

# Career experiences of women in science, technology, engineering, and mathematics fields: A systematic literature review

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## Abstract

This article offers a systematic review and synthesis of 28 empirical studies exploring the career experiences of women in science, technology, engineering, and mathematics (STEM) fields. Three central questions guided this review, and findings show that theoretically, women's career experiences are mostly studied from behavioral and organizational perspectives. Methodologically, a balanced approach (both quantitative and qualitative) was adopted in these the studies. The empirical evidence suggests that STEM women's career experiences are largely shaped by their own personal characteristics (motivation, self-efficacy, and passion) and influenced by their parents, male colleagues, and human resources (HR) practices. Meanwhile, STEM women continue to face a myriad of challenges in a predominantly masculine environment (gendered organizational culture, gender-based stereotypes, struggle with work-life balance, and lack of mentors). To cope with these challenges, STEM women in the reviewed studies use three types of strategies—conforming, impression management, and proactivity. Based on our review, we derive implications for theory and practice, as well as an agenda for future research.

## KEYWORDS

careers, STEM, systematic literature review, women

## 1 | INTRODUCTION

The workplace landscape in the contemporary world is fast changing as a result of various changes that have taken place in society at the economic, social, political, educational, and global levels (Afiouni, 2014; Arthur & Rousseau, 1996; Hall, 1996). This landscape shift prompts the need to rethink the meaning of careers and the current context of work (McDonald & Hite, 2018). For a field such as human resource development (HRD) where career development is considered as one of the core domains, furthering conversations about careers and career development is not only relevant but also necessary. As HRD scholars and practitioners commonly recognized, HRD can play a key role in developing career strategies that are attuned to the changing nature of work and careers (Burke & Ng, 2006; McDonald & Hite, 2018), while also recognizing the heterogeneity within our conventional understanding of the concept of careers. It is within this heterogeneous perspective that our research lies. Nevertheless, as HRD scholarship has indicated, career studies in general are not yet part of the HRD mainstream research. More specifically, careers of underrepresented populations (e.g., women) working in male-dominated occupations (e.g., science, technology, engineering, and mathematics—STEM) have received even less research attention from HRD scholars. In this article, we seek to extend the conversation around women's careers by tapping into an under-explored research territory—STEM fields. By doing so, it is hoped that we will help expand the current understanding of careers that is derived largely from studying men, and that we will stimulate more research interest in the careers of women, especially those in highly masculinized professions.

Our review of relevant literature shows that despite the advancement women have made in the professional world, women in STEM fields continue to be a minority group (Blickenstaff, 2005; Buck, Clark, Leslie-Pelecky, Lu, & Cerda-Lizarraga, 2008; Morganson, Jones, & Major, 2010). From a global perspective, women accounted for less than one third (28.8%) of the workforce in scientific research and development across the world in 2014 (Catalyst, 2018). From a local perspective, women's representation in STEM occupations varies greatly by country and by field. For instance, in the United States, women held 44% of all science occupations, including 45% of physical scientists; however, they represent only 14.5% of all architectural and engineering occupations, and even a smaller percentage in civil engineering (11%) (Bureau of Labor Statistics, 2016). In Australia, women made up 20.7% of employees in computer system design and 12.4% in engineering (Catalyst, 2018). In the European Union (EU), women have made noticeable progress towards reducing the gender gap in the workplace, as evidenced by 40.1% of representation in science and engineering in 2016, an increase of more than 20% since 2007 (Catalyst, 2018). Nevertheless, this progress is inconsistent across the STEM fields. For example, the number of women in technology sectors in the EU is relatively smaller (32.2%), compared with 40.1% of women in science and engineering (Catalyst, 2018). Further, statistics from UNESCO (2017) and the World Bank (2016) reveal that Arab women are actively pursuing STEM majors and careers.

Delving deeper, career exit for women in science, engineering, and technology (SET) peaks about 10 years into their careers (Center for Talent Innovation, 2014). On the global scale, nearly one third of women in the United States (32%) and China (30%) intend to leave their SET jobs within their first year, followed by Brazil (22%) and India (20%), mainly because they feel stalled in their careers (Center for Talent Innovation, 2014). Further, in certain industry sectors, the turnover rate is even more concerning. For example, in technology-intensive industries across the countries, 53% of women opted to leave for other industries, compared to 31% of men (Catalyst, 2014). Among women who earned engineering degrees, 38% quit engineering or never even entered the profession (Catalyst, 2018).

A number of reasons for women's career exit from STEM occupations have been identified by researchers. A few prominent contributors include gender bias (Buse & Bilimoria, 2014a; Dasgupta & Stout, 2014; Hart, 2016), feeling of isolation, hostile male-dominated work environments (Buday, Jayne, & Zoë, 2012; Herman, 2015), ineffective executive feedback, and a lack of adequate sponsorship (Center for Talent Innovation, 2014). More specifically, women working in STEM often found themselves challenged by gendered organizational structures, cultures, and management practices, all of which have created barriers to their career advancement and acceptance as

professionals (Acker, 1990; Bastalich, Franzway, Gill, Mills, & Sharp, 2007; Blickenstaff, 2005; Kossek, Su, & Wu, 2017). These barriers are rooted in the largely male-dominated STEM fields (Stout, Grunberg, & Ito, 2016); as a result, women are often not welcomed. In this respect, researchers remind us that stereotypical assumptions of STEM women are deeply entrenched with masculine norms of behaviors that are incongruous with the female gender role (Cheryan, Plaut, Davies, & Steele, 2009; Diekman & Steinberg, 2013). A couple of examples of these stereotypes that exist in STEM fields include a tendency toward social isolation and singular focus on technology (Hill, Corbett, & St Rose, 2010). Further, researchers have recognized that women opted out of STEM careers because these jobs were perceived as being incompatible with traditionally accepted feminine roles, values, identities, and life goals (Ahlqvist, London, & Rosenthal, 2013; Diekman & Steinberg, 2013). Because gender roles shape the way people see themselves (Eagly, 2013), women have reported feeling different from people who fit into STEM stereotypes (Cheryan et al., 2009) and discouraged to continue pursuing STEM careers.

