positions, ranging from project managers to director, and even president of the board of directors. Table 4 presents the career adaptability subthemes and some illustrative quotes for both female and male samples.

4.3.1. Career concern

In this phase of their career, the women equipped themselves with the necessary competencies to assume the impending leadership roles, navigated the ensuing changes, and effectively confronted the challenges that lay ahead. The empirical analysis revealed two subthemes: "reflecting on the leadership responsibilities" and "identifying salient leadership competencies to learn."

Concerning the first subtheme, the transition to roles characterized by responsibility over resources and people led the women to conceptualize their work in a different manner, reorienting the technical engineering focus toward team management and people development. Interviewee 2 explained how she changed her approach to work considering the perspective of the team members she supervised:

For me, a job is finished when it's finished, regardless of the working hours. Instead, I have to consider that my team is composed of employees who think they can work from 9 a.m. to 6 p.m., because they rightly have another life. I often have to coordinate the team well to ensure that deadlines are met without using extra man-hours or making extra efforts. (Interviewee 2)

The men in the sample also indicated that they employ different approaches when leading team members. They take care of their growth and the balanced distribution of the activities based on the characteristics of each collaborator, as the following quote exemplifies:

This company taught me how to be a manager, how to plan work, and how to plan workloads. You have to understand that you can't overload someone to 190% because you'll burn them out. The leitmotif of my career has always been understanding and structuring work groups so that everyone can contribute to the best of their ability. (Interviewee 23)

The interviewees also described their assessment of the leadership skills necessary to perform their new responsibilities, that we labeled "identifying salient leadership competencies to learn." Indeed, experimenting with leadership roles led women to become aware of skills that they had to develop to manage new responsibilities and to solve problems. Interviewee 13 described how, as a leader, she involved experienced people and then elaborated her own solutions:

In a leadership role, when I was struggling managing something, the first thing I did was look for someone in the company who knew more

than I did. However, I didn't limit myself to that because, given my increased responsibilities, it was also my job to try to find information and contribute something extra. (Interviewee 14)

The men also highlighted the need to mobilize new behaviors in a leadership position, such as relational skills. However, they used the acquired skills to manage new working situations related to their leadership role:

You always have to find a way to ask for something, perhaps manage a conflict... you have to find a lot of different approaches depending on the person. (Interviewee 27)

4.3.2. Career control

The main subtheme that emerged in the women in the sample was “showing self-determination in their career advancement”. When seeking or being offered promotions to managerial levels, they described how they had faced the challenge without fear, with the awareness that it represented a deserved achievement:

And so, when I think back on my journey, on the growth I've had anyway, I say, “OK, this is a new adventure. Let's start.” (Interviewee 9)

This awareness of one's abilities was most evident in upper leadership roles. However, determination weakens, making the choice to accept a new role more difficult. Despite one's skills and managerial position, this choice can seem unexpected, as highlighted by Interviewee 18:

I really cared about the technical director role, and I thought I was ready. I was thrilled when they offered me the position. Not the CEO, though. I have always considered myself a technician and a designer. But I didn't think I was capable of being a CEO. (Interviewee 18)

On the other hand, the men took their career progression for granted. They imagined it before being asked and were ready to accept it when the opportunity arose or they could easily find a new job opportunity that satisfied their career aspirations. Hence, they had greater career control, even in upper leadership positions. The following quote provides an example of how the ambition to become a partner arose and was naturally achieved:

I began to desire to reach the goal of becoming a partner of the organization. [...] I expressed to my manager that my goal was to become a partner because I saw that the progression was to start as an engineer, then become a project manager [PM] of a small job, and finally a PM of a large job, like the current one. Therefore, I saw that the next step would be to become a partner. (Interviewee 25)

4.3.3. Career curiosity

In the leadership positions, women showed career curiosity by “nurturing vocational inquisitiveness”. They manifested this behavior through interactions with individuals under their supervision or by undertaking novel, challenging projects that integrated their passion for the technical domain, expanding also their knowledge in the managerial facets of their work.

