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Michaela Mari
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Women's Entrepreneurship in STEM Disciplines

Issues and Perspectives

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Introduction

Over the years, the interest in STEM (the acronym for "Science, Technology, Engineering, and Mathematics") disciplines has been increasing worldwide, mainly because these disciplines are associated with a country's level of innovation and competitiveness, social and economic growth, thus to the overall level of well-being of society.

Within this scenario, the latest data from OECD clearly point out a low involvement of women in STEM. Data show indeed that, even if, within OECD countries, an average of 51% of women between 25 and 34 years old held a tertiary degree in comparison to 39% of men in 2019 (OECD 2021), women are still more likely than men to pursue an educational path focused on subjects relating to education, health, and welfare (OECD 2021). This gender gap in STEM education is typically ascribed to the existence of enduring gender stereotypes, based on the idea of specific gender roles and occupational gender segregation, as well as by the absence of female role models and mentoring.

These data inevitably affect the percentage of women entrepreneurs in STEM fields. Despite the paucity of data, the most updated available information show, in Europe, for example, that only 17% of start-up founders are women (European Parliament 2021).

The scant representation of women entrepreneurs within STEM fields also generated the consequence that the analysis of the characteristics of women entrepreneurs (and of their firms) operating in these fields has been mostly neglected in the women entrepreneurship research area until now. Notwithstanding, we claim that a more thorough understanding of issues related to women's entrepreneurship in STEM is crucial, as women-led firms in STEM are considered pivotal either for the countries' socio-economic growth, being sources of occupations and innovation (OECD 2018), or for younger women, acting as mentors and role models.

By stimulating scholars' reflections on women entrepreneurial propensity and on Women's Entrepreneurship in STEM Disciplines, this book thus aims at contributing to the emerging conversation on this issue, bringing together both global and country-specific evidence able to offer a new and insightful addition to the women entrepreneurship research area.

The book is developed in five chapters taking into account different perspectives related to women entrepreneurs in STEM fields, as well as different countries' object of investigation.

The first chapter, entitled "Understanding the Entrepreneurial Intention of Women in STEM Fields" by Elda Barron and Linda Elizabeth Ruiz, investigates how university context, family context, entrepreneurial experience, and individual attributes affect the entrepreneurial intentions of young women in STEM careers. By analyzing 81,319 responses of STEM career students (male and female) from 54 countries, the two scholars highlight, among the others, the relevance of individual variables, as women with a high self-efficacy tend to have great entrepreneurial intention.

The second chapter entitled "Individual Factors Explaining Women's Entrepreneurship in STEM Fields" by Kaethe Schneider is a systematic literature review whose aim is to investigate the individual factors able to explain women's entrepreneurship in STEM fields. By using the Rubicon model of action, results show that for all phases the learning experiences and corresponding competencies related to STEM, and entrepreneurial as well as management experiences are crucial individual factors for women's STEM entrepreneurship.

The third chapter, entitled "Analysis of the European Women Entrepreneurship in STEM Fields", by Maria de las Mercedes Barrachina Fernández, María del Carmen García Centeno and Carmen Calderón Patier aims at analyzing the characteristics of women entrepreneurs in STEM fields in Europe. Specifically, by considering both individual and country factors, the scholars aim at identifying the factors that make a female nascent entrepreneur more likely to be innovative in any potential way, evaluating the effect of the taxes in the decision to become an entrepreneur. Different results emerge; among them, the role of age, previous failure in business creation, and the GDP of the country are shown to have a positive impact on the innovative business creation process.

The fourth chapter, entitled "Women Tech Entrepreneurship in India", by Mili Shrivastava sheds light on a still under investigation country, i.e., India, highlighting the challenges and opportunities able to affect women IT entrepreneurship. Specifically, the role of the context in influencing the structural and normative factors is studied providing an interesting starting point for those scholars interested in analyzing such a country.

The fifth chapter, entitled "Public Policies and Private Efforts to Increase Women Entrepreneurship Based on STEM Background", by Aldo Alvarez-Risco and Shyla Del-Aguila-Arcentales, emphasizes the relevance of STEM education for girls and women and its implications for entrepreneurship. Results clearly show that room for further investigations still exists.

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Contents

Understanding the Entrepreneurial Intention of Women in STEM Fields

Elda Barron and Linda Elizabeth Ruiz

Abstract The participation of women in entrepreneurship is growing, and with it, the interest in understanding their behavior and motivations. This study explores the entrepreneurial intention of female students in STEM areas. We aim to understand the individual and university factors that affect entrepreneurial intention. We analyzed 63,633 responses from GUESSS data of STEM career students from 54 countries. Our findings highlight the effect of entrepreneurial learning and the moderating effect of the university environment on women's entrepreneurial intention.

Keywords Entrepreneurial intention · Women entrepreneurs · STEM · Entrepreneurship education · Gender · Theory of Planned Behavior (TPB)

1 Introduction

According to the National Center for Education Statistics of the United States (2019), the number of women obtaining science, technology, engineering, and mathematics (STEM) degrees and certificates during the last decade has been increasing. However, differences in the number between women and men remain to be significant. In the USA, women hold approximately 30% of the total degrees and certificates, whereas men hold 70%. Given the importance of STEM in innovation and entrepreneurship and its impact on a country's economic and innovation level, researchers and practitioners have been geared toward understanding the factors that influence this situation.

Consequently, different scholars have called for expanding the understanding of women entrepreneurs in STEM fields (Kuschel et al. 2020; Poggesi et al. 2020) for several reasons. First, there are only a few studies focusing on women entrepreneurs

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in STEM. Hence, a better understanding of the determinants in these areas could provide relevant insights into the topic. Second, women's role has been recognized to impact regional economic and social progress (Bullough et al. 2017). Third, a framework that helps women boost their activity must be developed.

Additionally, the relevance of women's participation in these areas has been noted to increase every single day with the inclusion and promotion efforts by public policies and private interests. However, evidence shows that women often have low involvement level in STEM, which can be attributed to gender gap in career choices and employment opportunities (OECD 2017). The gender gap in STEM career choices is significant in gender-equal countries (Mostafa 2019). This pattern presents an opportunity to examine the differences between women and men in STEM careers and their intentions to start a STEM venture.

Women's entrepreneurial participation raises many questions, especially in STEM fields, where their participation has increased. In this paper, we explore the conditions that allow the entrepreneurial intention of women in STEM fields. In this study, we examine individual and contextual conditions that drive the entrepreneurial intention of young women in STEM fields. We aim to explore the reasons why certain women enrolled in STEM careers tend to start a new venture. What are the conditions that enhance women's entrepreneurial career choice in STEM? This chapter further analyzes cross-country differences and similarities between the entrepreneurial intentions of young women in STEM fields.

We analyze these questions using Global University Entrepreneurial Spirit Students' Survey (GUESSS) data. The dataset includes 63,633 responses of STEM career students (male and female) from 54 countries. We then run a structural equation modeling (SEM) and multivariate linear analysis.

This chapter contains five main sections as follows. Section 1 introduces the research topic and goals of this work. Section 2 presents a literature review to determine the factors that affect entrepreneurial intention and an overview of the general theme. Section 3 illustrates the methodology and research model. Section 4 presents the analysis results. Finally, Sect. 5 presents the conclusion and highlights future research for this topic and study limitations.

2 Background

2.1 STEM Context

STEM education refers to fields of science, technology, engineering, and mathematics. In most countries, the number of women involved in STEM education fields is fewer than men, compared to other areas of study, such as arts and business, where the gap is lower, and women have considerable participation. This situation can be observed not only among students but also among university graduates, where gender gap is more prominent in the latter one. According to the OECD (2018), various educational prejudices can affect women's career decisions. For example, only 4.7% of adolescent women expressed preference to an engineering or computer career, whereas 18% of men have decided to take these career paths.

STEM careers and women's inclusion in this field have been increasingly promoted. However, much work is required to close this existing gap. In this regard, STEM education is relevant due to the labor market and labor trends in these specialized areas. For example, Latin American countries are facing problems in terms of covering workforce demands (OECD 2018). Consequently, several initiatives have been developed to mitigate the problem. For example, Women Who Code is an initiative that encourages women into technology careers. Similarly, universities are developing programs to attract women into this field.

Many STEM initiatives focus on encouraging women in STEM education. Nevertheless, entrepreneurship is also promoted in STEM areas to encourage women and men from STEM careers to start new ventures. However, entrepreneurship also has significant gender gap in certain regions. According to the GEM Women's Entrepreneurship Report, women's global average rate for entrepreneurial activity is 10.2%, whereas that of men is 14.8% (Elam et al. 2019). Although the entrepreneurial gap has been gradually addressed, certain regions and industries continue to exhibit considerable differences.

Different scholars suggest paying attention to education levels to understand individuals' entrepreneurial behavior (e.g., Wilson et al. 2009). Education provides diverse skills and experiences that can influence one's business startup intention. Previous research examines the impact of mandatory and self-selection courses on entrepreneurial intention and university facilities. Particular careers and business programs address entrepreneurship topics as part of their curricula, contrary to STEM careers where certain business topics are optional and excluded. Therefore, the entrepreneurial intention of students in these careers needs to be analyzed.

2.2 Entrepreneurship Education in STEM Fields

Entrepreneurship education has been the subject of various streams of research, which demonstrated that education significantly impacts entrepreneurship behaviors. For example, Wilson et al. (2009) analyzed students at middle and high school education and MBA degrees and suggested that entrepreneurship education impacts self-efficacy. This variable is essential for entrepreneurial intention development. Other authors also describe that education may impact women more than men. Similarly, Zhang et al. (2014) have examined the relationship between entrepreneurship education, entrepreneurial exposure, and perceived desirability and feasibility of university students' entrepreneurial intentions. The authors highlight the positive impact of entrepreneurship education on entrepreneurial intention development. These findings are similar to those of Soutiaris et al. (2007) on engineering students.

Certain studies suggest that entrepreneurship education is vital for business opportunity development and thus has been utilized mainly in business areas. In their study, Shinnar et al. (2009) suggested that non-business students have great interest in entrepreneurship education. STEM students often work on innovative product and service development. Thus, their interest in entrepreneurship education may be related to the perceived need for business skills to commercialize their products. Atkinson and Mayo (2010) suggested that the inclusion of entrepreneurship education in STEM areas will also improve students' entrepreneurial behavior and find a market for their innovations. Moreover, it will further help students to engage in STEM areas.

Accordingly, Colombo and Piva's (2020) recent publication describes that the inclusion of specific economics and management training may encourage a STEM student into entrepreneurship. These results strengthened Colombo and Grilli's (2005) previous research, which described the benefit of combining managerial and technical skills (commonly found in STEM areas) in entrepreneurship. Other scholars, such as Law and Breznik (2017), have analyzed engineers and business students' entrepreneurial intention. Accordingly, they also related to the need to enhance students' self-efficacy, in which others have proved the relevance of entrepreneurship education (Wilson et al. 2009).

2.3 Entrepreneurial Intention of Women in STEM Fields

Entrepreneurial intention has been the focus of different scholars. Ajzen's (1991) widely known theory of planned behavior describes three main factors of entrepreneurial behavior, that is, attitudes toward entrepreneurship, subjective norms, and perceived behavioral control. Different authors (e.g., Liñán and Chen 2009) have used this theory to extend knowledge, such as factors affecting entrepreneurial perceptions, in different subjects (e.g., Liñán and Chen 2009) and attitudes (e.g., Krueger et al. 2000).

As mentioned above, entrepreneurship education can impact students' entrepreneurial intention (e.g., Souitaris et al. 2007). STEM one focus of attention in the STEM area is related to gender, and women have been traditionally underrepresented in this arena. GUESSS 2018 describes an existing gender gap of entrepreneurial intention in STEM areas.

Results unexpectedly suggest that the gap is small compared with that in other specialized areas. Armuña et al. (2020) have recently analyzed entrepreneurial intention to identify gender differences by considering competence and skill factors. They described non-significant differences between genders. However, they found a significant difference in recognizing the potential value of an idea. Nevertheless, women often have better teamwork skills, which is a highly valued competence in entrepreneurship. Contrary to Armuña et al. (2020), who found no significant differences, other authors (e.g., Birkner 2020) have described that women may face challenges mainly because of subjective norms related to their gender (being women) and the normative masculine frame of the entrepreneurship and STEM fields.

Similarly, Elliott et al. (2020) suggested building a supportive environment as an important element for developing the activity within the STEM field. They found that the subjective norms of women's assigned roles remain predominant among women in STEM fields. Thus, building a supportive environment may strengthen women's perceptions about their capabilities, such as self-efficacy. Other authors (e.g., Neumeyer and Santos 2020) have highlighted the importance of building a gender-balanced team as women's presence may help develop entrepreneurial behavior in STEM areas.

Based on the above arguments, we formulate the following research questions:

1. What external factors contribute to the entrepreneurial intention development of women in STEM areas?
2. What internal elements in universities contribute to the entrepreneurial intention of women in STEM areas?

3 Methodology and Model

We develop a model based on Ajzen's (1991) theory of planned behavior and Liñán and Chen's (2009) entrepreneurial intention model to understand the entrepreneurial intention of women in STEM fields. We aim to measure the impact of different variables, such as entrepreneurial learning, entrepreneurial self-efficacy, university and social contexts, and moderator variables, on the relationship between attributes and intention. We also aim to discover the differences across education fields to boost entrepreneurial intention and gender differences. Figure 1 illustrates this research model. This concept captures resources provided by the university, namely, inspiration, training, and networking. It is a measure of climate to boost students' perceived entrepreneurial behavior.

We have also examined the factors that affect entrepreneurial intention of women students in STEM careers across countries. We use GUESSS 2018 data to explore how university context, family context, entrepreneurial experience, and individual attributes affect the entrepreneurial intentions of young women in STEM careers. GUESSS is a global research project that includes more than 200,000 students from more than 3,000 universities worldwide. For this research, the dataset includes 81,319 responses of STEM career students (male and female) from 54 countries. GUESSS categorizes STEM careers into computer sciences, IT, engineering, human medicine, health science, mathematics, and natural sciences. Table 1 shows the sample description.