The lack of participation of women in STEM fields is a complex and multifaceted issue (Hill et al., 2010; National Research Council Report, 2007), which causes a serious concern for several reasons. First, STEM occupations that fail to attract and retain women suffer from a lack of diverse perspectives essential for the creation of STEM technology and innovation (Blickenstaff, 2005) and further perpetuate gender inequality in the workplace (Beede et al., 2011). Second, as job opportunities in STEM fields were projected to grow five times faster than other sectors in the upcoming years and the supply of talent is not expected to meet the market demand (Fayer, Lacey, & Watson, 2017; Hewlett et al., 2008), attracting and retaining women in these historically male-dominated occupations would be a necessary solution to meet the increasing need for a STEM workforce. Third, the lack of active participation of women in STEM professions prevents a nation from reaching its full potential and decreases its global competitiveness and long-term economic growth (Catalyst, 2018).

From the discussion above, it becomes apparent that women around the world face challenges of entering and/or remaining in the male-dominated STEM fields. While their level of participation in STEM occupations might vary by country and by field, a commonality is that women struggle more than men to build a successful STEM career. On the other hand, many countries have not effectively tapped into this group of human resources (HR) despite the projected shortage of STEM talents. These realities have motivated researchers to investigate issues associated with women in STEM. Nevertheless, most of the previous scholarly attention has been given to identify the causes, such as why there is a low representation of women in STEM careers, with much less focus on the actual experience of women who lead a STEM career. As a result, our understanding of STEM women's career experiences is limited. Additionally, we found that extant research literature on STEM women, while abundant in volume, scatters across disciplines. In other words, there is no cohesive, synthesized account to help researchers and practitioners obtain a high-level view of women's career experiences in STEM. Finally, as HRD researchers, we are keenly aware of the importance of career development to both employers and employees. However, to our surprise, our search for HRD literature shows that STEM fields have been hardly studied by HRD scholars, let alone STEM women (Catalyst, 2018). For a discipline where, developing people is the core mission (Swanson & Holton III, 2009), HRD is missing a tremendous opportunity to contribute to the workplace, by not paying adequate attention to women in STEM and their unique career experiences.

For all reasons above, this article is a meaningful research effort. It addresses a timely issue (STEM women's career) of high theoretical, research, and practical relevance. For example, theorywise, the new insights generated by this systematic review and synthesis of multidisciplinary knowledge could be useful for building new career theories or expanding existing theories. For HRD scholars, it is hoped that findings from this article will illuminate additional areas for future exploration, stimulate cutting-edge ideas, and more importantly, prompt actions for innovative or transdisciplinary research. In terms of practice, this review will provide evidence-based findings that will help organizational leaders and HR professionals better understand how to attract and retain STEM women and facilitate their career success. Finally, for women in STEM careers, this review will provide information that allows for critical self-reflection and career assessment.

## 2 | PURPOSE AND RESEARCH QUESTIONS

This article aims to provide a systematic review and synthesis of empirical studies that explored women's career experiences in STEM fields. Three questions guided this review:

1. What theoretical perspectives have informed the empirical studies of STEM women's careers?
2. What methodological approaches have been used to explore STEM women's career experiences?
3. What characterizes STEM women's career experiences as reported in the reviewed empirical studies?

By examining patterns of theories used, methodological approaches employed, and major findings documented in current literature, this article aims to identify knowledge gaps that will shed light on opportunities for theory-building, future research, and improvement in practice.

In the remainder of this article, we first describe the systematic literature review (SLR) methodology we used to identify, select, and analyze research publications. Subsequently, we summarize our findings from the identified empirical studies of STEM women's career experiences in response to the three research questions. Based on our literature analysis, we then discuss the implications of this review for theory building, practice, and research.

## 3 | THE SLR METHODOLOGY

To map out the literature on STEM women's career experiences, we adopted the SLR methodology. As a stand-alone research approach, SLR addresses much broader questions than a single study (Baumeister & Leary, 1997) by systematically identifying, critically evaluating, and integrating the findings of all relevant, high-quality individual studies addressing one or more research questions. A good SLR establishes the extent to which existing research has progressed toward clarifying a particular problem, uncovering relationships among various empirical findings, revealing gaps and inconsistencies in the literature, and illuminating directions for future practice, policy, and research (Baumeister & Leary, 1997). SLR is characterized by being objective, systematic, transparent, and replicable, thus allowing for a more objective overview of the search results and helping to eliminate potential biases and errors (Denyer & Tranfield, 2009). Guided by these principles, we followed the three stages outlined by Tranfield, Denyer, and Polminder (2003). At the first stage, researchers are required to clearly define the review goals and delineate the subject area. At the next stage, researchers need to systematically follow the review process using methods that will allow for replication. Being able to replicate research is important because to show "how to pursue replicability in the face of its recalcitrance" is "the job of the social sciences" (Collins, 2016, p. 78). This requires sharing detailed information about how data are collected and analyzed in order to allow for an explicit understanding of the research outcome (Collins, 2016). At the final stage, researchers analyze and disseminate results.

### 3.1 | Searching for the empirical literature

For this review, we identified three bodies of literature as relevant to our topic: STEM research, gender studies, and career development. Specifically, we were interested in empirical studies that fall at the intersection of these three bodies of knowledge. We searched two databases (ISI Web of Knowledge and Scopus) because they encompass all the journals indexed in the Social Science Citation Index (SSCI) and all the leading journals in management, social science, and STEM disciplines. Specifically, we searched the management, applied psychology, and business categories in these two databases. We made use of variations and Boolean connection of various keywords, including "women," "woman," "female," "gender," "science," "technology," "engineering," "math," "STEM," "career," "career development," "job," "employment," or "vocation" to identify relevant publications. This initial search generated

221 publications, which were recorded and organized using RefWorks and an Excel table (Callahan, 2010). After removing duplicates, 165 publications remained in the data pool. Despite our intent to be inclusive, we recognize that research on women in STEM is widely dispersed; therefore, other publications likely exist beyond the boundaries of our search.

## 3.2 | Screening the literature

The screening of the 165 publications was guided by two sets of predeveloped criteria. Driven by the three research questions and the goal to build a comprehensive database of articles, we first formulated five inclusion criteria to help us identify the most relevant articles.

## 3.3 | Inclusion criteria

1. The article was published in English. This decision is due to the fact that neither of the two authors has access to non-English publications.
2. The article was peer reviewed. This decision is based on the common knowledge that peer-reviewed articles are authoritative indicators of the quality of the field (Aykol, Paliwadana, & Leonidou, 2013).
3. The article reports findings from an empirical study. This decision is driven by our intent to provide evidence-based recommendations for future research and practice.
4. The article focused on career experiences of women in STEM fields. In other words, women's career in STEM must be the central phenomenon under study, not antecedents or outcomes.
5. The article was published between 2000 and 2018. This time frame reflects our attempt to provide an updated understanding of latest research.