This expansion included managing the economic aspects of projects, experimenting with new organizational methods, managing a team, or involving young professionals that could stimulate the generation of new ideas without fear of losing their leadership role. For example, Interviewee 2 described how the new role provided her with a more versatile position and helped her develop better emotional management skills and support her team:

Now, I can do both. I manage some jobs from an economic standpoint, and a project technical leader supports me with the technical strategy. I haven't lost my role; I do both. So, I have a more complete role today. I needed this completeness because I feel more versatile, and I can embrace different projects. [...] As a Project Manager, I learned to manage my temper better and to encourage my team members. (Interviewee 2)

Contrary to the women—who proactively searched for new professional challenges to continuously update their competencies—career curiosity in the men was induced more frequently by their appointment to new roles or by the stimuli offered by organizational contexts. Interviewee 29, for example, stated that coaching sessions were provided by the company due to his new role:

Let's say that the experience with the coach allowed me to increase my leadership within the work group a little bit. It allowed me to be a little bit more direct in communication and therefore more effective as well. [After becoming a company partner] the company has reactivated a series of coaching sessions for me because they wanted to support me in the new role. (Interviewee 29)

4.3.4. Career confidence

Two subthemes emerged regarding the self-confidence of women during this career stage: “being aware of their strengths as leaders” and “creating a reputation as a professional.”

When offered leadership roles, the women initially hesitated, feeling that they were not living up to the opportunities offered. However, after reflecting on their personal characteristics and identifying those that would enable them to perform their role effectively, they accepted the challenge. Interviewee 18 described how she felt when she was offered the position of CEO of the company, and of how things turned out well in retrospect:

At the time, the CEO became chairman and asked me: “Would you like to become the CEO?” I replied, “Absolutely no. I'm not capable or qualified. I'm a technician.” And the CEO said: “No, you can do it!” [...] I couldn't see myself in that role, as I didn't even know what the board of directors did, but I gradually managed to get by even there. (Interviewee 18)

Unlike the women who devoted more effort to reflecting on how their personal characteristics may be relevant for leadership positions, the men were more willing to accept the role whether they felt prepared or not, without expressing their possible hesitation in the workplace:

When I took on the leadership of the technical department, it was something I really wanted to do, because I felt so confident in that area that I never had any doubts. However, when I took on the more managerial role, I did experience some difficulties, but these were my own difficulties, I was afraid that people would not recognize me in that role. I won't hide the fact that I had some hesitation, but I never expressed it. (Interviewee 22)

Moreover, at this point of leadership in their careers, the women perceived that they had an influence on their environment that we labeled “creating a reputation as a professional”, as the following interviewee demonstrates:

And I have seen precisely that over the years of collaboration, the esteem and trust on their part has grown, expressed several times explicitly to me personally on the phone or during contacts. (Interviewee 7)

The men also highlighted how they used the feedback provided by external people to validate their already recognized strengths as a leader. Nevertheless, in contrast to the women, they did not place particular emphasis on the intentional construction of their reputation as a professional. For example, Interviewee 27, talking about a company he had worked for in the past, explained how he reflected on the organization’s expectations and his ability to tackle proposed projects:

We already knew each other and had a mutual respect, so we had spoken on several occasions. We would occasionally joke about the possibility of returning. Then the personnel department called me again [...] and I decided to go back to the same place. (Interviewee 27)

4.3.5. Contextual factors

During the upper leadership phase, we found that the organizational workplace is an important facilitator of career promotion for women engineers. Specifically, the women highlighted the importance of working in an organizational context that promotes growth and well-being. This inclusive and person-developing context has been shown to facilitate the activation of the 4C’s of career adaptability. For example, Interviewee 11 relied on a personal coach who collaborated with the company to strengthen her confidence. Despite being in a high leadership position and holding the role of partner, she needed to reinforce her career confidence:

Having a coach is tiring because you have to look inward. Talking to her helps you understand things you may already know but never tell yourself. For example, she helped me set goals. She also helped me gain confidence. Every time I was offered a new role, she gave me the confidence to know that I could do it. She opens your eyes and gives you self-awareness. This awareness gives you confidence, and confidence allows you to be better with those you work with. (Interviewee 11)

For the men who had the opportunity to use coaching sessions, they did so with an approach not aimed at strengthening self-confidence, but rather at refining skills they believed they already had:

The experience, especially with the coach, has allowed me to increase my leadership within the work group, be more direct in communication, and therefore be more effective. (Interviewee 29)

Another contextual factor that enabled women to achieve work–life balance was the opportunity to benefit from flexible work arrangements. For Interviewee 20, for example, the availability of a hybrid work policy enabled her to balance her work and personal life more effectively when her daughters were younger, allowing her to advance in the career. Now that she is in a leadership role, this flexibility has reinforced her career control, enabling her to make autonomous decisions that benefit both her family and the company, while continuing to cultivate the relationship with her colleagues:

For me, hybrid work has been a lifesaver, especially when my daughters were younger. [...] I like going to the office, and now that my daughters are grown up, I do it to maintain human relationships. I visit clients often and perform inspections. I tend to work from home three to four days a week. I have the freedom to organize myself. (Interviewee 20)

In the male sample, many of the men with children declared that they felt the need to manage the family burden through flexible work arrangements and some external help for the support of the family. Interviewee 27 explained that the dynamics of the engineering sector require full dedication that goes beyond the traditional eight-hour working day, making it difficult to maintain a balance between personal and professional life:

This kind of work impacts the work–life balance. It is all-encompassing because it’s a profession, not just a job, even if you work in an organized place. (Interviewee 27)

Another enabling factor in career progression for women is represented by participating in networking initiatives for women engineers. In particular, in her role as Chair of the Board of Directors of the company, Interviewee 18 explained the motivations that inspired her to assist in establishing a network for women in the engineering field a few years ago:

The company’s networking initiative is a wonderful way to support women in the engineering sector. We usually meet occasionally. Meetings are not very frequent because we are many companies, and people come from different places. However, the idea is to share seminars. For example, we recently organized a very interesting one on psychological safety. We have also done seminars on difficult conversations and the use of language, always in the spirit of maintaining a culture of respect. (Interviewee 18)

In this stage of their career, the women did not perceive specific career barriers or constraints to attain leadership positions. A possible explanation can be ascribed to their ability to activate in the previous stages of their career those adaptability behaviors that created the premises for their subsequent career progression.

4.3.6. Discussion of phase 3: Upper leadership in STEM

This phase differed from the previous stages. The narratives revealed a shift in career concerns, transitioning from a focus on the meaning and impact of the engineering profession to an emphasis on enhancing organizational wellbeing and the effectiveness of the team members. For the men, career concern—that previously was expressed through reflections on themselves and their professional progression—now aligns with the dynamics of the women.

The career adaptability resources activated by women during the earlier stages of their profession establish the foundation for career control, thereby fostering self-determination and the recognition of their potential to assume responsibilities. In this stage, women persist in their pursuit of knowledge, but prioritizing now the development of emotional regulation skills to manage their emotions effectively to favor positive interactions with the team members. During the leadership phase, men tend to reflect less on their roles because their career trajectories are more linear. This leads them to take on increasing responsibility over time without facing gender-related challenges. Instead, they become more aware of the roles they want to achieve and take them more for granted.

Both samples demonstrate career curiosity, albeit with slight nuances. Women proactively seek new stimuli from different areas nurturing their vocational inquisitiveness, whereas men's exploration arises from opportunities offered to them related to new professional roles. Women cultivate confidence in their leadership skills through a process of self-awareness that entails continuous self-evaluation of their manifested strengths as well as a reflection regarding the perceptions of others concerning their professional competencies. Conversely, men take confidence for granted and consider the external positive feedback they receive as a validation of their already recognized potential. This is probably linked to the fact that men are able to take on important roles and gain technical and managerial experience from the outset of their careers. This ensures more consistent growth, as they have more opportunities to develop their leadership skills, which strengthen over time. Women, on the other hand, often have to assess their own skills and the reputation they have built, precisely because they do not always have the opportunity to gain significant managerial experience during the early stages of their careers.