We then set up a SEM analysis through Stata software and run a multivariate analysis to explore moderate effects. Table 2 presents the measures selected to capture students' entrepreneurial behavior. Based on the SEM analysis results, we developed a factor score for entrepreneurial intention to use a ranking measure to compare gender differences.

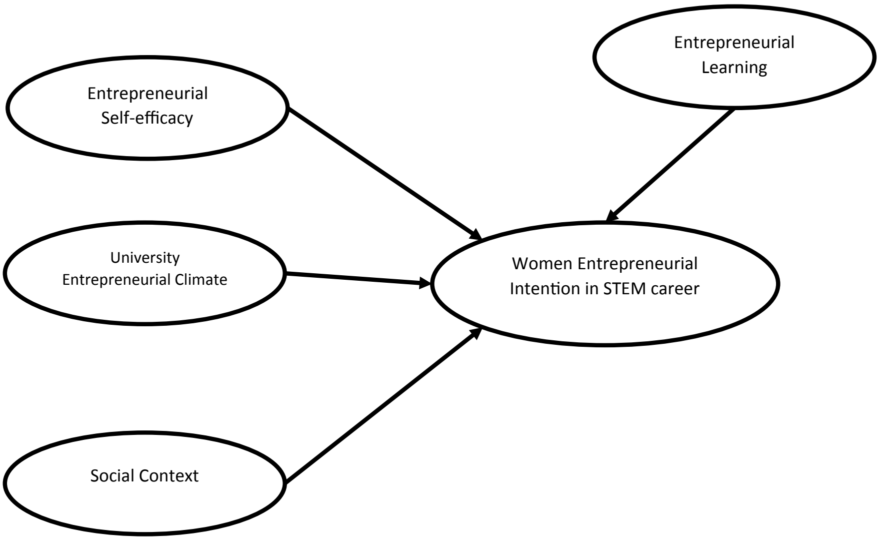


Fig. 1 Entrepreneurial intention of young women in STEM careers

Table 1 Characteristics of responses

Characteristics	Respondents ($n = 81{,}319$)	
	Number	Percentage
Gender		
Male	44,673	54.94
Female	36,345	44.69
Education		
Undergraduate (bachelor)	64,154	78.89
Graduate (master)	10,719	13.18
PhD	3,156	3.88
Others (e.g., MBA)	3,261	4.01
STEM field of study		
Computer sciences/IT	15,740	19.36
Engineering	33,555	41.26
Human medicine/health sciences	18,229	22.42
Mathematics	2,695	3.31
Natural sciences	11,100	13.65
Entrepreneurs		
Nascent	22,926	28.19
Active	7,389	9.09

Table 2 Measures

Construct	Definition	Reference
Entrepreneurial intention	Entrepreneurial intentions are desires to start a business	Linan and Chen (2009)
Entrepreneurial learning	This concept is related to specific knowledge about entrepreneurship acquired during a program that would improve entrepreneurial skills and intention	Souitaris et al. (2007)
Entrepreneurial self-efficacy	This concept captures an individual's confidence related to his/her entrepreneurial abilities	Chen et al. (1998); Zhao et al. (2005)
Social context	This context is based on subjective norms that measure the perception that reference people would approve an individual's decision to become an entrepreneur	Linan and Chen (2009)
University entrepreneurial climate	This concept captures resources provided by the university such as inspiration, training, and networking. It is a measure of climate to boost entrepreneurial behavior perceived by students	Franke and Lüthje (2004)

4 Findings

4.1 Entrepreneurial Intention: Gender Differences

As mentioned above, previous research examined the differences between gender, age, and institutional conditions to expand the understanding of entrepreneurial behavior. Accordingly, we contribute to the entrepreneurial field by analyzing the factors that affect the entrepreneurial intention of women STEM students.

Of the total STEM students, 37.4% are determined to be involved in entrepreneurial activity. We analyzed the gender differences across these students. Figure 1 shows gender differences across students and STEM students. Results show that males in STEM careers are more involved in entrepreneurial activities than females.

The portion of male students running their businesses (active entrepreneur) and starting a new business (nascent) is more significant than that of females (see Fig. 2). The active entrepreneur students in STEM careers comprise 61.38% and 38.62% males and females, respectively. In contrast, the nascent entrepreneurs are composed of 42% women and 57% men; the difference is lower than that in active entrepreneurs.

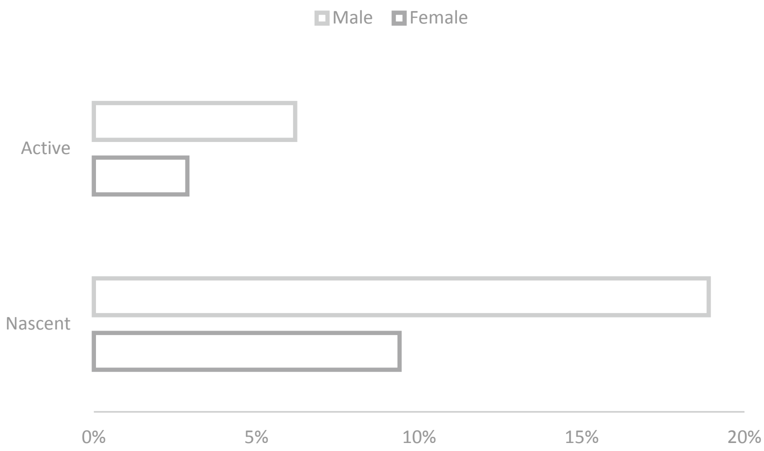


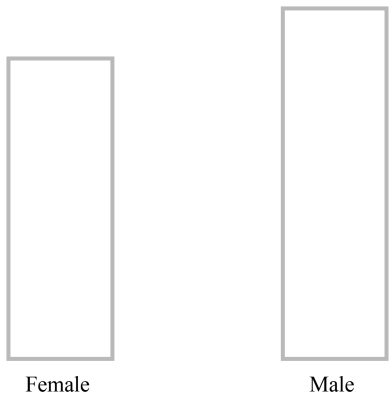
Fig. 2 Gender differences among entrepreneur STEM students

After determining the differences in entrepreneurial activity, we analyze gender differences in intention. Figures 3 and 4 show gender differences in entrepreneurial intention, which are consistent with the GEM's total early-stage entrepreneurial activity rate (Bosma et al. 2020).

According to the GEM, women's intention to start a new business is 17.6%, whereas that of men is 21%. These numbers show a decreasing difference. We found differences between the entrepreneurial intentions of women and men students in STEM fields. Moreover, we analyzed the intention of students from other fields. Our results show that males present a higher intention to become an entrepreneur than females across different career areas.

Men present a higher entrepreneurial intention level than women in all career areas. As expected, men and women exhibited the most significant entrepreneurial intention in business and management. An analysis of gender differences within

Fig. 3 Entrepreneurial intention of STEM students



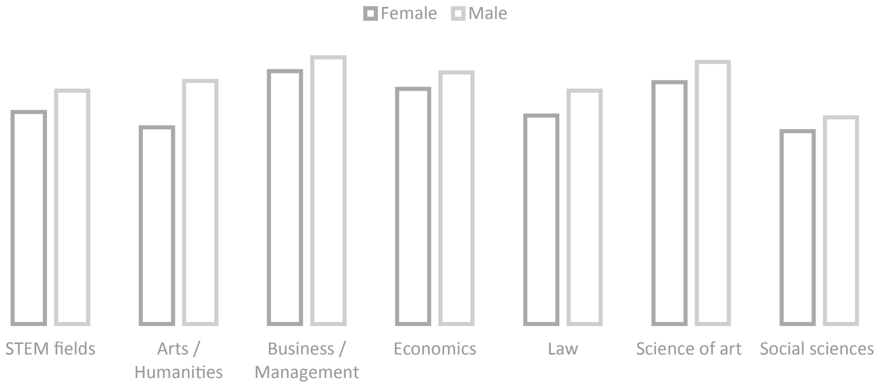


Fig. 4 Entrepreneurial intention of students

STEM fields showed that women present a higher intention score to become entrepreneurs in computer science, IT, and engineering than men. However, they present a negative score in human medicine, health, mathematics, and natural science. This result shows that women prefer to work in established organizations rather than become a traditional entrepreneur and start a venture.

4.2 Entrepreneurial Intention Across Countries

As per our findings, it was also determined that each nation provides students with different educational resources and contexts to boost entrepreneurial intention. Figure 5 shows the entrepreneurial intention of women in STEM fields across 54 countries based on the GUESSS data.

We found that women in STEM fields have higher scores of entrepreneurial intention in countries such as the USA, Australia, Portugal, and England. Conversely, countries such as Japan, South Africa, France, and Germany present lower scores.

We cannot observe a pattern in terms of income or country condition for STEM. Certain women decide to start a business because they perceived they do not have the conditions to work in the STEM field or particular countries provide conditions that promote women's entrepreneurial activity in STEM.

4.3 Understanding the Entrepreneurial Intention of Women in STEM Fields

We performed SEM analysis to validate and understand the model of the entrepreneurial intention of women in STEM fields. Figure 6 shows the model of

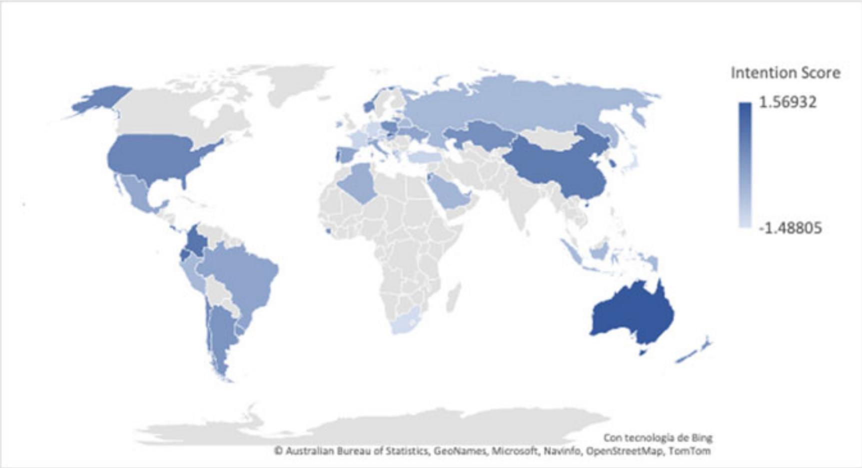


Fig. 5 Entrepreneurial intention of women in STEM fields

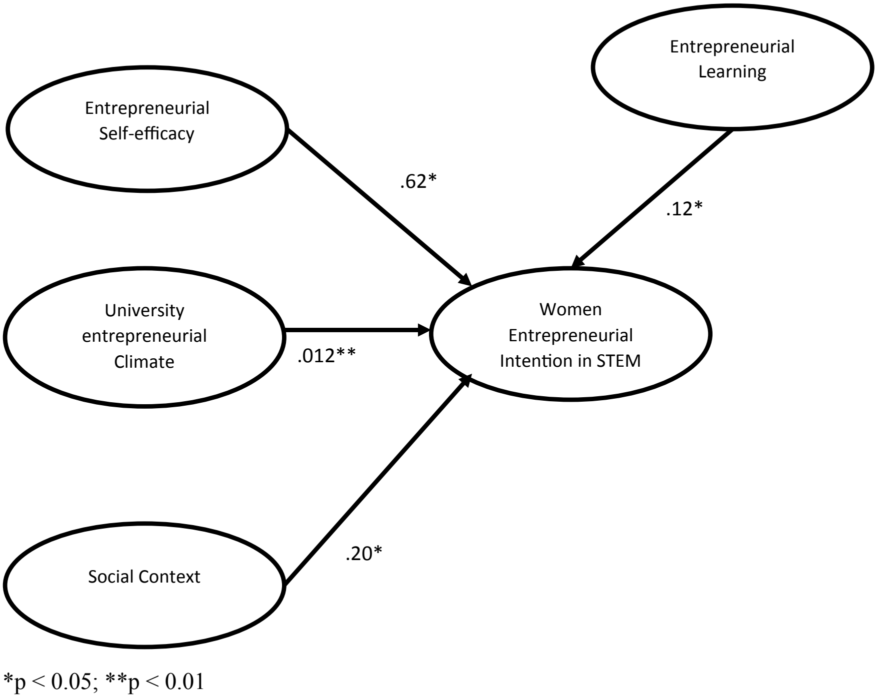


Fig. 6 Structural equation modeling results

entrepreneurial intention determinants. We include standardized parameters above the arrows. This empirical research confirms a positive relationship between external factors such as social context of entrepreneurial intention. Furthermore, individual factors show a positive influence such as entrepreneurial self-efficacy and learning. Results also show that the university climate variable is significant but has a more negligible effect than the others. Figure 6 summarizes the SEM results. Our model results show acceptable fit indexes of λ^2 = 87,282.67 and p-value = 0.00. Table 3 shows the results for the model fit.

Table 4 shows the multivariate linear analysis results. Model 1 runs variables only to determine a direct effect. Results from this model show that most individual and social context variables indicate a statistical and direct significance, except for the university entrepreneurial climate. In contrast to SEM, the regression shows an insignificant effect of university climate on entrepreneurial intention.