Guided by the above five criteria, we reviewed the abstracts of the 165 articles in the data pool. Among them, 94 articles did not meet all five inclusion criteria and were thus excluded for further consideration.

## 3.4 | Exclusion criteria

At the second stage of screening, we expanded our review from reading the abstract to reading the introduction, findings, and discussion sections of each of the remaining 71 articles. Our review was guided by three exclusion criteria we developed:

1. The article focuses on the educational pipeline of STEM majors, including the low representation of women and girls in scientific majors, and the intentions of students to pursue a STEM major and/or career. This decision is driven by the purpose of this review—synthesizing the literature on *career experiences* of women currently working in STEM fields. Twenty-six articles were eliminated after applying these exclusion criteria.
2. The article explores individual interests in STEM that did not translate into a career. This decision is based on the purpose of the article—understanding career experiences of women in STEM at large. Seventeen articles were eliminated after applying these exclusion criteria.
3. The publication is a book, monograph, book chapter, conference proceeding, editorial, thesis, or dissertation. This decision is based on the common knowledge that peer-reviewed articles are authoritative indicators of the quality of the field (Aykol et al., 2013).

After applying all three exclusion criteria, we eliminated a total of 43 articles. This left us with 28 articles for final review.

### 3.5 | Data management and analysis

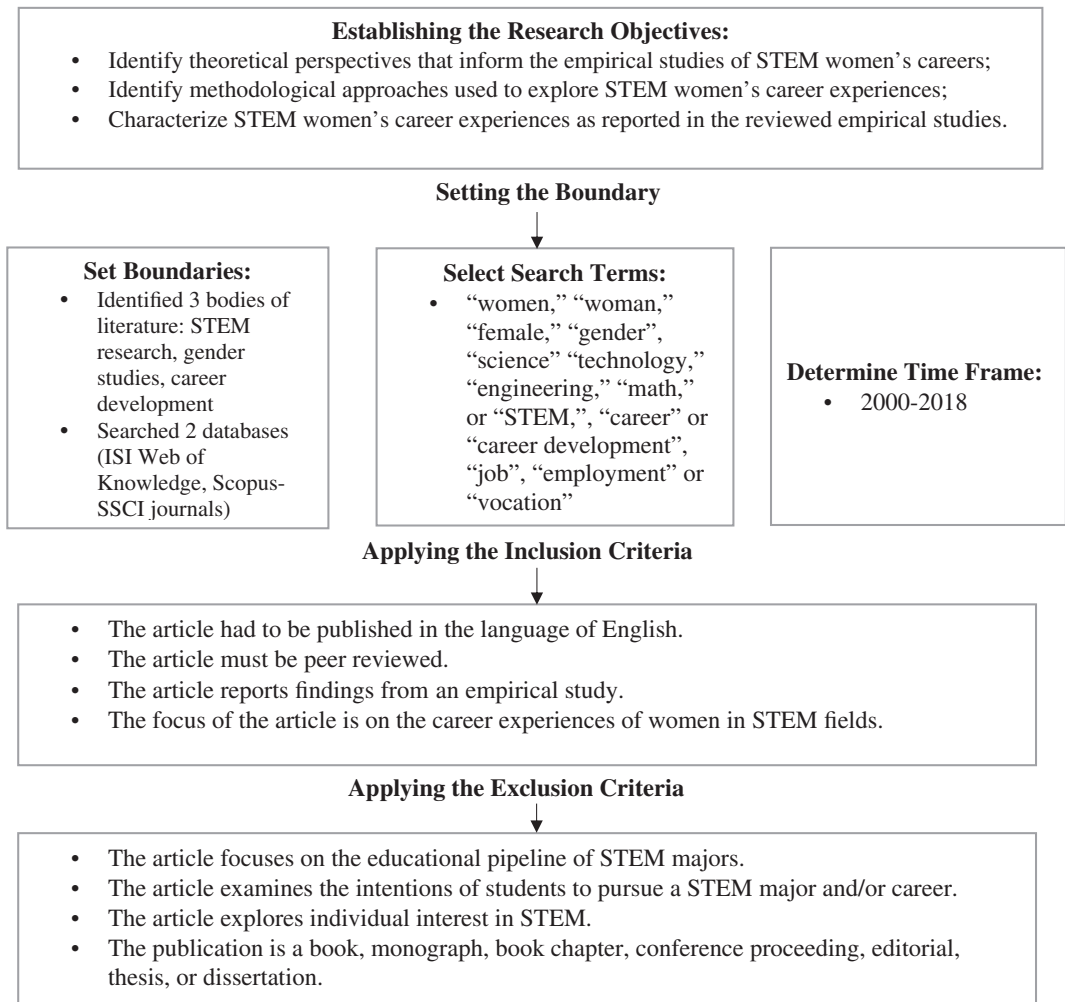
To prepare for data analysis, we used Garrard's (2013) matrix method for organizing the 28 articles. In the matrix, we recorded information regarding the authors, article title, journal title, theory used, research context, research design, and key findings. The 28 articles are marked with an asterisk (\*) in the reference list. Among the 28 articles, *Gender, Work, and Organization* was the most frequently targeted journal (8 articles), followed by the *Journal of Vocational Behavior* (4 articles) and *Sex Roles* (3 articles). We also found that scholarly interest in women in STEM careers has gained increasing attention in recent years, as evidenced by 17 publications between 2010 and 2017 ( $n = 17$ ), compared with 11 between 2000 and 2010.

To identify commonalities across the 28 studies, we performed a thematic analysis, a method for “systematically describing the meaning of qualitative material ... focuse[d] on extracting categories from the data” (Cho & Lee, 2014, p. 50). We open coded each article independently to ensure the rigor of analysis was met (C. T. Nolan & Garavan, 2015). Our coding mainly focused on the findings and discussion sections, using emic codes based on a word or phrase in the text (e.g., discrimination, father's support) for emergent ideas, key words, or phrases (Creswell & Creswell, 2017). This process led to an initial list of 85 codes. We then took a closer look at the 85 codes and grouped like-codes with similar meanings or understandings together (Cho & Lee, 2014; Webster & Watson, 2002). For example, three initial codes—*competing with men*, *lower salaries than men*, *masculine culture*—were later grouped into a higher-level code denoted as *gendered organization*. This process of grouping allowed us to reduce the initial 85 codes to 13 higher-level codes. To reach this end, we thoroughly discussed the rationale behind the grouping of the codes. In the case of a disagreement or a misalignment in the grouping, we relied on the academic literature (of STEM, gender studies, and career development) for guidance. For example, one of the codes that we have identified from the data analysis revolved around mentoring. The first author perceived mentoring as an *organizational-level influence* that played a role in the career experiences of women in STEM. On the other hand, the second author regarded mentoring as part of the *organizational-level challenges* that the women encountered while working. With these two conflicting ideas, we turned to the academic literature to help us better understand the scope of the mentorship code. While engaging with the literature, we came to better understand the specificities of the code that dealt with the challenges posed by the lack of mentors on the career experiences of women in STEM. With this new understanding, we decided to group mentoring with other like-codes that discuss the challenges women face in their STEM careers.