5. Discussion

Our analysis of the empirical evidence allowed us to answer the research questions and to describe how women in STEM deploy their career adaptability resources through the main stages of their career development and how contextual factors interact with these resources to support or limit their progression. Fig. 1 presents the conceptual framework that we derived from the narratives. For each career phase, the figure illustrates the configuration of the subthemes pertaining to the 4C's of adaptability and the characteristics of the social environment that influence the specific stage.

Drawing on CCT, we have also addressed a call that asked for further development of the extant research on the career adaptability construct. Specifically, the study has provided evidence of the malleable nature of career adaptability and consequently a preliminary representation of the dynamics of its 4C's components across the career lifespan. Our work has also expanded the analysis to the underrepresented group of women in STEM, with a comparative analysis conducted with a sample of men.

Contrary to previous studies that aimed to identify the coping strategies employed by women to confront systemic stereotype threat in STEM (e.g., Block et al., 2019; Cruz & Nagy, 2024), our proposed framework offers a more fine-grained conceptualization of the agency mechanisms through the 4C's of adaptability that may support career self-determination in women in this specific setting. Furthermore, the findings emphasize the interplay between career adaptability resources and the social factors that inhibit or facilitate women's career progression in different stages.

5.1. Theoretical contributions

Bridging two unrelated streams of research, namely women's careers in STEM and career construction theory, this study offered significant contributions to the existing discourse on women in male-oriented contexts.

First, a preliminary review of the extant literature revealed a paucity of contributions concerning women's agency in shaping their own careers in STEM, focused on behaviors that either contrast or conform to gender stereotype threat (Makarem & Wang, 2020). In studying women's career development in challenging work environments such as STEM fields, CCT offers an insightful theoretical perspective highlighting the control women may exert over the course of their career. We have provided novel insights on the role played by career adaptability in facing career transitions, demonstrating persistence in engineering careers and in attaining professional aspirations.

Second, there was a scarcity of studies that sought to understand women's career pathways through their lifespan, focusing on specific moments such as women entering the labor market or approaching retirement (Kuchumova et al., 2024; McMahan et al., 2012). We have moved from a static and quantitative approach to career adaptability to a qualitative and dynamic perspective, providing empirical evidence of career adaptability as a self-regulatory ability used to solve problems arising from developmental career tasks and career transitions. Our work illuminates the manner in which the four distinct dimensions of career adaptability manifest in varied forms according to the stage of career development differently between males and females.

Moreover, our work contributes to the scant evidence that career adaptability may be assessed qualitatively (Luke et al., 2016; McMahan et al., 2012; Whiston et al., 2015). We have expanded the descriptors of the different dimensions of career adaptability across three career phases.

Finally, through the theoretical lens of CCT and relying on a qualitative design, we have addressed the complex dynamics of the micro-level factors (the 4C's of adaptability) and the meso-level factors (the role of family, the characteristics of the workplace and the presence of developmental networks) that influence women's persistence in STEM careers. A thorough analysis of both levels, coupled with a preliminary investigation of their interplay, revealed that despite the presence of social barriers and gender bias, career adaptability may orient women to proactively pursue their career aspirations, influencing the environment, especially in the upper leadership phase. On the other hand, contextual factors, contingent on each career stage, are triggers for the activation of career adaptability resources. Contrary to previous studies that have examined the impact of generic categories of social and workplace support on the persistence of women in STEM (e.g., Fouad et al., 2016), we offer a more comprehensive interpretation of the role of the social environment in the different career stages.

5.2. Practical implications

The present study offers several practical implications for women aspiring to achieve leadership positions in STEM fields, as well as for educational institutions and organizations that aim to attract and retain talented women in these scientific sectors.