Model 2 included a moderator variable as the university entrepreneurial climate may moderate the relationship between entrepreneurial learning and entrepreneurial intention, similar to that in model 1. Model 1 shows that individual, social context, and moderator variables are significant, whereas the direct effect of university climate was not significant. Model 3 includes an additional moderator variable, namely, entrepreneurial self-efficacy. Results of model 3 suggest that entrepreneurial

Table 3 Test for the model fit

Statistical test	Outcome	Parameter	Source
Chi square	$\chi^2 = 67{,}282.670$ $P = 0.000$	$P < 0.05$	
Root mean square error of approximation (RMSEA)	RMSEA = 0.100 PCLOSE = 0.00	RMSEA < 0.1	Browne and Cudeck (1993)
Comparative fit index (CFI)	CFI = 0.883	CFI = 0 to 1 A value close to 1 indicates a perfect fit	McDonald and Marsh (1990)

Table 4 Results of the model of entrepreneurial intention of women in STEM fields

Variable	Model 1	Model 2	Model 3
Entrepreneurial learning	0.1197*	0.1134*	0.11298*
Entrepreneurial self-efficacy	0.6652*	0.6652*	0.6798*
University entrepreneurial climate	0.0015	0.0045	0.0019
Social context	0.2043*	0.2018*	0.2038*
Entrepreneurial learning × university entrepreneurial climate		0.0218*	0.010*
Entrepreneurial learning × entrepreneurial self-efficacy			0.037*
Regression function			
R^2	0.5139	0.5150	0.52

Notes N = 36,345. * denotes $p < 0.05$. Entrepreneurial intention is the independent variable self-efficacy moderates the relationship between entrepreneurial learning and self-efficacy. Similar to models 1 and 2, individual variables and social context are significant, except for the university entrepreneurial climate.

These results provide a framework to understand the factors that affect the entrepreneurial intention of young women in STEM careers. Furthermore, these findings suggest the important role of individual variables in entrepreneurial intention. Entrepreneurial learning and confidence in skills are strong determinants of the intention to start a business among women in the STEM field. The perception of being in an environment that supports a person's decision to become an entrepreneur is also important. Thus, a supportive society toward entrepreneurship may benefit women who decide to start a business.

5 Conclusions

This chapter contributes to the understanding of how particular conditions could boost the entrepreneurial intention of women students in STEM. We analyzed variables from the perspectives of an individual and different contexts, considering the normative support (social context) and university climate toward entrepreneurship. Individual variables have been determined to play a significant role, indicating that women with high self-efficacy tend to have great entrepreneurial intention. This finding can also be observed among those perceived to be receiving any type of entrepreneurship education because they perceived entrepreneurship education will improve their entrepreneurial skills. Our analysis also highlights the importance of normative support for entrepreneurship. Thus, women likely have a high entrepreneurial intention level in supportive societies.

Based on the results of this study, we suggest well-designed strategies for entrepreneurship that consider environmental and individual factors. As mentioned above, the higher the perception of entrepreneurial learning, the greater the positive effect on entrepreneurial intention among women. Therefore, in STEM areas, in which entrepreneurship is an optional university subject, strategies that encourage women to participate in entrepreneurial programs should be designed. These strategies can increase their business skills and thus improve their confidence to engage in entrepreneurial activities.

Universities are aware of the importance of the role of society. As mentioned above, societies that support entrepreneurship will also help women engage in entrepreneurial activities in STEM areas. However, offering entrepreneurial subjects and activities where women can participate may reduce the effect of non-supportive societies.

For future research, we suggest to extend the knowledge about women in STEM fields. Other countries' cultural factors must also be considered, such as risk aversion behavior. Moreover, a university's entrepreneurial culture also plays an important role. Thus, we suggest analyzing macro, meso-, and microenvironments. Research in STEM areas within corporations is also suggested to further analyze the behavior of women within this environment. Another line to explore women entrepreneurship in STEM is related to their perceived motivations and restrictions within this context. What motivates women in STEM fields to start a new business? What are the main barriers they perceive?

This research has important implications for theory and practice as one of the few entrepreneurship studies in STEM fields. This study provides scholars a framework to develop models in different contexts of women entrepreneurs and academic entrepreneurs. We also contribute to the entrepreneurship and gender theory by analyzing the entrepreneurial intention of women within the STEM field, which is a highly masculine area.

Practitioners can develop programs that enhance entrepreneurship in STEM fields by considering the importance of entrepreneurship education and a supportive environment among women.

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Individual Factors Explaining Women's Entrepreneurship in STEM Fields

Kaethe Schneider

Abstract Although the gender imbalance in starting businesses in fields of science, technology, engineering, and mathematics (STEM) poses a problem, there is only a small body of research on the individual factors driving women's entrepreneurship in STEM fields. In the current study, we investigate state-of-the-art research on the individual factors that explain women's entrepreneurship in STEM by conducting a systematic literature review. The present review addresses the question of what is known about individual factors explaining women's entrepreneurship in STEM fields in the scientific literature. A sample of 15 articles identified from 193 screened abstracts was analyzed using a theory based qualitative content analysis. The explanatory variable of entrepreneurial entry was modeled as a process consisting of entrepreneurial intention formation, intention initiation, and intention realization. Besides phase-specific driving factors, the results show that for all phases learning experiences and corresponding competencies related to STEM, and entrepreneurial as well as management experiences are crucial individual factors for women's STEM entrepreneurship. As a research program on women's entrepreneurship in STEM has not yet been established, more theory based research should contribute to developing progressive research questions and comparable research objects. Internationally comparable studies and statistics related to gender including validated scales on entrepreneurial entry and career choice should be established in the future.

Keyword Entrepreneurship · STEM · Women · Systematic review · Individual factors

1 Background

Fields of science, technology, engineering, and mathematics (STEM) are critical drivers for achieving economic growth, job creation, as well as societal and human development. However, in light of gender equality issues, the gender imbalance

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in starting businesses in STEM fields poses a problem. Although sufficient data is still not available on women's entrepreneurship in STEM fields, it seems that women establish businesses in industries that are already dominated by women, as for example industries such as personal services, health care, education, arts, entertainment, and recreation, accommodation, and food service activities. For instance, in Germany, 10.5% of TEA men established a business in the information and communications technology sector (ICT) in 2017/2018, while 0% of TEA women were found in this field (Elam et al. 2019). For 2017/2018, the global average of the ratio "Women [Women ICT (percentage of TEA women)]/Men [(Men ICT (percentage of TEA men)]" identified in the GEM Women's Entrepreneurship Report 2018/2019 is 0.3 (Elam et al. 2019). The Total early-stage Entrepreneurial Activity Rate (TEA) is a key indicator of the level of new enterprise creation. Entrepreneurs are defined here according to the OECD-EUROSTAT Entrepreneurship Indicators Programme (EIP), as "…persons (business owners) who seek to generate value, through the creation or expansion of economic activity, by identifying and exploiting new products, processes or markets" (OECD 2012). Bosma and Kelley (2019) show in the Global Entrepreneurship Monitor (GEM) for 2018/2019, that of the 49 economies surveyed by GEM in 2018, only six show equal TEA rates between men and women. Interestingly, the innovation-driven economies of the European and North American regions include many economies with a lack of gender equality. Based on American Community Survey data, Demiralp et al. (2018) found for the USA that women typically work in health occupations (e.g., physicians, dentists, physical therapists, opticians) (77.8%); only 13.1% work in computer and mathematical occupations, 6.7% in architecture and engineering, and 2.4% in life and physical sciences occupations.

The underrepresentation of women entrepreneurs in STEM fields can be explained by various factors, such as socio-cultural, political, economic, and individual factors. To support women entrepreneurship in STEM fields there is a need to increase the number of women entrepreneurs. Training and education play an important role in this regard. For designing educational and training programs it is at least necessary to have an understanding of the individual factors that facilitate women's entrepreneurship in STEM fields.

Although we can point to a growing body of literature in the field of women's entrepreneurship in STEM, it seems that there is still considerable uncertainty concerning the individual factors driving women's entrepreneurship in these fields (Kuschel et al. 2020). In the current study, we consequently plan to investigate state-of-the-art research on the individual factors that explain women's entrepreneurship in STEM by conducting a systematic literature review.

The subordinate research question we address is as follows: What information is available in the scientific literature on individual factors explaining women's entrepreneurship in branches based on sciences, technology, engineering, and mathematics?

2 Theoretical Foundation

Our systematic examination of research studies explaining individual factors of women's entrepreneurship in STEM is based on the Social Cognitive Theory of Career and Academic Interest, Choice and Performance developed by Lent et al. (1994), the Rubicon model of action phases developed by Heckhausen and Gollwitzer (1987), and the personality theory of McAdams and Pals (2006).

In line with the study results that the entrepreneurial intention results from development (Obschonka et al. 2010), the social cognitive theory of career and academic interest, choice, and performance is useful to address this developmental character (Kanny et al. 2014). Thus, in their theory Lent et al. (1994) integrate the different career states of formation and elaboration of interests, career choice selection options, and performance and persistence in educational and occupational pursuits. Following Lent et al. (1994), interest has an impact on goals, which affects action, and that again has an influence on performance. Based on the theory, the interaction of person inputs and the contextual determinants results in learning experiences, the sources of self-efficacy (Lent et al. 1994). There are a variety of personal variables, represented in an exemplary manner in theory, for example, interests, abilities, values, and gender (Lent et al. 1994). Regarding the contextual determinants, Lent et al. (1994) differentiate between proximal and distal variables. While distal variables are background factors, such as family of origin educational background, that affect learning experiences, it is proximal context variables such as, for example, personal career network contacts, that shape the structure of career relevant opportunities (Lent et al. 1994).

Learning experiences which consist of personal performance accomplishments, vicarious learning, social persuasion, and physiological states and reactions have an influence on self-efficacy and outcome expectations, respectively, while self-efficacy expectations also affect outcome expectations (Lent et al. 1994). The combination of self-efficacy expectations and outcome expectations predict interests, goals, actions, and performance (Lent et al. 1994).

In addition to this theory, we will refer to the Rubicon model of action phases with which Heckhausen and Gollwitzer (1987) modeled the course of action in four phases, the pre-decisional, pre-actional, actional, and post-actional phases. While in the pre-decisional, motivational phases, deliberation processes regarding the desirability and feasibility of wishes bring about intention formation, the pre-actional volitional second phase resulting in intention initiation is characterized by opportunity awareness and waiting for an opportunity to move towards the goal state. The second phase is followed by the actional phase, in which intention is realized in order to deactivate in the last phase, the motivational post-actional one, the intention.

Because the model can contribute to differentiating the developmental process of career choice, it can be well combined with the social cognitive theory of career and academic interest, choice, and performance.

Besides socio-demographic characteristics, we conceptualize the variables of the person inputs of the Social Cognitive Theory of Career and Academic Interest, Choice and Performance based on the personality theory of McAdams and Pals (2006).

The authors conceive personality "*as (a) an individual's unique variation on the general evolutionary design for human nature, expressed as a developing pattern of (b) dispositional traits, (c) characteristic adaptations, and (d) self-defining life narratives, complexly and differentially situated (e) in culture and social context*." (McAdams and Pals 2006, p. 204).

Due to our focus on individual variables that can be promoted through training and education, we refer to characteristic adaptations and identity. Characteristic adaptations are "motivational, social cognitive, and developmental variables that are contextualized in time, situations, and social roles." (Costa and McCrae 1985) People differ in terms of identity conceived as a person's self-concept (Heatherton et al. 2007) that they construct by narrating their life story.

From the perspective of methodology, we can group our results according to the epistemic lens through which we look at research questions: Taking a first-person perspective ("I") allows the researcher to study the interior of the personality, experience in the mode of subjectivity, while taking a third person perspective ("it") goes along with an objective view, here on entrepreneurial behavior. The second-person perspective is of an inter-subjective nature because of the relation between an epistemic agent and the mental state of another subject.

3 Methods

To investigate state-of-the-art research on individual factors that explain women's entrepreneurship in STEM we conducted a systematic literature review. The purpose of a review is to identify relevant information from available publications on the research question. The research question here is: What is known about individual factors explaining women's entrepreneurship in STEM, as revealed by scientific literature?

For the selection of publications, inclusion and exclusion criteria will be defined in advance. We analyze the studies according to the research question, the samples, methods, and results and then we systematize the results by theoretically and methodologically derived categories.

3.1 Study Selection Criteria

The criteria for the studies to be selected from the literature review (see Table 1) are that they should be studies that are empirical or literature reviews, written in English, German or French and published in the period from 1980 to 2020. The research focus of the included studies is on individual factors that explain women's entrepreneurship in STEM fields. Accordingly, we exclude studies of a theoretical nature or ones written in languages other than English, German, or French. Likewise, excluded

Table 1 Inclusion and exclusion criteria for the review

Characteristics	Criteria of inclusion	Criteria of exclusion
Type of study	• Quantitative empirical studies • Qualitative empirical studies • Literature reviews	Theoretical studies
Languages	• English • French • German	Other languages
Year of publication	1980–2020	Prior to 1980
Research focus	Individual factors explaining women's entrepreneurship in STEM fields	• Institutional factors • Organizational factors • Cultural factors • Societal factors • Non-STEM fields

are studies related to non-STEM fields or to organizational, cultural, societal, and institutional factors.

3.2 Search Strategy

We searched the literature of relevant disciplines, such as social, educational, business, and economic sciences. As databases, we selected the following: EBSCO including Business/Economics Databases, Education Databases, Gender/Sexuality Databases, Psychology/Sociology Databases, Web of Science, Fachportal Pädagogik, including among others Education Resources Information Center (ERIC), and Google Scholar. As there are different search criteria in the available databases, we set database-dependent search criteria: For EBSCO the strategy was to search within the (1) titles of the full available texts, (2) scholarly (peer reviewed) journal articles, (3) published in the period from January 1980 to November 2020, to ensure inclusion of studies from the beginning, and (4) to find search terms.