After we finalized the higher-level codes, we moved into the third and final step that allowed us to derive themes from the 13 higher-level codes. For example, the codes *gendered organization*, *discrimination* and *changing culture* were grouped into the theme titled *Challenges Encountered*. The 13 final codes were grouped into four themes: (a) personal characteristics, (b) role of others and the organization, (c) challenges encountered, and (d) coping strategies. These four themes represent the saturation of the data—the point when we stopped identifying additional themes. The above SLR process is presented in Figure 1.

## 4 | GUIDING THEORETICAL PERSPECTIVES

A total of 13 theories, theoretical frameworks, or conceptual models were specified in the 28 studies. Among them, gender and feminist theories were most frequently cited in six studies (Allen, Armstrong, Riemenschneider, & Reid, 2006; Haas, Koeszegi, & Zedlacher, 2016; Miller, 2004; Powell, Bagilhole, & Dainty, 2009; Rhoton, 2011; Watts, 2009), followed by social cognitive career theory in four studies (Buse, Bilimoria, & Perelli, 2013; Fouad, Singh,



**FIGURE 1** Systematic literature review (SLR) methodology

Cappaert, Chang, & Wan, 2016; S. A. Nolan, Buckner, Marzabadi, & Kuck, 2008; Singh et al., 2013), and social construction theory in three studies (Adya, 2008; Crump, Logan, & McIlroy, 2007; Martin, Wright, Beaven, & Matlay, 2015).

Other theories that informed the reviewed studies include communication boundary management theory (Allen et al., 2006), role-congruity theory (Cardador, 2017), integrated model of career change (Fouad et al., 2016), identity theory (Hatmaker, 2013), frayed careers (Herman, 2015), career path (Ranson, 2003), deficit theory (Settles, Cortina, Malley, & Stewart, 2006), and turnover models (Singh et al., 2013). Despite the diversity, these theories revealed one pattern—that is, career experiences of women in STEM were rooted in both behavioral and organizational perspectives. Informed by these perspectives, we were able to gain a deeper understanding of the behaviors the women adopted while working in STEM, such as working harder and developing their expertise. We were also able to identify institutional variables that either enabled or inhibited the STEM women's career progression, including gender discrimination and lack of career progression policies. The remaining ten studies did not mention any guiding theories (Aaltio & Huang, 2007; Duberley & Cohen, 2010; Ecklund, Lincoln, & Tansey, 2012; Glass, Sassler, Levitte, & Michelmore, 2013; Hatmaker, 2013; Kameny et al., 2014; Orser, Riding, & Stanley, 2012; San Miguel & Kim, 2015; Schmader, Johns, & Barquissau, 2004; Servon & Visser, 2011).

## 5 | METHODOLOGICAL APPROACH

In terms of research methodologies, 19 of the 28 studies adopted a qualitative design, 5 of which identified specific qualitative approaches, including grounded theory in 2 studies (Buse et al., 2013; Cardador, 2017), ethnography in 2 studies (Miller, 2004; Watts, 2009), and phenomenology in 1 study (San Miguel & Kim, 2015). Interviewing was used almost exclusively as the means to collect qualitative data. The remaining nine publications include six quantitative studies (Fouad et al., 2016; Glass et al., 2013; S. A. Nolan et al., 2008; Schmader et al., 2004; Settles et al., 2006; Singh et al., 2013) and three mixed methods studies (Ecklund et al., 2012; Ranson, 2003; Servon & Visser, 2011). All six quantitative studies relied on survey as the only source of data. For example, Glass et al. (2013) utilized the National Longitudinal Survey of Youth 1979 to better understand the lack of persistence of women in STEM fields in comparison to women in other professional jobs. Fouad et al. (2016) used six scales to measure domain self-efficacy and outcome expectations that were developed from a focus group interview with 50 women engineers who either left engineering or are currently working as engineers. Nolan et al. (2008) surveyed 455 participants to find out mentoring-related obstacles to development and retention of women in chemistry. In the three mixed methods studies, a combination of survey, interview and focus group were used to gain holistic insights into gender segregation in elite academic science (Ecklund et al., 2012), the retention and advancement of women in science, engineering and technology careers (Servon & Visser, 2011), and issues beyond gender differences of women's and men's careers in engineering in Canada (Ranson, 2003).

Further, in the 28 empirical studies, western countries were selected exclusively as the research context, with the exception of one study that focused on China (Aaltio & Huang, 2007). Among the western countries, the United States was the most popular venue for research (in 16 studies), followed by the United Kingdom (in five studies—Duberley & Cohen, 2010; Herman, 2015; Martin et al., 2015; Powell et al., 2009; Watts, 2009), and then Canada (three studies—Miller, 2004; Ranson, 2003; Orser et al., 2012). European countries that were studied include France, the Netherlands, Italy (Herman, Lewis, & Humbert, 2013), and Ireland (Herman, 2015). Another western country selected was New Zealand (Crump et al., 2007).

## 6 | FINDINGS ABOUT STEM WOMEN'S CAREER EXPERIENCES

The overall career experiences of women in STEM can be understood under four themes: (a) personal characteristics, (b) role of others and the organization, (c) challenges encountered, and (d) coping strategies. These four themes and their high-level codes are presented in Table 1.

### 6.1 | Personal characteristics

The 28 studies revealed three key personal characteristics that the women participants exhibited in their pursuit of a STEM career: motivation, self-efficacy, and passion. These three characteristics represent three of the 13 high-level codes identified during our data analysis.