Our findings confirm prior evidence that for women, reaching top roles in engineering is a more dynamic process than for their male counterparts. Thus, understanding the more nuanced ways to activate career adaptability resources in education, early career stages, and upper leadership positions might accelerate the process of increasing the number of women in top STEM positions. Our research also highlights the impact of some contextual factors that could facilitate or hamper women's career development, which varies depending on the career phase a woman faces. Because career adaptability interacts with the external environment, it is necessary to be aware of the social factors that might influence career planning to leverage the enabling factors to help women develop their careers and to mitigate the effects of potential barriers.

Educational institutions can benefit from the findings and promote women's persistence in STEM fields in the early stage of their education in several ways. First, the transition of women toward higher education in STEM fields may be accelerated by their high school choice. Therefore, lower secondary schools could provide students with early exposure to STEM-related professions and offer female students specific support in exploring their STEM interests, nurturing a sense of belonging in the STEM community. Furthermore, the implementation of STEM educational initiatives within school systems has the potential to facilitate active engagement between teachers and parents in the cultivation of students' positive attitudes toward their future education and careers in STEM fields, mitigating those masculine gender norms that might influence the family environment. In a similar vein, high school environments have the potential to cultivate female students' interests in technological professions through enhanced interactions with companies, which may offer internships and allow students to observe women in STEM-related roles. Another interesting insight offered by the study is related to the values women ascribe to the STEM field in considering job opportunities. The decision of women to pursue a study program in engineering emerges from a forward-thinking approach that encompasses both the anticipation of evolving market demands and a discerning consideration of their impact on society. As highlighted by [Schmader \(2023, p. 230\)](#), "there is no direct evidence that I could find that STEM careers are more likely than other careers to be competitively, rather than communally, structured. However, when any environment is designed primarily for and by men, the style and structure of work are more likely to conform to what is considered the male default in that culture". University career services have the potential to play a pivotal role in leveraging women's intrinsic motivation and their sense of vocation in pursuing a STEM profession, making the educational offerings more attractive for women. They can highlight how the programs can prepare professionals with the requisite competencies to confront future workplace challenges and make more explicit their virtuous influence in improving society. Finally, the role of professors as mentors could be further enhanced in STEM disciplines. Professors might serve as advocates for an inclusive learning environment and as a valuable source of information regarding job opportunities while students are developing their theses or planning their internships.

Insights from the study might also help companies operating in STEM sectors to redesign their HR management practices and cultural norms that promote gender equality. Although the literature has provided evidence of efforts devoted by companies to promote diversity training to instill in individuals the beliefs and attitudes to support gender inclusiveness, the efficacy of such training is quite mixed ([Devine & Ash, 2022](#)). Based on our findings, there are specific workplace policies that women consider to be valuable and to contribute to their retention within a particular organizational context. To commit to gender equality in the workplace, companies need to adapt their policies to align with the expectations and needs of women across various stages of their careers. As highlighted by the interviewed women, during the early stages of STEM careers, it is necessary to gather direct, practical experience, such as fieldwork (on construction sites); to fortify technical skills by engaging in new projects; to acquire knowledge from experienced mentors; to participate in training aimed at obtaining specific certifications; and to spend time abroad. Therefore, it is imperative to provide women with assistance in career planning by designing developmental experiences and organizing periodic meetings with their supervisors, to encourage discussions on career progress and the subsequent establishment of professional goals. This approach has the potential to enhance women's self-awareness regarding their competencies and their sense of belonging to STEM fields and the associated work environments. Specifically, mentorship represents a significant relationship for women that fosters their technical skills and confidence in their abilities, thereby enhancing their visibility in professional settings. In the upper echelons of leadership, women undergo a transition from predominantly technical responsibilities to those of a managerial nature. The opportunity to rely on a personal coach or to share experiences in a professional network facilitates the acquisition of the necessary competencies to perform in leadership roles. Moreover, organizational policies that aim to promote work-life balance seem to mitigate the opting-out phenomenon and the postponement of career progression among women. Flexible working hours and hybrid work arrangements may help attenuate the disparity between men and women in the engineering domain and in leadership roles by addressing issues regarded as significant challenges for balancing parental responsibilities. Finally, our research showed that to act successfully as enablers, HR management policies require the allyship of specific roles, especially those in positions of power. Supervisors and CEOs should be seen as approachable role models to admire and respect, and their behaviors may promote an inclusive culture and ensure equal opportunities for leadership.