In EBSCO, our central database, we searched for articles using the core search terms in the English language: "female" AND "entrepreneurs" AND "(science or technology or engineering or mathematics)", "women" AND "entrepreneurs" AND "(science or technology or engineering or mathematics)", "female" AND "entrepreneurship" AND "(science or technology or engineering or mathematics)", "women" AND "entrepreneurship" AND "(science or technology or engineering or mathematics)", "predictors of women" AND "entrepreneurship" AND "(science or technology or engineering or mathematics)", "predictors of female" AND "entrepreneurship" AND "(science or technology or engineering or mathematics)", "predictors of female" AND "entrepreneurs" AND "(science or technology or engineering or mathematics)", "predictors of women" AND "entrepreneurs" AND "(science or technology or engineering or mathematics)", "predictors of female"

AND "entrepreneurs", "predictors of women AND entrepreneurs". As the number of hits per category of the search terms "science", "technology", "engineering" and "mathematics" in the central database of EBSCO was low, we selected the operator "or" to widen the focus of topics by covering one single group of STEM discipline.

As the literature search in Web of Science, Fachportal Pädagogik, and Google Scholar are complementary to the EBSCO database search, we did not widen the focus here in terms of the topic: Regarding the search in Web of Science we included the criteria "titles", "custom year range: 1980–2020", and the search terms "STEM" AND "women entrepreneurs", "STEM" AND "female entrepreneurs" and in the basic search: "STEM" AND "Women and entrepreneur*". The search in Fachportal Pädagogik was conducted without any further criteria except for the key words "STEM" AND "women" AND "entrepreneurship". In Google Scholar, we searched for articles meeting the criteria (1) "any desired time period"—"beliebige Zeit", (2) "any desired language"—"beliebige Sprache", (3) "sort according to relevance"—"nach Relevanz sortieren", and (4) the key term "predictors of STEM entrepreneurship in women". We excluded pages after the first 13 because of relevance and efficiency of search. Figure 1 shows the search process which was conducted on 24 November 2020 based on the inclusion and exclusion criteria presented in Table 1. In case we could not automatically select the inclusion criteria in the databases, we needed to select the papers by ourselves.

3.3 Included Studies

Applying the predefined criteria, we reached a total number of 15 selected articles, which are analyzed to study the explanatory factors.

4 Results

4.1 Descriptive Characteristics

An overview of the general information on author, year of publication, journal, research object/question, study design, place, and results are presented in Table 2. The current studies are relatively up to date because they were published in the period from 2012 to 2020. Most studies STEM from North America and Europe, with the exception of the two studies from Hong Kong and India, and were published in management and entrepreneurship related journals. In the "International Entrepreneurship and Management Journal", three studies were published; otherwise, they were no groups of texts relevant to the study in any one journal.

Three of the included studies are qualitative (Orser et al. 2012; Ozkazanc-Pan and Muntean 2012; Martin et al. 2015), eight are quantitative (Armuña et al. 2020;

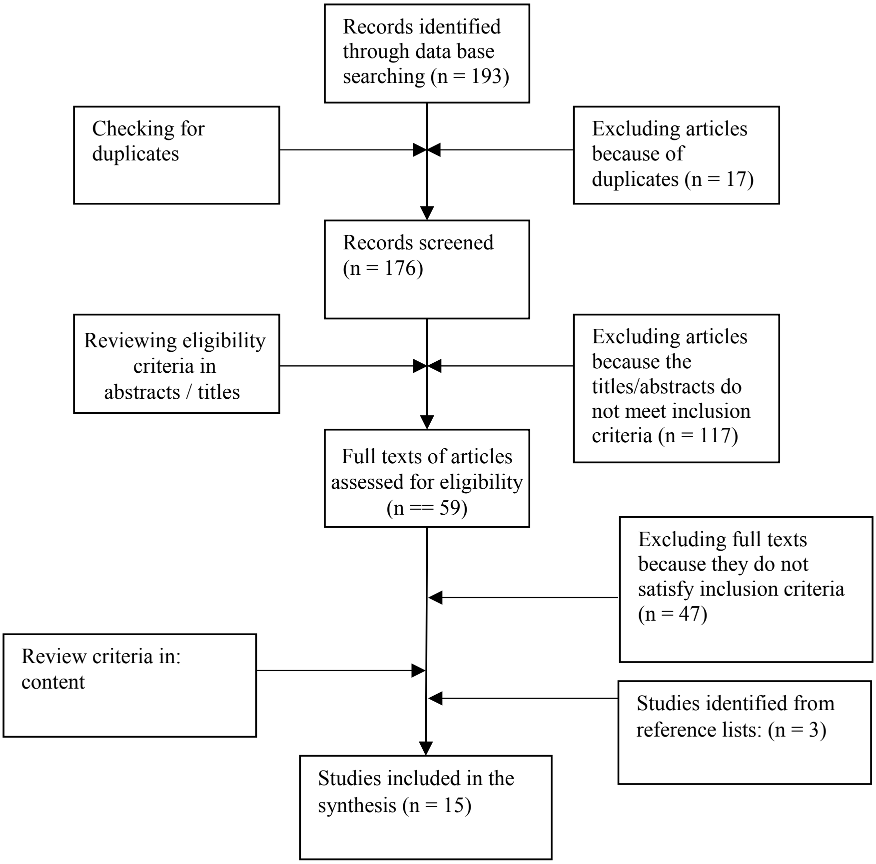

Fig. 1 Literature search procedure for articles

BarNir 2012; Colombo and Piva 2020; Demiralp et al. 2018; Dilli and Westerhuis 2018; Law and Breznik 2017; Sharma 2020; Woolley 2019), one is a mixed methods (Pascher et al. 2015), two are systematic literature reviews (Poggesi et al. 2020; Kuschel and Lepeley 2016), and one is a narrative literature review (Kuschel et al. 2020). Seven studies among the quantitative studies are of an inferential statistical nature (Armuña et al. 2020; BarNir 2012; Colombo and Piva 2020; Dilli and Westerhuis 2018; Law and Breznik 2017; Sharma 2020; Woolley 2019). They focus, from a third person perspective, respectively on explaining entrepreneurship intention, entrepreneurs' decision to incorporate innovative technologies in new ventures, entrepreneurial entry, entrepreneurial awareness, and choice of sector for entrepreneurial activity. Compared in the descriptive quantitative study (Demiralp et al. 2018) are companies and biographical backgrounds of female entrepreneurs, characteristics and outcomes of women and male entrepreneurs in STEM fields, women entrepreneurs in STEM and non-STEM fields, and self-employed women

Table 2 Information on the included studies

No	Authors	Year	Title	Journal	Research object/questions	Study design	Results
[1]	Armuña, C., Ramos, S., Juan, J., Feijóo, C. and Arenal, A	2020	From stand-up to start-up: exploring entrepreneurship competences and STEM women's intention	International Entrepreneurship and Management Journal	To explore the relationship between entrepreneurship competencies and intention (EI)	Sample: • Participants of the ActuaUPM entrepreneurship program, potential STEM entrepreneurs • Final sample of 140 participants with 82.1% men and 17.9% women • 138 valid answers Methods: • Structured questionnaire • t-test means comparison • Factor analysis to define the model of competences, • Multiple regression model to study the relationship between competences and skill factors in EI Place, Nation: Madrid, Spain	• The intention of becoming an entrepreneur predicted by competences loading in area of opportunity and ideas ($\beta = 0.339$; $t = 3.983$; p value = 0.000) followed by commitment competences ($\beta = 0.325$; $t = 3.803$; p value = 0.000) decision making ($\beta = 0.162$; $t = 1.895$; p value = 0.060), organization ($\beta = 0.180$; $t = 2.050$; p value = 0.042) • The relation between self-assessed competences and entrepreneurship intention is not moderated by gender R-square = 0.284

(continued)

Table 2 (continued)

No	Authors	Year	Title	Journal	Research object/questions	Study design	Results
[2]	BarNir, A	2012	Starting technologically innovative ventures: reasons, human capital, and gender	Management Decision	• To investigate the factors that promote the entrepreneurs' decision to incorporate innovative technologies in new ventures • "Are the reasons given for starting technologically innovative new ventures (TINVs) different from those given for starting ventures based on traditional technologies?" • "What is the role of human capital in the TINV start-up decision?" • "Do gender differences exist in the reasons and human capital associated with starting a TINV?"	Sample: • Established technology venture entrepreneurs: n = 518 • Nascent TINV entrepreneurs: n = 432 Methods: • Survey questionnaires • Panel Study of Entrepreneurial Dynamics II (PSED II), which is a national database of individuals in various stages of starting a business • Non-parametric methods and logistic regressions to test hypotheses Nation: USA	• The decision to start a TINV of female nascent entrepreneurs compared to established technology affected by general human capital (employment breath and education) ($\beta = 0.08$, $p < 0.10$ and $\beta = 0.28$, $p < 0.05$, respectively) and explain 6 percent of variance, • Industry experience was not significantly related to the decision of women • Technology background had a negative effect on the TINV start-up decision

(continued)

Table 2 (continued)

No	Authors	Year	Title	Journal	Research object/questions	Study design	Results
[3]	Colombo, M. G. and Piva, E	2020	Start-ups launched by recent STEM university graduates: The impact of university education on entrepreneurial entry	Research Policy	To analyze the relation between entrepreneurial entry and the human capital through university education	Sample: • The population of graduates who obtained only one MSc degree after attending one bachelor's degree program at POLIMI university • Population includes 13,840 individuals • Out of the 13,840 graduates included in the population, 2.7% established at least one limited liability company Methods: • Database 1: demographic data and information concerning the university curricula of all individuals who have enrolled in any degree program at POLIMI university • Database 2: Italian Business Register to identify all the Italian limited liability companies where POLIMI graduates had been listed as shareholders • Probit regressions to analyze the association between POLIMI recent graduates' entrepreneurial entry and the type and quality of human capital Place, Nation: Milan, Italy	• Wealth of family of origin, education, entrepreneurial experience increases the probability of entrepreneurial entry • Being female decreases the probability • The probability of establishing a new venture double (from 0.56% to 1.13%) when specialization in scientific and technical domains increases from 0.12 (i.e., the variable mean value minus one standard deviation) to 0.38 (i.e., the mean value plus one standard deviation) • The probability of entrepreneurial entry increases (from 0.60% to 1.14%) when graduates participated in economic and management courses • Pseudo $R2 = 0.057$

(continued)

Table 2 (continued)

No	Authors	Year	Title	Journal	Research object/questions	Study design	Results
[4]	Demiralp, B., Morrison, L. T. R., and Zayed, S	2018	On the commercialization path: Entrepreneurship and intellectual property outputs among women in STEM	Technology and Innovation	To compare characteristics and outcomes of women and men entrepreneurs in STEM fields; women entrepreneurs in STEM and non-STEM fields; and self-employed women and women in wage/salary employment in STEM fields	Sample: • Self-Employed women 2015 in the US: 5,200,295 • Self-employed men 2015 in the US: 9,024,328 Methods: • Literature review • Descriptive data analysis • Data from the 2015 American Community Survey (ACS) and the U.S. Census Bureau's 2007 and 2012 Survey of Business Owners (SBO) Nation: USA	• More self-employed women in STEM compared to men have received a bachelor's degree that is not related to science or engineering • The heterogeneous career paths of self-employed women in STEM (earning further graduate degrees in health care or accessing informal or on-the-job-training in STEM) • Women working in STEM wage/salary employment have more often a science and engineering related degree (e.g., nursing, architecture mathematics teacher education) compared to self-employed women in STEM who have more science- and engineering degrees • Relative to men, more self-employed women in STEM have received a master's degree

(continued)

Table 2 (continued)

No	Authors	Year	Title	Journal	Research object/questions	Study design	Results
[5]	Dilli, S., Westerhuis, G	2017	How institutions and gender differences in education shape entrepreneurial activity: a cross-national perspective	Small Bus Econ	To investigate the role of differences in STEM education at the national level for three stages of the entrepreneurial process: entrepreneurial awareness, the choice of sector for entrepreneurial activity, and (entrepreneurial growth aspirations; not of interest here); knowledge-intensive sectors	Sample: • 19 European countries (number of respondents given in parentheses): • Austria (91), Belgium (951), the Czech Republic (39), Denmark (1079), Finland (195), France (124), Germany (901), Greece (239), Hungary (217), Ireland (279), Italy (176), the Netherlands (248), Norway (282), Poland (30), Slovenia (244), Spain (1673), Sweden (284), Switzerland (210), the United Kingdom (UK; 1933), and the USA (1051) Methods: • GEM data • Base multilevel Probit regression techniques, Nation: 19 European countries, USA	• Women see significantly fewer opportunities and are • Less likely to start a business in highly knowledge-intensive branches than men • The probability of women to see an opportunity to start a business is 3% smaller and the probability to start a business in highly knowledge-intensive sectors is 6% smaller compared to men • Gender differences can be fully explained by differences in individual characteristics for the entrepreneurial awareness and the choice of sector • Tertiary education and networks increase the chance of perceiving opportunities and of the selection into knowledge-intensive sectors

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Table 2 (continued)

No	Authors	Year	Title	Journal	Research object/questions	Study design	Results
[6]	Kuschel, K., Ettl, K., Díaz-Garcia, C. and Alsos, G. A	2020	Stemming the gender gap in STEM entrepreneurship - insights into women's entrepreneurship in science, technology, engineering, and mathematics	International Entrepreneurship and Management Journal	To combine "insights from research about women's entrepreneurship and research about the gender aspects of STEM fields"	• Narrative literature overview of five selected articles on women's entrepreneurship in STEM • Emphasize institutional, organizational, and individual factors influencing women's entrepreneurship in STEM fields, • Synthesis of results of five studies included in the issue Nation: Europe, USA, Canada	• The hypothesis is not confirmed that fewer STEM women than men have entrepreneurial intentions • The process of forming an entrepreneurial intention is promoted by self-efficacy, entrepreneurial competences, specifically in opportunity identification and evaluation, identity formation of integrating opposite roles of "being a woman" on the one side and the double masculinized roles of "being an entrepreneur" and "being a professional in the STEM fields" on the other side

(continued)

Table 2 (continued)