#### 6.1.1 | Motivation

As the empirical evidence shows, the women in STEM were motivated to work hard by both external and internal forces. The number one external motivator we found was the need to prove one's self. The women would go to great length to develop their professional identity and technical skills to demonstrate their competency as engineers

**TABLE 1** Theme identification

Themes	High-level codes
Personal characteristics	1.1. Motivation 1.2. Self-efficacy 1.3. Passion
Role of others and the organization	2.1. Role of parents 2.2. Role of male colleagues 2.3. Role of human resources practices
Challenges encountered	3.1. Gendered organizational culture 3.2. Gender-role stereotyping 3.3. Struggle with work-life balance 3.4. Lack of mentors
Coping strategies	4.1. Conforming 4.2. Impression management 4.3. Proactivity

and scientists (Adya, 2008; Hatmaker, 2013; San Miguel & Kim, 2015). For these women, the extrinsic motivation behind proving themselves was not solely to promote their careers, but also to be taken seriously by their male counterparts (Hatmaker, 2013). As expressed by one of the women "...it was a defining moment. It was defining to the extent that I was hell bound and determined to prove I was the best engineer they ever hired.... It gave me a determination at that point. I was going to show that this is our new really good engineer instead of EO hire" (Hatmaker, 2013, p. 389).

In addition, the women identified goal orientation or being purpose-driven as an important intrinsic motivator for them to pursue career advancement in science and engineering fields (e.g., Buse et al., 2013). For example, by setting a clear career path and diligently pursuing excellence, Latina scientists and engineers had the internal drive to work hard despite various barriers that they had to overcome to achieve their career goals (San Miguel & Kim, 2015). One of them noted, "It's just getting the plan and knowing exactly what you have to do... So you have to have your plan and your goals" (San Miguel & Kim, 2015, p. 142).

### 6.1.2 | Self-efficacy

Self-efficacy refers to the women's confidence in their own ability to pursue a career in STEM. In the Chinese context, women in the information technology (IT) industry identified their personal competence and talent as being more important than the *Guanxi* (relationship) network (Aaltio & Huang, 2007), as expressed by one of the women in the study, "I obtained the current position because I'm qualified." (Aaltio & Huang, 2007, p. 235). These women approached their work with a strong orientation toward competition and personal development intertwined with career focus (Aaltio & Huang, 2007; Crump et al., 2007; Singh et al., 2013). Similarly, Buse et al. (2013) identified self-efficacy as one of the distinct individual factors that separated the persistent women engineers from others who opted out of the engineering workforce. In their study, women with self-efficacy were better prepared to find new assignments, deal with difficult situations, tackle tough problems, manage conflicts, and enact changes in their day-to-day work (Buse et al., 2013). As these studies show, the higher levels of self-efficacy women demonstrated, the more persistent they were in STEM professions (Buse & Bilimoria, 2014b).

### 6.1.3 | Passion

The third personal characteristic is the STEM women's work passion. In Aaltio and Huang's (2007) study, the women participants discussed a "can-do" attitude and their love for their jobs. In another study, Latina scientists and engineers noted that having passion about and confidence in the work they do would ultimately facilitate career progression in STEM (San Miguel & Kim, 2015). Similarly, women working in the U.S. IT industry believed that only by displaying confidence and the right attitude would they be able to advance in their career (Orser et al., 2012). One of the women noted, "Through confidence building, I have learned to take those initial assumptions in my stride" (Orser et al., 2012, p. 84).

## 6.2 | Role of others and the organization

Through our analysis of the 28 articles, we identified the importance of others in influencing women's career experiences in STEM. In fact, women's interactions and relationships with other individuals or groups, both within and outside the workplace, greatly affected their career experiences. Three sources of influencers were identified in the 28 studies: (a) parents, (b) male colleagues, and (c) HR practices.

### 6.2.1 | Role of parents

Parents, especially the father, played a major role in the career choice of women in STEM. The father was considered an important role model who evoked some of the women's interest in STEM (Hass et al., 2016). For example, as an academic engineer, one father encouraged his daughter to do something different or new, and to pursue a career in STEM (Hass et al., 2016). Similarly, with the assistance from their fathers who are academics, British women gained access to the male world of science (Hass et al., 2016). One woman credited her father for her interest in pursuing engineering: "My father had workshops in the house: a woodworking shop, and also, a metalworking shop, and we always helped [...]. We always fixed our own bicycles" (Hass et al., 2016, p. 402). In Duberley and Cohen's (2010) study, 12 of 31 fathers introduced their daughters to important contacts and elevated their awareness of what they could accomplish with a science career. For women in Canada, the historical contributions of their fathers to the oil and gas industry, along with their mothers' work in the field, gave them an insider's view of engineering and motivated them to consider an engineering career (Miller, 2004). As for South Asian women, the pursuit of an IT career was somewhat forced by their parents who work in the IT industry with a technology or engineering background (Adya, 2008).

### 6.2.2 | Role of male colleagues

Reflecting on their career development, European women scientists stressed the impact of senior males on their integration into the scientific world and research groups (Hass et al., 2016). One of the women in Hass et al.'s (2016) study spoke about her advisor:

"He always said, 'Why don't you do your habilitation? You could actually do your habilitation'. And then he always explained, [...], 'You will then certainly have [better] options' [...]. Somehow I realized that this was a good point. And I did that then from April to August every night, that particular year, I wrote my habilitation"

(p. 403). The support of an established male colleague and his extensive social network contributed to the women's career advancement in science and also helped them secure competitive jobs and grants (Hass et al., 2016). Nonetheless, some women in the same study (Hass et al., 2016) suffered from a lack of support from their male colleagues. For example, one engineer recounted how her supervisor gradually withdrew his support and networks and played an adverse role in her career development after she openly disagreed with him on a work issue. In a similar manner, male colleagues openly expressed their opinion that "American women would never make it in IT careers" and worked against their career advancement (Adya, 2008, p. 614).

### 6.2.3 | Role of HR practices

HR practices, specifically in the form of developmental opportunities, influenced women engineers' career experiences and subsequent turnover intentions (Singh et al., 2013). Access to developmental opportunities, such as training and professional development programs, was found to be positively associated with American women engineers' self-efficacy and success on the job (Singh et al., 2013). In addition, long-tenured women engineers emphasized the importance of continuous learning opportunities in their persistence in an engineering career (Buse et al., 2013). Opportunity to work on new technologies, projects, or products ranked high for the U.S. women engineers (Buse et al., 2013). For example, one woman in Buse et al.'s (2013) study explained, "[My company] was giving me assignments that were brand new, Greenfield, nobody had done before. [...] My whole career has been cutting edge stuff, brand new. It was the new stuff that kept me" (p. 146). Nonetheless, women working in the U.S. IT sector reported challenges associated with HR practices, including lack of training programs and resources, limited access to social networks, and the prevalence of the "Boys' Club" and its deterring effect on women's career progression (Orser et al., 2012). As one participant observed, "Many common HR practices do not seem to be in place in IT" (Orser et al., 2012, p. 82).