5.3. Limitations and future research directions

Despite the contributions of our research, certain limitations need to be acknowledged that may provide promising avenues for future research. First, we interviewed mainly civil engineers working for large companies that have the resources that facilitate career advancement and well-being for their women employees, such as flexible working hours, personal coaching, and tailored training programs. The implementation of these policies contributes to enhancing career progression for women in this professional environment. Indeed, a number of women in our sample made the decision to transition to a new company, specifically in the period immediately preceding or following childbirth. This transition led women to apply for companies that have demonstrated specific attention in addressing work-life balance. The fact that the companies involved in the study show a high commitment to gender

equality represents a boundary condition for our study. Subsequent research could concentrate on the career construction path of women who have become leaders in this field as freelancers or in smaller design studios, where the economic and personnel resources to offer measures to support employees can be more difficult to activate, or in companies that do not invest in an inclusive environment. Consequently, further studies may explore the question of whether the 4C's of career adaptability resources and contextual factors remain constant or change for women in leadership roles in different STEM contexts.

Second, our sample is quite homogenous since we interviewed women and men drawn from the same cultural and geographical area, namely Italy. The context we investigated is still permeated by gendered workplace structures, so future studies could replicate the same research in countries where women in STEM have had broader representation in leadership positions over a longer period of time. This endeavor would increase the transferability of our findings and thus provide further evidence of how career adaptability is employed by women in persisting throughout their STEM career development trajectory. Our sample was also homogeneous regarding race, ethnicity, and socioeconomic background. Future studies should adopt an intersectional perspective to understand how career adaptability and contextual factors are influenced by the interconnectedness of social categorizations that create overlapping systems of disadvantages and discrimination.

Third, while we included both women and men in leadership positions in the engineering field, thereby enhancing the robustness of the findings, we recommend carrying out further validation of the findings with a sample of women leaders in other non-STEM fields. This would allow for the expansion of knowledge regarding the gender-specific challenges that characterize the STEM professions and the specific agency strategies women manifest through career adaptability to persist in their career in this setting.

Finally, our study offers preliminary evidence of the interplay between specific behavioral and contextual factors for women in each of the three main career stages. Subsequent studies could further enrich this evidence by conducting quantitative investigations on the specific 4C's of adaptability and the social environment in which each career decision is made. The adoption of a longitudinal design represents a potential avenue for future studies to explore, for example, the specific features of developmental relationships (such as mentoring, coaching, and networking) and their interaction with career adaptability across the different stages of the career span.

6. Conclusion

Informed by career construction theory, the present study sheds light on how career choices and transitions are made by women in STEM. Differently from previous studies, our research advances the understanding of women's persistence in engineering careers over a long-term period. Our findings enrich the debate on how women succeed in STEM careers by investigating the configurations of adaptive behaviors they exhibited when choosing to study STEM fields, entering male-dominated work environments, and being promoted to leadership positions. Our research offers a valuable opportunity for women in STEM to understand how to proactively leverage their adaptability resources over time to become aware of the personal resources and the social environment that can be activated to achieve their career aspirations. Our recommendations for the educational and organizational levels may contribute to increasing the representation of women in STEM professions and leadership roles.

CRedit authorship contribution statement

Sara Bonesso: Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Resources, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Federica Bressan:** Writing – review & editing, Writing – original draft, Visualization, Validation, Methodology, Investigation, Formal analysis, Data curation, Conceptualization.

Declaration of competing interest

Authors declare that they have no conflict of interest.