No	Authors	Year	Title	Journal	Research object/questions	Study design	Results
[7]	Kuschel, K. and Lepeley, M.-T	2016	Women start-ups in technology: literature review and research agenda to improve participation	Int. J. Entrepreneurship and Small Business	• To focus "on women and gender differences in new high-technology ventures (NHTVs), defined as young business ventures that develop and offer high-technology solutions" • "To make a contribution to advance the understanding and the complexity of the relationship between NHTVs and gender"	Sample: • Criteria of inclusion: • Female-owned or female founders, or women employees, or sex-role stereotypes, or gender as an independent variable • Studies of a sample of entrepreneurs or firms in the technological industry • The firm should be a start-up or be • At its early business stage • Number of included articles: 22 Methods: • Literature search and review of peer-reviewed academic articles in Google Scholar and EBSCO Collection, books, chapters, high-technology reports, ad hoc corporations, and government sources Nation: worldwide	• General human capital defined by a person's education, and employment opportunity predict the decision to start a new high-technology venture of women, • Wealth seeking and employment reasons are negatively associated with the decision • Social networks are crucial for getting funds from venture capitalists in the high-tech sector

(continued)

Table 2 (continued)

No	Authors	Year	Title	Journal	Research object/questions	Study design	Results
[8]	Law, K.M.Y. and Breznik, K	2017	Impacts of innovativeness and attitude on entrepreneurial intention: among engineering and non-engineering students	International Journal of Technology and Design Education	To investigate the impact of attitudinal antecedents on the entrepreneurial intention of students	<u>Sample:</u> • 251 (25.2%) engineering students who took an entrepreneurship course in their classes from universities in Hong Kong • 747 (74.8%) non-engineering students (Business and Science backgrounds) from universities in Hong Kong <u>Methods:</u> • Questionnaires • Partial least squares (PLS) approach to SEM Place, Nation: Hong Kong	• Attitudes may have a stronger impact on the intention of female students compared to men, • "Innovativeness" may impact the intention of male students stronger compared to women • For the other variables the differences were not statistically significant

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Table 2 (continued)

No	Authors	Year	Title	Journal	Research object/questions	Study design	Results
[9]	Martin, L., Wright, L., Beaven, Z., and Matlay, H	2015	An unusual job for a woman? Female entrepreneurs in scientific, engineering, and technology sectors	International Journal of Entrepreneurial Behavior & Research	"To understand how particular women had created and were running rapid-growth SET enterprises"	<u>Sample:</u> • 15 female academic entrepreneurs who had set up and were running SET businesses • The business had been set up for at least five years and employed a minimum of four people <u>Methods:</u> • Qualitative approach (social constructionist approach) • Four semi-structured interviews with participants over a six-month period, plus reviews of their letters, plans, diaries, and blogs, written prior to and during business development and throughout the period of research <u>Nation:</u> UK	• Because of the gendered concepts of "entrepreneurship" and "technology" women's entry into STEM entrepreneurship is assumed to be a process that may disadvantage the women • Self-employment in STEM results from the confidence in the technical expertise • The minority status and difficulties with gender were compensated through expertise and competence • Besides industry knowledge individual characteristics such as determination, attention to detail, strong interpersonal skills, and strong networks of family, friends, and contacts are seen as crucial in this sector • Participants cope with gendered difficulties by assimilating to the norms of the masculinized STEM field

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Table 2 (continued)

No	Authors	Year	Title	Journal	Research object/questions	Study design	Results
[10]	Orser, B., Riding, A., and Stanley, J	2012	Perceived career challenges and response strategies of women in the advanced technology sector	Entrepreneurship & Regional Development. An International Journal	"To examine perceived barriers to women's career advancement specific to advanced technology sectors (aerospace, defense, life sciences, engineering and information and communications technology (ICT))"	Sample: • 115 women members of Canadian Women in Technology (CanWIT) Methods: • Analysis of qualitative data from an online survey conducted in 2006 • "Line-by-line examination of statements and statement coding on a sentence and then concept basis" based "on an initial set of coding categories" • "Data in each of these categories (or 'tree nodes', as defined in NVivo) were then further coded according to the subthemes which emerged" Nation: Canada	• The challenges they face in the technology sector are regarded as a result of gender • Gender has an influence on self-efficacy and performance expectancies, lack of social capital, networking opportunities, and sense of belonging • The influence of gender on individual level barriers to STEM is evident in gender typical differences in expectations, self-efficacy, interests, role investments, and career outcomes

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Table 2 (continued)

No	Authors	Year	Title	Journal	Research object/questions	Study design	Results
[11]	Ozkazanc-Pan, B. and Muntean, S	2017	Networking towards (in)equality: Women entrepreneurs in technology	Gender Work Organization	• To "investigate gendering practices through which women entrepreneurs become disadvantaged in the technology sector • To "focus on women entrepreneurs' experiences networking to access valuable entrepreneurial resources and examine the role of technology incubators and accelerators in facilitating this access"	Sample: • Six incubators and accelerators • 21 individuals including 14 female entrepreneurs, one male entrepreneur who had co-founded a company with his wife and chose specifically to become a certified woman-owned business, and six administrators (three male, three female representatives of incubators or accelerators) Methods: • Qualitative fieldwork approach: open-ended interview questions, observations, and participant-observations Place, Nation: US Northeast and Midwest	• Gendered networking, organizational practices, and norms contribute to gender inequality • Women's networks do not include people giving them information on incubators or accelerators • Social networks are considered by women as relational, relationship-building compared to a transactional instrumental type of male networking practice • White male networks increase the probability of access to job and high status contacts compared to female and minority dominated networks • While women rely on strong network ties, they typically have no access to the information, and individuals with weak ties • Incubators and accelerators play a gatekeeper role in supporting technology entrepreneurship • The male dominance in the incubator or accelerator contributes to the unawareness of gendered practices and the unwillingness of gender sensitive practices,

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Table 2 (continued)

No	Authors	Year	Title	Journal	Research object/questions	Study design	Results
[12]	Pascher, U., Roski, M. and Halbfas, B	2015	Entrepreneurial aspirations and start-up motives of women chemists in Germany	International Journal of Gender and Entrepreneurship	To "explore female chemists' entrepreneurship in Germany and to analyze the motivational factors with the aim of contributing to a better understanding of highly qualified women becoming entrepreneurs"	Sample: • 7 self-employed women chemists and one self-employed chemical engineer • 65 business founders in the chemical industry and related industry fields Methods: • Combined qualitative with descriptive quantitative methods • Interpretative interview method • Qualitative study on the basis of biographical interviews tracing the professional biographies of women self-employed chemists • By focusing on motives and causes of women self-employed chemists in quantitative study, Place, Nation: Germany	• The most important reasons of the chemists starting their own business were nearly the same for women and men only differing in the ranking positions • For women, the motive lack of opportunities in organizational employment and for men the motive fulfillment of a business idea was different among the top five motives • Most of the females undertook late in their career transition from organizational employment to entrepreneurship • The rate of female entrepreneurs might result from career development opportunities in companies

(continued)

Table 2 (continued)

No	Authors	Year	Title	Journal	Research object/questions	Study design	Results
[13]	Poggesi, S., Mari, M., de Vita, L. and Foss, L	2020	Women entrepreneurship in STEM fields: literature review and future research avenues	International Entrepreneurship and Management Journal	"To explore the published management research on women entrepreneurs in Science, Technology, Engineering and Mathematics (also known as STEM) fields in order to offer a first, comprehensive state-of-the-art of this research"	Sample: • Data collection in Scopus, Web of Science (WoS), and Business Source Complete (EBSCO) • Inclusion criteria: Peer-reviewed academic journal, Language English, Research discipline Business, management and accounting, Research methodology Theoretical and empirical, Time period Up to 2018, Sector STEM, Relevance Article addressing women entrepreneurship in STEM fields • Included studies: 32 Methods: • Systematic literature review • "Systematically investigate the selected papers" along "the gender issue, the main topic investigated by the authors and the suggested implications, both for research and practice"	• Two clusters of entrepreneurship: academic and non-academic entrepreneurship in STEM • Reasons for the underrepresentation of women academics in STEM field entrepreneurship: higher commitment to academic careers due to lower positions in academia compared to men, missing or less prior management exposure in companies, family obligations, and ethical reservation towards research commercialization • Barriers of non-academic entrepreneurship in STEM fields: lower education levels, and industry credentials, less management expertise, and role conflicts compared to men

(continued)

Table 2 (continued)

No	Authors	Year	Title	Journal	Research object/questions	Study design	Results
[14]	Sharma, L	2020	Exploring entrepreneurship among STEM women with mid-career break	Journal of Small Business & Entrepreneurship	To "assess the entrepreneurial intentions and level of perceived barriers to entrepreneurship among women in STEM with mid-career break"	Sample: • Full time or part time, working (in job) or non-working women with a minimum graduate level education in science, technology, engineering or mathematics, some work experience in the corporate or academia, break from the regular service for at least one year • 227 women in STEM with mid-career break Methods: • Self-administered questionnaire • Multinomial logistic regression and ordinal logistic regression were performed Place, Nation: India	• For STEM women with mid-career break in India, the high levels of entrepreneurial intentions are not influenced by marital status, education, years of work experience, or current working status • Could not identify any predictors for the level of perceived barriers that were experienced by the majority of women as high or moderate

(continued)

Table 2 (continued)

No	Authors	Year	Title	Journal	Research object/questions	Study design	Results
[15]	Woolley, J. L	2019	Who starts high-technology firms and the relationship between founders' gender, educational and occupational backgrounds, and firm outcomes?	Academy of Management Discoveries	• "Which women become technology entrepreneurs" • "How the heterogeneity of entrepreneurs' backgrounds influences the outcomes of their firms" (not of interest here) • "What are the backgrounds of women entrepreneurs of technology firms?" • "Do female founders of technology firms have similar educational and occupational backgrounds to male founders?"	Sample: • Selection criteria of firms: a single-business venture, founded to develop, produce, and sell nanotechnology products on the merchant market • Sample size: 595 firms Methods: • Database of U.S. nanotechnology firms • Level of nanotechnology activity was identified by the firm's products, patents, and technology data • Descriptive statistics, t tests • The Firm outcomes were analyzed using event history analyzes on the data with maximum likelihood estimation and robust standard errors • Data with consistently decreasing survival prospects were modeled with Weibull, Gompertz, and exponential distributions Place, Nation: USA	• While men were more often (30% vs. 22%) often working as professors compared to women, women are more likely in their previous occupations research scientists and post-docs than men (11% vs. 6%) (0.1 significance level) • Two-thirds of the female and the male founders respectively earned doctoral degrees • More than 50% of both female and male founders have business experience • 63% of the female founders have doctorates of which nearly all (97%) were earned in STEM related fields: 36% in chemistry related areas, 20% in physics and biophysics, 20% in engineering and materials sciences, 20% in biology-related domains • High education level as well as a variety of educational backgrounds • Female founders of high-technology firms were more likely to have prior occupations as a professor or research scientist than as executive in companies

and women with wage/salary employment in STEM. While two of the three qualitative studies deconstruct from a social constructivist perspective gendering practices disadvantaging women entrepreneurs in the technology sector and investigate the gendered context and meaning making of accessing STEM entrepreneurship (Martin et al. 2015; Ozkazanc-Pan and Muntean 2018), the other qualitative study analyzes from a second-person interpretative perspective perceived barriers to women's career success specific to the advanced technology sector (Orser et al. 2012). In the mixed methods Pascher et al. (2015) analyze the motivational factors to understand the professional biographies of self-employed women chemists (Pascher et al. 2015). In the systematic reviews (Poggesi et al. 2020; Kuschel and Lepeley 2016), the focus is on women and gender differences in new high-technology ventures (NHTVs) and on published management research on women entrepreneurs in Science, Technology, Engineering, and Mathematics. The narrative review reveals insights from research on women's entrepreneurship and research on the gender aspects of STEM fields (Kuschel et al. 2020).

There is a wide range in the number of participants in the studies. In the qualitative studies, there is a range of seven to 115, while in the quantitative studies there is a range from 65 to 152 million participants. The great range, especially in the quantitative studies, is related to the fact that in the cases where the number is lower, the sample was selected for research purposes, while in the studies with larger samples reference was made to already existing national and international surveys.

The participants of the quantitative studies can be categorized as participants in educational formal or informal programs (Colombo and Piva 2020; Law and Breznik 2017), as participants in national surveys (Demiralp et al. 2018), as participants in international comparative surveys (Dilli and Westerhuis 2018), founders in a specific STEM domain (Pascher et al. 2015), nascent established technology venture and TINV entrepreneurs (BarNir 2012), and as participants, characterized by a specific position in the life course (Sharma 2020). The participants of the qualitative studies are representatives of accelerators, resp. incubators (Ozkazanc-Pan and Muntean 2018), female STEM entrepreneurs, members of a nationwide association of women in technology (Orser et al. 2012), self-employed women in a specific STEM domain (Pascher et al. 2015) and established female entrepreneurs in STEM (BarNir 2012). The number of included studies of the systematic reviews is 22 and 32, and for the narrative review, it is five.

While most of the current quantitative and qualitative studies collected their data with the aid of questionnaires or interviews, except for two studies in which observations, reviews of letters, plans, diaries, and blogs are also included, the authors of the literature reviews took their data from peer-reviewed academic articles.