## 6.3 | Challenges encountered

As revealed by the 28 articles, STEM women face a number of challenges in their careers. Among them, four are most frequently reported: (a) gendered organizational culture, (b) gender-role stereotyping, (c) struggle with work-life balance, and (d) lack of mentors.

### 6.3.1 | Gendered organizational culture

At the organizational level, women reported experiencing gender-based discriminations that were embedded within the larger organizational culture (Allen et al., 2006; Herman, 2015). In Cardador's study (2017), women engineers in the United States identified both explicit and implicit gender sorting mechanisms that their organizations used to move them away from the technical path into management. Women were perceived to be more suited for managerial roles and therefore were encouraged to take on roles that emphasized the "people side" of engineering (Cardador, 2017, p. 604). Consequently, the gendered career patterns were reinforced by the organizational structure, with women acknowledging that they might have left the engineering profession had they stayed in technical roles (Cardador, 2017). For women in academic science careers, science was considered as institutionally gendered and a predominantly male pursuit with prevalence of gendered opportunity structures within their universities (Duberley & Cohen, 2010). As an example, one participant shared,

"Their view was that I shouldn't be ambitious. I should just do my job, be a nice little girl and not make a fuss. Unfortunately, I'm not that kind of woman and I wanted to be promoted and I got the attitude of, 'Oh well, why do you want to be promoted? Women aren't supposed to be ambitious and anyway you don't need the money'. And I said, 'It's not the money. It's the bloody status I want!'"

(Duberly & Cohen, 2010, p. 194). In their study, Settles et al. (2006) found that sexual harassment and gender discrimination have a significant negative impact on women's overall attitude toward their employment in academic science positions in the United States.

### 6.3.2 | Gender-role stereotyping

The gendered career patterns discussed above reinforced the stereotypes about women engineers—being less technically capable than their male counterparts and dispositionally suited for more feminine roles (Cardador, 2017). For example, a women participant shared, "I feel like in meetings, women are thought of as being better at communicating and so they frequently are put in the role of taking notes, but I think that's just based on stereotyping and not actually based on real world evidence" (Cardador, 2017, p. 604).

In addition, occupational roles and organizational practices in the U.S. IT industry were stereotypically geared toward a male life style, characterized by long working hours and extensive travels (Orser et al., 2012). In consequence, women were marginalized in their own profession and the assumption that their roles as mothers and wives preceded their professional role was pervasive in this literature (Orser et al., 2012; Schmader et al., 2004). In New Zealand, the IT culture, as explained by women working in the field, has a deeply entrenched stereotypical image of a "geek" male who lacks communication and social skills (Crump et al., 2007, p. 364), making women feel isolated and lack a sense of belonging. Further, stereotypes were also conveyed through language (Ecklund et al., 2012). For example, when interacting with their male colleagues, women physicists identified gendered language (e.g., women are not good at math) as inherently masculine (Ecklund et al., 2012).

### 6.3.3 | Struggle with work-life balance

Women working in STEM fields acknowledged their struggle in simultaneously managing the demands at work and at home (Allen et al., 2006; Duberly & Cohen, 2010; Kameny et al., 2014). As a woman in STEM, one participant attributed her struggle to "being a very involved mother of two young kids and still wanting to be a 'rising star' at work"—the trajectory she had before marriage and family (Kameny et al., 2014, p. 55). Work and family issues were identified as career barriers to women working in IT (Orser et al., 2012), with challenges including taking care of children and the elderly while dealing with the pressing demands of the job. Glass et al. (2013) found that family obligations decreased American women's commitment to work in STEM and increased their intent to leave their professions. On the other hand, American women engineers who persisted in their careers appreciated their managers for understanding their juggle between family and work roles and for their managers' empathetic support (Fouad et al., 2016).

### 6.3.4 | Lack of mentors

Lack of mentoring support was identified as a career barrier for women chemists in the United States (S. A. Nolan et al., 2008). Even when mentors were available, American women engineers, regardless of their career interests,

were encouraged to pursue management paths instead of technical ones mainly because of their people and communication skills (Cardador, 2017). Further, academic scientists explained how the lack of mentors and/or role models prompted them to switch their majors and subsequently their careers from physics to biology where they felt they would fit better and receive more guidance (Ecklund et al., 2012). In another study (San Miguel & Kim, 2015), one participant shared her mentoring experience:

“You can get mentored by a junior person or a peer, but some of your strongest mentoring relationships are usually somebody who is more experienced than you. And there weren't very many before me. So, there weren't really other women for me to ask to help me, and most of the role models that I had, especially in the first 15 years of my career, were men. So those were my mentors”

(p. 140). In addition, Latina women scientists highlighted the importance of peer/informal mentoring in their career success and development (San Miguel & Kim, 2015).

## 6.4 | Coping strategies

Women in STEM have adopted various strategies to cope with the challenges they encountered in order to progress in their careers. Specifically, three strategies were commonly used: (a) conforming, (b) impression management, and (c) proactivity.

### 6.4.1 | Conforming strategies

Conforming strategies are characterized by conformity to existing organizational structures and acceptance of the status quo (Herman et al., 2013; Orser et al., 2012; Powell et al., 2009). For example, European women in science, engineering, and technology careers continued to conform to ideal male worker practices and values, and refrained themselves from challenging the traditional masculine image within their organization (Herman et al., 2013). U.S.-based women engineers, on the other hand, employed rationalization as a means to cope with their organizational culture that imposed gendered expectations on work (Hatmaker, 2013). In Canada, women engineers in the oil and gas industry reported that their early acculturation to the engineering field had convinced them that only by conforming to traditional masculine behaviors and norms would they be able to succeed in their engineering careers (Miller, 2004).