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Appendix

Interview process

In the first part of the interview, the participants were asked to describe their current role and to briefly retrace the most important transitions that occurred in their career from the choice of the high school to their current position. Then, they were asked to narrate their decision-making processes and behaviors. This allowed us to investigate the following core themes: women's career adaptability and contextual factors that support or hamper the pursuit of their career aspirations.

Each career path was reconstructed following three main phases, namely education and internships during studies, early career, and upper leadership. Concerning the first phase, we gathered information from their choice of high school to graduate with a STEM degree, focusing on personal interests and contextual influences (family, friends, school and academic contexts, and other environmental conditions).

We also asked the participants to describe their internship experiences before completing their bachelor's and master's degrees, how they came to choose their thesis topic, and the types of interactions with their professors as well as the companies that hosted them during their internships. This allowed us to delve into their expectations and beliefs before entering the job market.

In the second phase, we investigated the early-career experiences in the engineering work context, asking the participants to describe their job search, the organizational environments they chose, the difficulties they faced, and the actions they took.

Finally, we focused on when the participants assumed managerial roles, taking on the leadership of organizational departments or teams up to the current role. In this last phase, we asked the participants to describe when they experienced career promotion, and if and how they changed their behaviors in relation to these emerging responsibilities. Furthermore, the participants described their career plans and expectations in the short and medium terms.

Throughout the three stages, the women recalled episodes in which they experienced gender-related discrimination and events in which they benefited from the support of reference figures (mentors, coaches, people in their personal and professional networks, etc.). We also invited the participants to narrate what actions, if any, they took to manage their work-life balance, again asking for specific examples.

The same protocol was used for both men and women in the sample to avoid orienting specific questions based on gender. Regarding the selection of the men in the sample, we reasoned that the men who would agree to participate in this research would be the most sensitive to diversity and inclusion issues, creating a bias in the responses. Consequently, we decided to formulate the research presentation without mentioning gender issues (called "Careers in STEM: Career Dynamics in Engineering Working Setting") so that the respondents could freely reconstruct their careers without being biased by potential gender dynamics.

Research protocol

Interviewee's background

- Brief description of the current job position (responsibilities and number of collaborators).
- Can you give me a short overview of your career development ("in bullet points") from high school to the actual leadership position?
- Marital/partnership status.
- Children, if any.
- Reconcile personal issues with the career progress (work-life balance).

Education

- Tell us about your educational path starting from high school and the reasons that led you to undertake your studies.
- Explain the role of family (e.g., father, mother, siblings, other relatives) and external people (e.g., peer students and professors) in influencing your choice.
- Describe the motivation to choose specific educational programs.
- Narrate concrete events that support your feelings/thoughts/beliefs.
- How did you find and choose your internship (if any)? Can you tell us your personal experience?
- How did you choose your thesis topic?
- What were your career expectations before entering the workforce?
- Did you experience any difficulties in navigating the transition between study and work? How did you overcome them?

Early career

- How did you search for your first job?
- Can you walk us through the initial stages of your career path and tell us how you chose your first job? (e.g. Did you have a clear idea, or did you consider multiple options?)
- Can you describe to us the job interview and the organizational environment you experienced?
- What were the most important moments that led you to reflect on your career, and how did you approach them in the initial phase of your career? (Choosing a company, the job interview, how did you feel about your first job?)
 - Have you encountered any barriers that have hindered you? If so, can you tell me each one?
 - If you experienced a transition to other companies, what were the reasons that led you to do so? Were they somehow gender-related? E.g., no career growth, no flexibility for work-life balance, etc.)
- Did you have one or more reference points within and/or outside the company who helped you grow in the development of your career?

Upper leadership

- Can you tell us about career promotions in leadership positions?
- Did you change your behaviors in relation to the emerging responsibilities and how?
- Have you encountered any barriers that have hindered you? If so, can you tell me each one?
- What are the elements of your profession that contribute to your sense of fulfillment?
- Did you have one or more reference points within and/or outside the company who helped you to achieve career advancements?
- What is your next step in advancing your career? What are your professional goals for the future?

Data availability

The data that has been used is confidential.

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