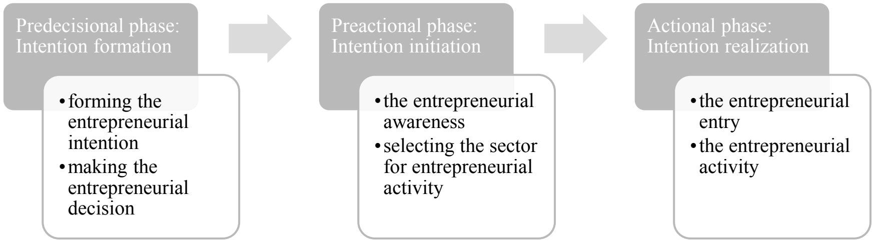

Fig. 2 Matching of dependent variables referring to an entrepreneurial action and the first three action phases of the Rubicon model

4.2 Systematization of Results

Analyzing these studies, we can differentiate between five dependent variables: (a) entrepreneurial intention, (b) entrepreneurial decision to start a venture, (c) entrepreneurial awareness, (d) choice of sector for entrepreneurial activity, and (e) entrepreneurial entry. By means of the Rubicon model of action, it becomes clear that entrepreneurial intention realization, here conceived as entrepreneurial entry or entrepreneurial activity, follows a process that needs to be explained for the whole course of action. Based on the Rubicon model of action phases developed by Heckhausen and Gollwitzer (1987) we can conclude that three of these four phases reflect the above mentioned differently explained variables in the analyzed studies. Figure 2 shows how the dependent variables of the present study are matched with the action phases of the Rubicon model.

The pre-decisional phase of entrepreneurial entry/activity results in formatting the intention of making the decision to start an entrepreneurial activity which is followed by the pre-actional phase of entrepreneurial awareness and selection of an entrepreneurial sector. As soon as the entrepreneurial intention is initiated, the entrepreneurial activity will be realized.

As the currently analyzed studies do not imply the explanatory variables "interest" and "performance" of social cognitive theory, we will adapt the social cognitive theory of career and academic interest, choice and performance in such a way that the variables to be explained, namely interests, goals, actions will be substituted by the variables in the Rubicon model of action phases: intention formation, intention initiation, and intention realization.

The individual factors are represented in the social cognitive theory of career and academic interest, choice, and performance by person inputs, learning experiences, self-efficacy, and outcome expectations. We categorize the person input variables based on the personality theory of McAdams and Pals (2006). Table 3 shows the theoretically derived coding schemes for the person input variables.

The analyzed studies, in which the predictors for entrepreneurial intention formation, initiation, and realization are studied, belong to the type of third person studies which are characterized in our case by an empirical methodology based on inferential

Table 3 Coding scheme of personal input variables based on McAdams and Pals (2006)

Code	Description	Example
Characteristic adaptations	"Motivational, social cognitive, and developmental variables that are contextualized in time, situations, and social roles" (Costa and McCrae 1985)	Abilities, competences, knowledge, attitudes, motives
Identity	Self-concept (Heatherton et al. 2007)	Narratives of being competent

statistics, while the present qualitative studies that focus on interpretative questions fall under the second-person perspective.

We group the results according to the different characteristics:

- phases of intention course,
- type of individual variables including person inputs grouped around the two dimensions of characteristics adaptations, and identity as well as sociographic characteristics, learning experiences, self-efficacy and outcome expectations, and
- methodological perspective.

Figures 3, 4, 5, 6, 7 and 8 show a systematized integration of the results by giving an overview of which types of the individual level factors analyzed in the present studies interact with the respective intention states of the entrepreneurial action of women in STEM, based on methodological perspectives.

For reasons of clarity, a separate model is developed for each intention state of the STEM entrepreneurial entry. As "contextual influences" and "background contextual affordances", the non-individual components of the social cognitive theory of career

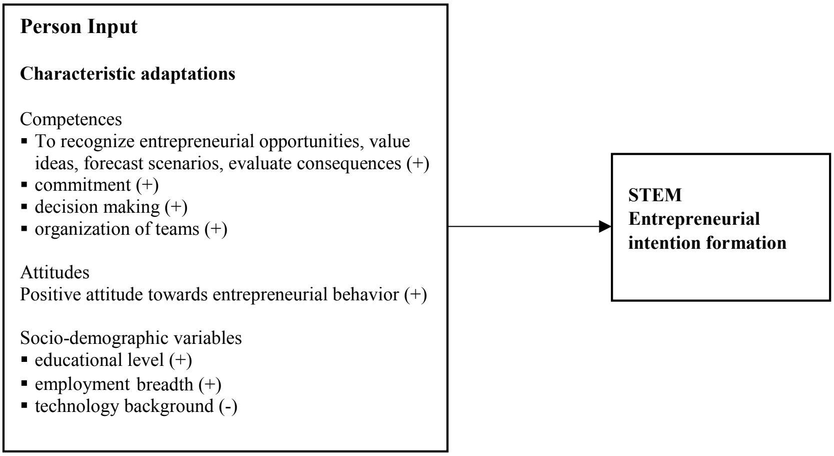

Fig. 3 Model explaining the entrepreneurial action state of intention formation in women's STEM entrepreneurship (Quantitative studies based on inferential statistics; directions of relationships are presented in parentheses)

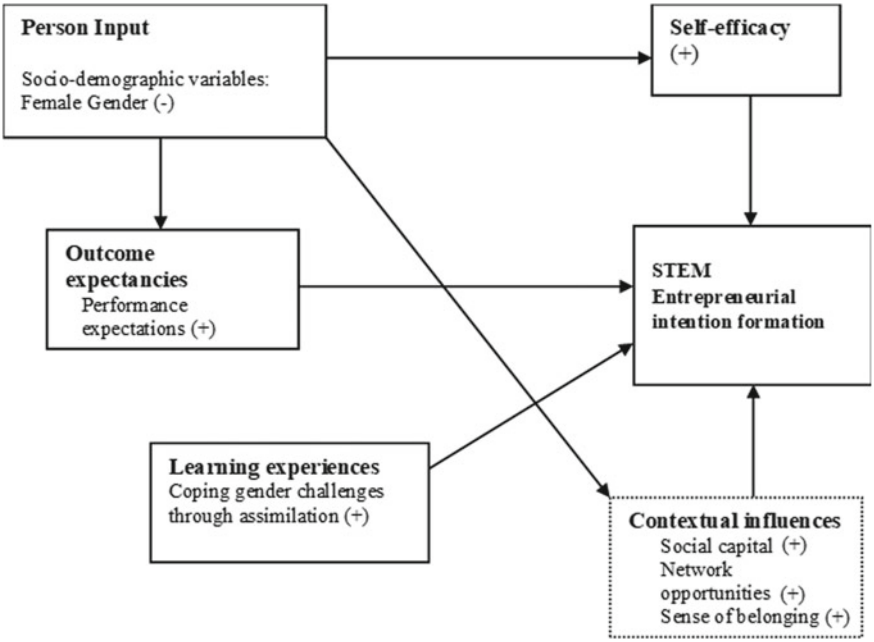

Fig. 4 Model explaining the entrepreneurial action state of intention formation of women's STEM entrepreneurship (Qualitative studies; directions of relationships are presented in parentheses)

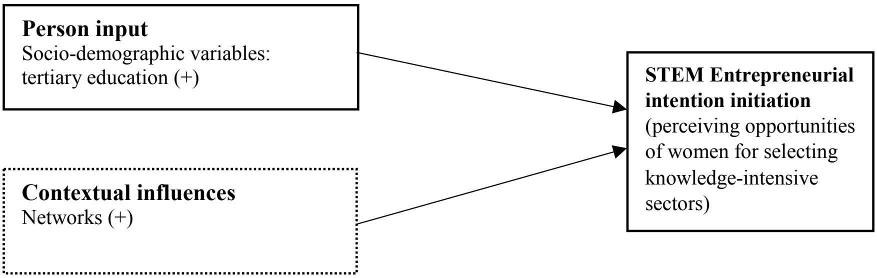

Fig. 5 Model explaining the entrepreneurial action state of intention initiation of women's STEM entrepreneurship women (Quantitative studies based on inferential statistics; directions of relationships are presented in parentheses)

and academic interest, choice, and performance are not the focus of the current study, we will present them in the figures with dashed lines. Moreover, for the last action phase, intention realization, we will distinguish between the models of academic and non-academic entrepreneurship in STEM fields (Poggesi et al. 2020) because of the available differentiated data.

Besides characteristic adaptations, such as entrepreneurial competence, and favorable attitudes towards entrepreneurship, socio-demographic variables, such as a

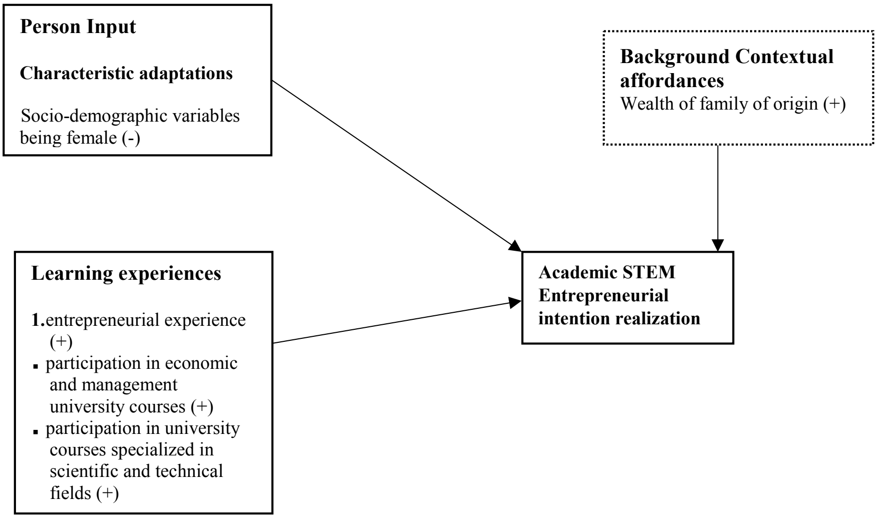

Fig. 6 Model explaining the entrepreneurial action state of intention realization in women's academic STEM entrepreneurship (Quantitative studies based on inferential statistics; directions of relationships are presented in parentheses)

high educational level, breadth of employment, contribute to women's STEM entrepreneurial intention formation (Armuña et al. 2020; BarNir 2012; Law and Breznik 2017) (see Fig. 3). The technology background is negatively related to the entrepreneurs' decision to incorporate innovative technologies in new ventures (BarNir 2012).

In the qualitative studies (Orser et al. 2012) gender is regarded as challenge women face in establishing their business in technology. Gender may influence the predictors of STEM entrepreneurial intention formation, including sense of self-efficacy, performance expectations, and the contextual influences of social capital, network opportunities, and sense of belonging. The learning experience of coping gender challenges through assimilation seems also to be positively associated with the probability of women's STEM entrepreneurial intention formation (see Fig. 4) (Kuschel et al. 2020; Kuschel and Lepeley 2016).

Figure 5 shows that for the process of intention initiation, here perceiving opportunities and selecting the field of knowledge-intensive sectors, besides the contextual influences of networks, the person input variable of tertiary education plays a crucial role (Dilli and Westerhuis 2018).

For the last process element of career choice, entrepreneurial intention realization, we developed three models, two academics (Figs. 6 and 7) and one for non-academic (Fig. 8) STEM Entrepreneurial intention realization. The first two models are differentiated by models based on qualitative and quantitative studies.

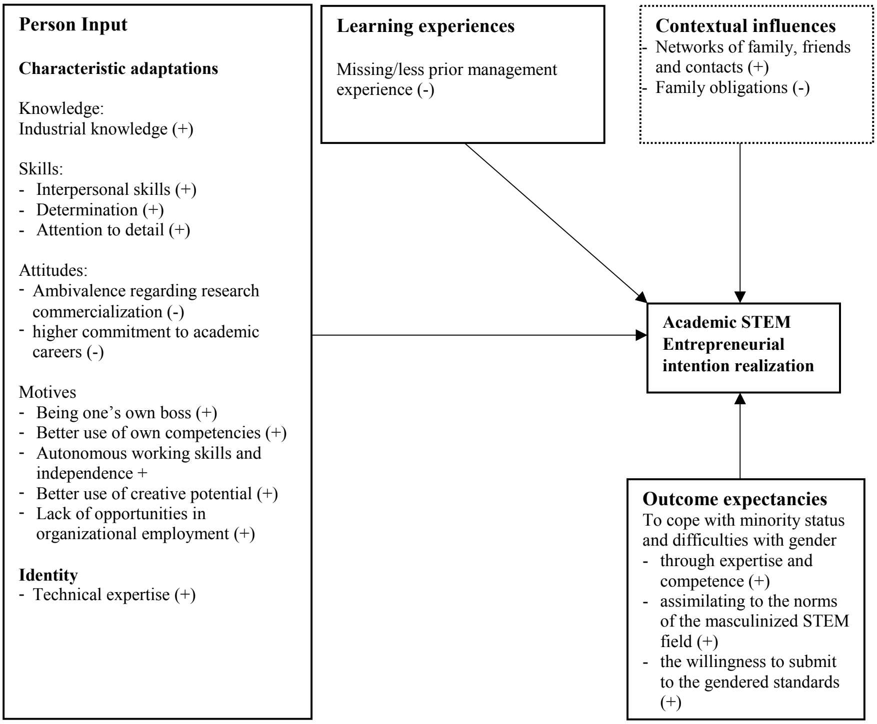

Fig. 7 Model explaining the entrepreneurial action state of intention realization in women's academic STEM entrepreneurship (Qualitative studies; directions of relationships are presented in parentheses)

For academic intention realization, we found in a quantitative study (Colombo and Piva 2020) that a specialization in scientific and technical fields, learning experiences in economic and management courses as well as entrepreneurial experiences, are positively correlated with the academic STEM entrepreneurial intention realization while being female, decreases the probability of realizing the academic STEM entrepreneurial intention of women (Fig. 6).