### 6.4.2 | Impression management strategies

Impression management refers to women's attempt to refrain from engaging in behaviors or practices that would be considered as “feminine” in various STEM industries (Rhoton, 2011). In doing so, women portray a certain image at work that is more aligned with conventional masculine norms (Miller, 2014; Rhoton, 2011; Watts, 2009). For example, to adapt to their organizational culture and secure their jobs, American women engineers purposefully chose to “dress down,” “change the tone of their voice,” or “pull their hair back” (Buse et al., 2013, p. 144). Also, women working in STEM fields intentionally chose to distance themselves from their female colleagues who display stereotypical femininity, a strategy called “professional socialization” (Rhoton, 2011, p. 703). Similarly, to be viewed as an engineer rather than a woman, American women engineers aimed to project a professional image of themselves by downplaying their gender role and refraining themselves from displaying conventional feminine behaviors and traits (Hatmaker, 2013). They focused on being technically proficient, building a professional reputation by successfully

completing projects, and working harder than their male peers (Hatmaker, 2013). In sum, from a career standpoint, the suppression of feminine characteristics is seen as a means to complying with the standard norms of any of the STEM occupation, which allows the women to advance in their careers and to better integrate into the masculine organizational culture (Cardador, 2017; Ranson, 2003).

### 6.4.3 | Proactive strategies

As a career coping strategy in STEM fields, some women chose to challenge the image of the male ideal worker and resist conforming to organizational practices and norms (Herman et al., 2013). When U.S. women engineers encountered situations, which imposed gender expectations on their behaviors, they used blocking mechanisms (i.e., tactics used to deter work requests that are rooted in gendered assumptions) to bring their professional identity back to the forefront of the interaction and to challenge the hegemonic masculine organizational culture (Hatmaker, 2013). For example, blocking was used by the STEM women to challenge the assignment of gendered tasks (e.g., note taking and carrying out administrative duties) and to avoid being associated with them (Hatmaker, 2013). By the same token, women engineers in the United States also actively challenged discriminatory situations and noted implicit gender bias practices in the workplace (Buse et al., 2013). In the United Kingdom, in an attempt to challenge the masculine culture of the STEM fields, women in science and technology resorted to pursuing entrepreneurship strategies, such as starting their own businesses in a STEM field (Martin et al., 2015). These entrepreneurship strategies were developed mainly from the women's interests and education as well as their desire for greater opportunities as an entrepreneur (Martin et al., 2015). Nonetheless, women entrepreneurs in STEM fields also acknowledged that the expectations on how they should operate their business were highly gendered (Martin et al., 2015). For example, many women discussed role-playing in different business scenarios in STEM fields in order to meet the expectations of the larger entrepreneurial community.

## 7 | DISCUSSION

Our analysis of the 28 empirical studies gave us deep insights about STEM women and their career experiences in three aspects. First, women's experiences in STEM careers are shaped by a myriad of contextual factors. Internally, three personal characteristics—motivation, self-efficacy, and passion—drove the women to pursue and persevere in a male-dominated STEM career. Externally, the women's experiences in STEM careers were influenced by their parents (fathers in particular), male colleagues, and HR practices (especially developmental opportunities). While the external factors were seemingly nuanced, they had a noticeable impact on the women's career trajectories. What is worth mentioning is the profound influence of fathers, which has not been emphasized by previous research.

Second, women face a number of roadblocks in their pursuit of a STEM career including gendered organizational culture, gender-role stereotypes, struggle with work-life balance, and the lack of mentors. These challenges are not new, and the fact that they have sustained over time suggests the depth of the problems that women face at work and the deeply embedded structural and cultural barriers in STEM disciplines.

Third, women who lead a STEM career are highly resilient. As the 28 studies showed, whether they chose to passively conform to conventional norms and expectations, actively engage in impression management, or proactively evoke change in their workplace, the STEM women did not allow the roadblocks to get in their way. The creative solutions they found reflect the women's uncompromising commitment to succeed in their STEM careers in spite of the challenges. The tenacity they demonstrated may be partially explained by the three internal qualities they possess—motivation, self-efficacy, and passion for work.

## 8 | IMPLICATIONS FOR THEORY DEVELOPMENT

The findings from this systematic review highlighted the multifaceted and multidirectional nature of women's careers in STEM fields, cutting across individual, organizational, and societal levels. Perhaps this is why researchers such as Iellatchitch, Mayrhofer, and Meyer (2003) reminded us that applying theoretical and analytical concepts to empirical career research is "neither simple nor one-dimensional" (p. 729). Recognizing such a unique feature of women's STEM careers has several implications for theory building.

First of all, to establish a comprehensive or accurate understanding of women's experiences in STEM careers, researchers must first recognize the multifacets and multidirections that characterize a woman's STEM career. Doing so may require researchers to conceptualize careers differently—instead of situating careers in the traditional organizational boundary, look at careers in a larger context. Broadening the research focus will help capture the changing dynamics and complexity of the career landscape for STEM women. It will also encourage researchers to embrace theoretical lenses that go beyond the organization as the site for professional careers.

Second, in this review, we identified 13 theories used to guide some of the 28 empirical studies. Despite the diversity, these theories were informed primarily by two perspectives—behavioral and organizational. These perspectives have their own embedded limitations, especially considering our finding that women's experience with STEM careers is a multifaceted and multidirectional phenomenon. In this case, conducting a macro-, meso-, and microlevel analysis could be more helpful. Macrolevel analysis will help us situate STEM careers in the larger societal context; mesolevel analysis can help us unpack the impact of different groups, communities, and institutions that have interactions or associations with STEM career women; and microlevel analysis can help us take a close look at the social interactions of individuals such as STEM women. Along the same line of thinking, we also urge career researchers to integrate theories from different disciplines to generate additional insights. For example, in addition to using a critical or feminist theory as the only guiding framework, combine it with other contextual career theories such as career construction theory and chaos theory of careers. These emerging theories of career development help us link careers to other environmental forces (e.g., social context, systems, agency, and power), thus enabling career scholars to appreciate the complexity of women's careers while capturing the dynamic interplay across the macro-, meso-, and micro-levels.

Following the logic above, we can safely conclude that the scope of the 28 empirical studies was narrow as a result of using narrowly focused theoretical perspectives. Similarly, the quantitative studies we analyzed also utilized theories in a very limited manner. Neither of these approaches was helpful to advancing career theories. For an applied field such as HRD where sound theories are lacking (Swanson & Holton III, 2009), embracing broad perspectives is critical to the generation of credible findings that can be used for new theory building or existing theory validation. For example, incorporating the macro-, meso-, and microlevel analysis approach to both qualitative and quantitative inquiry will extend our understanding of STEM women careers from their individual perspectives to include institutional and societal standpoints, thus providing us with richer data for theorizing. Another example is that quantitative researchers could leverage a mixture of methods (e.g., theoretical sampling, field observations, open-ended interviews, and structured questionnaires) in the prehypothesis development stage of their study (Bamberger, 2017) to better understand the complexity of their research topic (e.g., women's careers). The insight generated from such research endeavor may lead to the identification of new theoretical career constructs or eliminating existing ones in the process of hypothesis development and research design.

## 9 | IMPLICATIONS FOR PRACTICE

Through this review, we identified a few challenges facing women in STEM careers, which can be addressed by organizational leaders and HR practitioners. First, women have to deal with a number of stereotypes ascribed to them in the male-dominated STEM fields; this stereotypical thinking has influenced many organizational practices such as

hiring, promotion, job assignment, and career development. HRD professionals can take a lead in educating leaders, managers and recruiters through individual-level interventions (e.g., implicit bias training, facilitated critical reflection sessions and one-on-one mentoring) and organization-level interventions (e.g., skill-based hiring, competency-based job assignment, and performance-driven promotion). The combination of these interventions will heighten decision-makers' awareness of their own assumptions and reduce their biases when it comes to recruit, manage, and develop female STEM professionals. They will also help foster an organizational culture that promotes gender equity and fairness, as well as increase women's representation in the workplace (Gibson, 2006).

Second, our review shows that women, compared to their male counterparts, have less access to organizational resources such as mentoring, learning, and career development opportunities. This is largely due to the structural barriers and power dynamics that exist within the organization. HRD practitioners can take the lead in providing direction for the (de)-gendering of the organization and eliminating the politics of access in order to give women the space and structure they need to succeed in their STEM careers. Here are a few organization-level interventions for consideration: (a) removing the structure barriers by redistributing power both vertically and horizontally across the organization, (b) formulating gender-neutral policies that will ensure women have the equal access to organizational resources and support systems as men do, and (c) empowering qualified women to assume more responsibilities or senior roles they are capable of. As research confirmed, giving women access to organizational power structure helps change the gendered culture of the organization, because women with more power can act as change agents who will advocate for gender friendly policies (Stainback, Kleiner, & Skaggs, 2016).

## 10 | OPPORTUNITIES FOR FUTURE RESEARCH

While this SLR is among a few attempts at integrating multidisciplinary knowledge, this review has several limitations, each of which, however, offers an opportunity for future research. First, this review included studies that explored the career experiences of women in STEM at large. Future research could go in more depth to look at women's career experiences in different STEM disciplines. Doing so will help researchers gain a better appreciation for context and discipline sensitive influencers. In addition, future research can compare the career paths of STEM women in different categories, for example, women who exited the STEM workforce, women who received STEM education but never pursued a STEM career, and women who have succeeded in STEM professions. These types of comparative studies will enhance our understanding of the career facilitators and inhibitors specific to STEM. We also call for future research that focuses on exploring the influence of the national context on women's career choices and experiences. For instance, it will be interesting to conduct cross-country comparisons to find out if women in similar cultural contexts share similar career experiences in STEM occupations. On the other hand, it will be equally meaningful to compare and contrast STEM careers of women in countries that present strikingly different cultural values. Furthermore, future research is needed to look into the potential impact of demographic differences (e.g., race, ethnicity, gender, and sexual orientation) on the career experiences of the STEM women.

The second limitation of this review is the publication bias (Wang, 2019). In this article, we included only peer-reviewed journal articles published in English; as a result, we might have missed out important knowledge about the topic that was disseminated through other non-refereed publication outlets (e.g., conference proceedings, theses and dissertations, books, monographs, book chapters, practitioner-focused journals, and magazines) in the languages other than English. Due to this limitation, our conclusion that STEM women's career experiences were examined largely in the western context may not be accurate. For future SLRs, we strongly encourage the inclusion of publications from both refereed and non-refereed sources and possibly in multiple languages. Further, to enable replicability—an essential goal of the SLR methodology, we have provided a detailed description of the SLR process that we followed. However, this, by no means, suggests that our SLR process was flawless. In fact, we are highly aware of the possible biases introduced through the coding and grouping process. Also, we acknowledge the potential loss of some nuances of the

findings when comparing the 28 studies for this review (Nolan & Garavan, 2015). For all these reasons, our review offers only one of many possible insights into STEM women's career experiences.

Third, this review included only 28 empirical studies, so any generalization of our findings to a larger population should be made with caution. Based on this review, 27 of the 28 empirical studies focused on STEM women in western countries (the global north). This finding is concerning to us because as the world is becoming more global and diverse, there is an imminent need to understand workforce challenges across all regions in order to build cross-cultural knowledge and global competency. However, with findings from only 28 studies, our concern may not be representative. For this reason, more studies with larger sample sizes are necessary.

Fourth, methodologically speaking, we see a great need for studies informed by diverse research paradigms. Based on the 28 empirical studies we reviewed, there is a limited use of methodologies and methods in both qualitative and quantitative studies. For example, in addition to relying solely on surveys and existing instruments to collect quantitative data, consider adopting the quasi-experiential design and developing psychometrically sound measurements that will allow for more rigorous assessments and organizational application. Also, engage in more mixed research methods studies (e.g., Shockley, Ureksoy, Rodopman, Poteat, & Dullaghan, 2016) and longitudinal studies (e.g., Autin, Douglass, Duffy, England, & Allan, 2017; O'Brien, Friedman, Tipton, & Linn, 2000) as these approaches help generate balanced and holistic insights.

Finally, unlike previous research that focuses primarily on describing women's experiences in STEM, this review extends our knowledge by revealing three specific strategies (i.e., conforming, impression management, proactivity) that women used to address the challenges they encountered. However, due to the limited amount of empirical evidence available, we remain unclear about the degree of impact of women's efforts on challenging the status quo (Bastalich et al., 2007; Evetts, 1998). This limitation opens a door for many future research opportunities. We encourage scholars interested in this line of inquiry to further investigate (a) strategies adopted by STEM women, (b) the effectiveness of these strategies on women's career success in STEM, and (c) the impact of women's actions in driving positive organizational and/or individual change.

## 11 | CONCLUSION

Our review of 28 publications indicates that previous empirical research on STEM women's career is deficient in several areas. First, as a research topic, women's career experience in STEM has not received equal attention as other aspects of career issues such as career motivation and career attitude. Secondly, previous research on this topic was guided by limited theoretical perspectives. Thirdly, the research approaches used were often discipline-bound and monodisciplinary. Finally, little effort has been made to integrate and assess extant research on STEM women's career experiences. By suggesting practical strategies and a comprehensive research agenda, we hope this review will benefit not only HRD practitioners and scholars, but also other stakeholders, such as business leaders and STEM educators. For women in STEM careers, we hope what we offered through this review will provide meaningful thoughts for critical self-reflection and career assessment.

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