The qualitative studies focusing on the academic STEM entrepreneurial intention realization reveal that the characteristic adaptations of industrial knowledge, specific skills, the self-concept of being a technical expert, and a variety of motives such as autonomous working and independence, and better use of creative potential might have a positive effect on realizing women's academic STEM entrepreneurial intentions while having missing/less prior management experience, an ambivalent attitude regarding research commercialization, and a higher commitment to academic careers seem to decrease the probability of realizing intentions (Martin et al. 2015; Pascher et al. 2015; Poggesi et al. 2020) (Fig. 7) In addition, the outcome expectations of coping with gender challenges through expertise and competence, assimilating to the

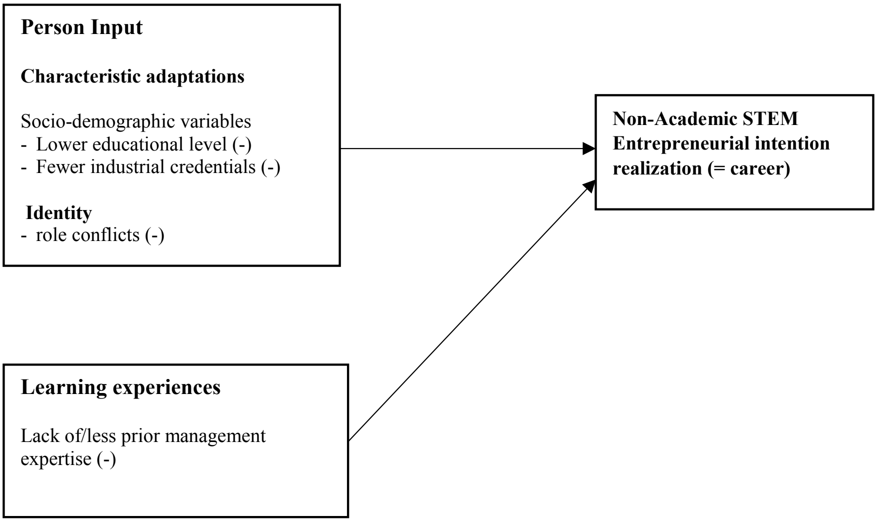

Fig. 8 Model explaining the entrepreneurial action state of intention realization in women's non-academic STEM entrepreneurship (Literature review; directions of relationships are presented in parentheses)

norms of the masculinized STEM field, and the willingness to submit to the gendered standards may promote the realization of intentions (Martin et al., 2015).

Referring to Orser, Riding, and Stanley (2012), Poggesi et al. (2020) summarized the individual level career barriers of non-academic STEM women entrepreneurs: they are seen in lower educational level, fewer industrial credentials, lack of/less prior management expertise, and role conflicts (Fig. 8).

5 Conclusions

The aim of this study was to investigate state-of-the-art research on individual factors that explain women's entrepreneurship in STEM by conducting a literature review. Based on the theoretical foundations of the Social Cognitive Theory of Career and Academic Interest, Choice and Performance developed by Lent et al. (1994), the Rubicon model of action phases developed by Heckhausen and Gollwitzer (1987), and the personality theory of McAdams and Pals (2006), we modeled the explanatory variable of entrepreneurial entry as a process consisting of entrepreneurial intention formation, intention initiation, and intention realization.

The STEM entrepreneurial intention formation of women seems to be predicted by characteristic adaptations, such as entrepreneurial competencies, favorable attitudes towards entrepreneurship, high level of education, and employment breadth.

Female gender may have a negative influence on the predicting variables of intention, for example, performance expectations and self-efficacy, while the learning experience of coping with gender challenges through assimilation seem to be positively associated with the probability of women's STEM entrepreneurial intention formation.

For the process of intention initiation, here perceiving opportunities and selecting the field of the knowledge-intensive sector, tertiary education plays a crucial role. Due to the high level of knowledge required in this sector, which includes fields of social sciences, for example, this relationship is plausible.

A differentiated perspective is addressed for intention realization: Academic intention realization might be affected positively by several learning experiences, such as specialization in scientific and technical fields, learning experiences in economic and management courses, as well as entrepreneurial experiences, by the characteristic adaptations of industrial knowledge, specific skills, self-assigned technical expertise, and a variety of motivations, such as autonomous working ability and independence, and better use of creative potential. In contrast, being female, having an ambivalent attitude regarding research commercialization and a higher commitment to academic careers seem to decrease the probability of realizing women's academic STEM entrepreneurial intentions. Being able to cope with minority status and gendered challenges through expertise and competence, assimilation to the norms of a male-dominated majority, and willingness to submit to gendered standards might positively affect women's realization of intentions.

Lower educational levels in STEM relevant fields, fewer industrial credentials, lack of/less prior management experience, and role conflicts seem to decrease the probability of realizing women's non-academic STEM entrepreneurial intentions. Regarding intention formation, we can state that while in the social cognitive theory of career and academic interest, choice and performance, personal inputs have indirect effects via learning experiences which predict both self-efficacy and outcome expectancy via interests, in our model personal inputs seem to directly affect intentions. Another surprising result is the discrepancy between the predicting factor of the educational level of established female technology venture entrepreneurs and nascent TINV entrepreneurs in the USA, on one hand, (Dilli and Westerhuis 2018), and the missing influences of education, years of work experience, or current employment status for STEM women with a mid-career break in India (Sharma 2020), on the other. While confidence in technical expertise is seen from an inter-subjective perspective as a promoter of **e**ntrepreneurial intention realization (Martin et al. 2015), the technological background of nascent TINV entrepreneurs seems to be negatively related to intentions (Dilli and Westerhuis 2018). Apparently, there is a difference between the decision to found a technological enterprise and the decision to incorporate innovative technologies into new ventures, which requires expertise that can be incorporated by externals.

For all phases, our limited conclusions about the data are that learning experiences and corresponding competencies related to STEM can be gained through formal learning or other channels, and entrepreneurial as well as management experiences are crucial individual factors for women's STEM entrepreneurship. These competencies might also allow women, by questioning and refuting stereotypes, to master gendered challenges such as gendered organizational practices in incubators and accelerators (Ozkazanc-Pan and Muntean 2018) that contribute to gender inequality. The influence of learning experiences, education, and competencies is a reason for the key role played by a gender sensitive educational system in furthering women's STEM entrepreneurship.

Summarizing the current research studies of individual level factors explaining women's STEM entrepreneurship, we can affirm that, even though there is a growing body of scholarly literature devoted to women's entrepreneurship in STEM, research on female STEM entrepreneurship is still in an early stage. A research program has not yet been established with progressive research questions, comparable research objects, and theory based dependent variables.

Regarding research desiderata, we identify a research gap in internationally comparable studies and statistics of entrepreneurship related to gender. For instance, in Germany, a representative study on women's STEM entrepreneurship using data drawn from national statistics cannot yet be conducted because of missing relevant scales included in surveys or small sample sizes for the population studied.

The current systematic literature study contributes to a first overview of state-of-the-art research on individual factors that explain women's entrepreneurship in STEM. However, this study is exploratory, as it is limited especially by a relatively low number of included studies. We referred to peer-reviewed journals. In future studies, monographs and editions should be included in the search process.

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Analysis of the European Women Entrepreneurship in STEM Fields

Maria de las Mercedes Barrachina Fernández, María del Carmen García Centeno, and Carmen Calderón Patier

Abstract Nowadays, the world is a highly interconnected and competitive place, presenting many opportunities but also many challenges to be faced. Science, Technology, Engineering, and Mathematics (STEM) are the core subject areas that will develop innovations directly related to everyday life. There are a lot of products and services created from the knowledge of STEM. STEM competencies are key in a society that wishes to reach high levels of productivity and competitiveness. STEM skills support a range of high-end activities such as the discovery of new energy sources, improvement of supercomputing capabilities, and advances in artificial intelligence (AI). It also plays a role in enhancing the Internet of Things technology, which will improve a patient's quality of life and ultimately, propose solutions to the most urgent and complex challenges of our time. The European Union is a global leader in gender equality, but there are still several stereotypes that need to be challenged. According to a report from the European Institute for Gender Equality, achieving gender equality in STEM topics could add 1.2 million jobs to the job market, increasing Europe's GDP to between €610–820 billion by 2050. According to the State of Women-Owned Businesses Report 2019 (American Express), the number of female entrepreneurs has grown, with the number of businesses owned by women increasing by 114% over the past 20 years. STEM education has become a priority for leaders around the world as it creates a globalized economy based on knowledge and technology. According to OECD reports, engagement with STEM topics encourages innovation by educating young people in critical thinking and the use of evidence for decision-making purposes. In the near future, the most sought-after professionals in the job market will be trained in innovation, creativity, critical thinking, collaboration, problem solving, and the application of knowledge to

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real-life problems. This study is focused on analyzing the characteristics of women entrepreneurs in STEM fields in Europe. It will try to identify the main differences between the European countries in terms of their characteristics, policies, challenges, and barriers. The analysis will be covering a range of economic, social, psychological, and educational variables. A range of different sources was used, e.g., Global Entrepreneurship Monitor (GEM), WDBD Database, and Eurostat.

Keywords Female entrepreneurship · STEM fields · European countries

1 Introduction

There is a proven gap between the presence of males and females in science, technology, engineering, and mathematics (STEM) professions. Although this gap has been reduced over the last twenty years, it still remains. According to several studies, childhood is one of the main stages in life during which the gender gap in STEM professions increases significantly. Concretely, girls lose interest in STEM topics between the ages of 9–12 (Goodwin et al. 2013).

STEM is a field and curriculum focused on education related to the disciplines of science, technology, engineering, and mathematics. These disciplines provide students and researchers with the necessary skills to solve problems, understand information, analyze and evaluate evidence, and ultimately, make decisions. Therefore, these areas are key to increasing national innovative capacity and global competitiveness in general.

Even though there are more women than men graduating from universities in Europe (57.6%), there are twice as many men graduating in STEM disciplines as there are women (Eurostat 2016). Moreover, specifically in the field of technology, according to Eurostat statistics from 2016, only 16.7% of the specialists in information and communication technologies (ICT) are women. The European Institute for Gender Equality estimates that attracting more women to STEM disciplines would increase economic growth, and therefore job creation, by up to 1.2 million by 2050. Consequently, this would have a long-term impact on the GDP of up to 820 billion euros by 2050 (Morais Maceira 2017).

The main goal of this study is to analyze the characteristics of female entrepreneurs in STEM fields in Europe and to try to identify the main differences between European countries in relation to characteristics, policies, challenges, and barriers. The analysis will be based on different concepts: concretely, economics, social, psychological, and educational variables. The chapters have been organized as follows: first, a literature review supporting the research provided. Then, the research methodology and data collection have been highlighted along with the main results of the study, together with a discussion. Finally, conclusions, as well as limitations and future lines of research have been proposed.

2 Literature Review

The interest in STEM areas has increased exponentially in the last decade as those disciplines are expected to create most of the job positions of the future. Consequently, they will also contribute to innovation, competitiveness, and economic growth (OECD 2017).

In Europe, there is a tremendous gap between male and female graduates in STEM fields. In 2018, only 19.8% of graduates with a bachelor's degree in information and communication technologies were female, and 26.8% of graduates from one in engineering, manufacturing, and construction (Eurostat 2020).

However, there are studies which suggest the possibility of achieving novel perspectives and more creative and diligent attitudes to gender balance (Reinking and Martin 2018). Even though there is a lack of studies focused on the importance of female entrepreneurship in the economy (Poggesi et al. 2019), in the literature there are different theories that could explain the existing poor representation of women in STEM fields. One of the main reasons is due to stereotypes in society, mainly based on male dominance (Gunderson et al. 2011; Shapiro and Williams 2012). Another potential reason is the role of peer groups during the academic life of students, which means that students will engage in group activities for having group engagement (Crosnoe et al. 2008). The third, more common, theory for the STEM gap between women and men is based on those personality characteristics that are perceived to be appropriate for technological- and science-related professions, mainly focusing on the generalization that women are more social and outgoing than men and, therefore, they should be working in activities to take advantage of those skills (Cheryan et al. 2015). In general, the main reasons that girls avoid choosing a STEM career are related to stereotypes, negative perceptions, and external pressures (OECD 2008).

It is important to remark that the education systems of different European countries are diverse, with differences regarding the number of years that education is compulsory. For example, in Portugal or Belgium full-time education is compulsory for 12 years; meanwhile, in France or Hungary, it is for 13 years (Eurydice 2020). Moreover, there are also differences in the number of hours of instruction in mathematics and science, with Malta setting a good example, as its program is double the number of hours for secondary students compared with Lithuania. Another important factor when considering education is the qualification level of the teachers. This varies between European countries; for example, in Spain or Germany, secondary-level teachers should have a master's degree; meanwhile, in France, additionally to obtaining a master's degree, teachers must pass a highly competitive examination (DEPP 2020), etc.

Poggesi et al. (2020) identified two different types of female entrepreneurs, academic and non-academic. They also identified the lack of research in academic women entrepreneurship in STEM fields. According to their review, the motivation for women to become entrepreneurs needs to be investigated in order to study the opportunity characteristics of female entrepreneurship and their differences with necessity entrepreneurship.

There are plenty of examples of STEM differences, and some are outlined below. In 2011, the design department of LEGO, the Danish toy company, discovered that around 90% of their consumers were boys. This highlighted the huge gender gap, considering that their products, the LEGO bricks, are normally gender-neutral. After four years of research, LEGO addressed the girls' market, creating little dolls with different storylines, and the initial results after the usage of this product indicated that girls tend to be more focused on the little details.

Another example relates to Tokyo Medical University in Japan. The university recognized that the entrance exams had been manipulated to exclude women for the purpose of avoiding a potential shortage of doctors. The justification was that women tend to reduce their working hours when they have children or try to quit once they have a family.

According to several researchers, women need positive experiences and the possibility to explore, be creative, be curious, and think independently in order to solve problems (Banchi and Bell 2008).

According to the report "Bridging the Digital Gender Divide," prepared by the Organisation for Economic Co-operation and Development (OECD), the gap between men and women starts at an early age, and it continues at university and in the workplace.

Statistics from the UNESCO Institute (2016) show that in Europe, Latvia has the highest percentage (51%) of female researchers. On the other hand, the Netherlands has the lowest (25.4%) number of female researchers (Women in Science 2018). Comparing this to worldwide data, in Myanmar, more than 80% of researchers are female.

Different studies that analyzed the sectors in which women tend to become entrepreneurs have concluded that women-owned businesses are 32% more likely to focus on retail consumer products and services (Hisrich and Brush 1984; Kelley et al. 2012); the average age at which they decide to become entrepreneurs is around 40 years (Hisrich and Brush 1984).

Women are also underrepresented among commercialized patent holders; only 5.5% of them are women (Hunt et al. 2013). Several studies suggest that increasing the number of women in electrical and mechanical engineering, the life sciences, and professions that are closely related to design and development would increase the number of women-held patents.

In grant funding, too, there are gender gaps, mainly attributable to a less favorable assessment of women as principal investigators and not to the quality of their proposed research (Witteman et al. 2019).

Another interesting point of view found in the literature is the relation between female entrepreneurship and work-family conflicts (Poggesi et al. 2019), suggesting that the social support in the family could be a helpful solution to the negative consequences caused by the family interference with work.

The STEM-related employment prediction for the future varies. According to recent research from the strategic company Mckinsey (2020), job positions that are purely manual will be seriously affected, as activities linked to manual skills will decrease by 18% by 2030 in Europe. However, positions requiring STEM skills will increase in demand in all industries by 39%. The research also emphasizes that by 2030, finding appropriately skilled workers will be challenging due to the high demand for both technical and soft skills. The European Commission's annual scoreboard, which monitors the participation of women in the digital economy (European Commission 2020), showed that the gender gap is present in all the indicators analyzed; however, countries such as Finland, Sweden, and Denmark were the most active in promoting an active role for women in the digital economy. On the other hand, in Bulgaria, Romania, and Greece, women had fewer opportunities for involvement in the digital economy.

Looking at the policies applied to boost female entrepreneurship linked to STEM, Poggesi et al. (2020) stated that the practical implications of research in women entrepreneurship, which looks at improving the education of women entrepreneurs and inspiring them using role models, are still very weak.

There are different policies and incentives at supranational, national, and regional levels to increase the participation and engagement of women in STEM fields. Several organizations have played a key role in promoting STEM causes. For example, the European Commission has developed a regulatory framework with three different purposes: gender equality in careers, gender balance in decision-making, and integration of the gender dimension in research and innovation (Fatourou et al. 2019).

Most young European women become interested in STEM fields between the ages of 11 and 12. According to a survey performed by the Microsoft Corporation (2017), girls become interested in STEM fields at age 11.2 in Finland and 12.2 in Belgium. The same young women lose interest in those fields between the ages of 15 and 16. The conclusion is that there is a four-year window in which the interest can increase and develop. The factors that could help sustain the interest are female role models, practical experience and hands-on exercises, teacher-mentors, real-life applications, and of course, confidence in equality. The above-mentioned Microsoft report also highlights the key actions necessary to reinforce girls' attraction to STEM fields. The most important among these is the integration of coding and computer science education into the education curricula, a focus on developing computer science skills, defining the digital skills strategy according to national and supranational requirements, and recognizing visible role models and introducing them to the girls.

According to an international report (Ishikawa et al. 2013), only in Switzerland is the proportion of women in science the same as that of women in all other fields.

There are different European programs to foster gender equality in STEM fields. In Europe, there is a broad initiative promoting women in science, called "Women in Research and Innovation," which is part of the European Gender Equality Strategy of the Horizon 2020 program. This program is based on activities, such as face-to-face meetings and information campaigns with examples of women in science, with the main purpose of inspiring female students to take up careers in science. There are also national programs with the same purpose, such as “Go MINT” in Germany, the GISEL Project in Finland, and the “STEM Talent Girl” project in Spain.

UNESCO’s 2017 report, “Cracking the code: girl’s and women’s education in science, technology, engineering and mathematics (STEM),” has examples showing how to improve the interest, engagement, and achievement of girls in those fields. This report established the different levels of actions needed to increase interest in those fields, including at the family and peer levels (through educational advisors and promoting parent-child dialog), school level (including overcoming challenges, recruiting male and female teachers, building teachers’ capacities, strengthening teaching practices, promoting an inclusive learning environment, cultivating learning beyond the school walls, and removing gender bias from learning materials) and societal level (through the creation of policies and legislation, positive images of women in STEM using the media, and building partnerships).

Entrepreneurship is key for economic growth, as it is directly linked to job creation (Kuschel et al. 2018). According to the 2019 Global Entrepreneurship Monitor report, only 6 out of 49 countries had a similar rate of early-stage entrepreneurial activities (TEA) for women and men. In general, when economic development increases, the gender gap also increases, as the number of established business activities among women declines (Kelley et al. 2017). Globally, only one in three businesses are owned by women, including small, medium, and large firms with a woman as a principal owner, according to data from the World Bank. Moreover, men have an increased propensity to save and borrow money for the purpose of starting a business than women. The main challenges for women when trying to start a business are mainly related to accessing financial accounts and services.

3 Data and Methodology

This analysis has been executed using data from different databases related to individuals and to countries. First, the data from individuals has been obtained from the database of the Global Entrepreneurship Monitoring (GEM) program, one of the most relevant databases for evaluating entrepreneurship. Second, the data from the countries have been obtained from other relevant sources, in this case, the World Bank Database (called WBDB from World Bank Doing Business) and the Eurostat database. First, it is important to highlight that the WBDB database contains data from different categories such as general and regional information, economy and finance, population and social conditions, industry, trade, and services, agriculture and fisheries, external trade, transport, environment, and energy or science and technology. Second, the Eurostat database, which provides official information related to countries that belong to the European Union and containing information from, at least, the last 12 years.

In Table 1, the variables used in this analysis are shown. For this study, the dependent variable is focused on the "innovative entrepreneur" defined with the variable *innovative*. For this variable, it is important to mention that it has been extracted from the GEM database and measures the innovation service offered to the user. This variable is an indicator taking values 1 or 0, depending on the type of service offered to the user (innovative or not innovative). This is the only variable that could be directly related to analyzing the STEM fields in which the business is developed.

Moreover, in the model used, different independent variables have been utilized. At individual level, those variables are: the education level (*inedu*), which defines the level of education of the entrepreneur, the entrepreneurial network (*knowent*) which defines if the entrepreneur has a strong network of entrepreneurs contacts, the opportunity perception (*opport*) which gives an idea of the opportunity that the entrepreneur perceives in the area, the entrepreneurial skills (*suskill*) which provides information about the self-confidence of the entrepreneur, relevant previous experience related to entrepreneurial activities (*discent*), the age of the entrepreneur (*age*), and an indicator created from the age, the age squared (age^2). At country level, the variables utilized were the Gross Domestic Product (GDP), the household size (*hh_size*) and the women mean age when having the first child (*age_first*).

3.1 Data Evaluation and Model

The study performed is focused on the European countries, evaluating 30 different countries and in the period 2011–2015, containing a total of 420.985 registers. After applying a gender filter to obtain data from female individuals, the registers are limited to 214.720 registers. Considering that this study is focusing on evaluating the innovative female entrepreneurship in Europe, the information has been filtered to consider only recent entrepreneurship activities (variable TEA equal to 1) obtaining a total of 8.175 registers.

The model considered in this study was a logistic regression, having *innovative* as the dependent variable and the other variables shown in Table 1 as the independent variables.

4 Results

The analysis performed is focused on performing an evaluation based on a logit model for most of the European countries, considering *innovative* as the dependent variable of the model. It is important to highlight that the data was filtered with the purpose of focusing the analysis on female entrepreneurship. The European countries included in the analysis were: Austria, Belgium, Estonia, Finland, Hungary, Latvia, Norway, Portugal, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Poland, Slovak Republic, Spain, Sweden, Switzerland, Turkey, and the

Table 1 Variables utilized in the analysis

Level	Class	Variable ID	Variable description	Format	Database
Individual level	Background	Inedu	This variable has value 1 when the entrepreneur has reached at least an university degree and has the value 0 if not	Indicator	GEM
	Perceptual	Knowent	This variable has value 1 when the entrepreneur has a strong network of entrepreneur contacts and has the value 0 if not	Indicator	GEM
		Opport	This variable has value 1 if the entrepreneur perceives relevant business opportunities in the area evaluated and has the value 0 if not	Indicator	GEM
		Suskill	This variable has value 1 if the entrepreneur has confidence in his/her own skills to start a business and has value 0 if not	Indicator	GEM
	Previous experience	Discent	This variable has value 1 if the entrepreneur has relevant entrepreneurial experience and 0 if not	Indicator	GEM
	Personal	Age, age^2	Entrepreneur's age	Number	GEM
Country level	Economic	GDP	Gross Domestic Product, defined as GDP per capita (in US dollars and nominal format)	Number	WBDB
	Demographic	Age_first	Mean age of women when having the first child	Number	Eurostat
		Hh_size	Average household size	Number	Eurostat

Table 2 Result from descriptive analysis on the variables utilized

Country	Mean age (years)	Country	Mean age (years)
Austria	39.26	Luxembourg	39.58
Belgium	39.24	Latvia	35.15
Germany	41.35	Netherlands	40.82
Estonia	37.02	Norway	48.11
Spain	38.31	Poland	35.81
Finland	39.24	Portugal	35.23
France	37.62	Sweden	42.98
Greece	37.42	Slovakia	35.78
Hungary	37.1	Switzerland	42.13
Ireland	40.34	Turkey	35
Italy	36.11	United Kingdom	39.96

United Kingdom. Some European countries were not included as they were not having available data for the period evaluated.

4.1 *Initial Analysis of the Mean Age*

This section includes the details of the mean age of the women funding innovative businesses for each of the European countries analyzed (Table 2).

There are strong countries with mean age above 40 years, such as Germany, Sweden, Switzerland, Ireland, Netherlands, or Norway. On the other hand, the country with the lowest women mean age for funding an innovative business is Turkey with 35 years old. The country analyzed with the highest women mean age for funding an innovative business is Norway with 48.11 years old.

4.2 *Model Results*

To evaluate the innovative venture creation, the model utilized was a logistic regression and it was developed with an open-source software (Anaconda and executed in Python programming language).

The results obtained after running the created code for the mentioned model are detailed in Table 3.

First, it is interesting to mention that the R-squared value achieved in this model is 0.033, similar to other studies with analogous scope developed in the literature (Mohammadi Khyareh 2018).

Table 3 Result obtained with the logit model for female European entrepreneurs

Parameter	Coefficient	*P*-value**
Age	−0.0482	0.0004
Age^2	0.0004	0.0059
Discent	0.3141	0.0042
Suskill	0.1788	0.0071
Opport	0.3523	0.0000
Knowent	0.1047	0.0509
Inedu	0.2242	0.0000
Hhsize	0.5702	0.0000
Age_first	−0.2808	0.0000
GDP*	0.6636	0.0000

*Calculated with the logarithm, ** Significant at 5%

The obtained results suggest that for the evaluated European countries, one of the most critical factors for women when deciding to start an innovative business is age. It can be seen in table 3, that the age has a negative influence, and it is a significant variable in all the countries evaluated. Moreover, the age squared confirms that this variable has a decreasing relationship when the rates are increasing, due to the fact that the age squared is significant and its influence is positive.

Focusing on the variable related to the entrepreneurial experience (variable *discent*), it is observed that the mentioned variable is significant and that its influence is positive in the decision of founding an innovative company.

The variable *opport,* which evaluates how the entrepreneur perceives business opportunities in her area, shows that this fact is a significant variable, and it affects the probability of founding a new business in a positive way (0.35).

The variable related to confidence, represented in the analysis performed with the variable *suskill* is a significant variable, with a positive coefficient, as expected, having an absolute value of 0.1788.

The variable *knowent* which is related to the entrepreneurial network that the individual has before starting a business is not a significant variable for females when deciding to start an innovative firm.

The level of education seems to be also an important fact when starting an innovative company. The variable is represented with *inedu* and have a significant and positive influence with an absolute value of 0.2242.

Related to the variables strongly linked with the national level, the variable related to the Gross Domestic Product (*GDP*) is significant according to the results obtained, however, the coefficient is positive, so it affects in a positive way when deciding to start an innovative firm.

One of the highest coefficients in the results obtained in general is the one associated with the size of the family (variable *hhsize*). It has a significant influence and positive influence (0.57) when founding an innovative company.

At national level, it is also analyzed the age in which the women are having their first child. The variable (*age_first*) is significant and has a negative influence in the founding of an innovative company.

5 Discussion

This study proposes an analysis to find the typical characteristics of the female entrepreneurs funding companies related to the STEM fields. This analysis was performed using different types of input variables at individual level: educational background (level of education), perceptual (know entrepreneurship, opportunity perception, skill perception), previous experience (business failure in the past), personal (age), but also at national level: financial (Gross Domestic Product) and demographic (family size and mean age giving birth).

After testing different types of regression, this study has proposed a logistic regression to evaluate the characteristics of European women to be more likely to fund a company related to STEM fields. The main findings are explained in detail below.

The first and most relevant finding is that age is a relevant fact when funding a company related to innovation. This means that the older the women, the less possibility of acting as an entrepreneur of an innovative company. This is an important fact for governments and policy makers when creating the conditions to apply for support in starting a company. It is key to create an entrepreneurial ecosystem in which young women could feel that their ideas could become feasible businesses. Moreover, the mean age for funding a business related to STEM fields is relatively high in most European countries. This is potentially related to having the experience, the funds, and the contacts to take the step of funding a company.

The second finding is that failure in business creation is a positive fact, especially when analyzing women entrepreneurship. This means that having previous experience funding a company (independently whether this is related to STEM fields or to other ones) is having a positive impact when creating a business related to STEM fields. The reason could be closely related to the fact that the experience obtained in previous company creation processes would be useful to create a new company in which lessons learned could be applied, and networks could be exploited to obtain successful results in the new business creation.

The third finding is that the GDP of the country is having a positive impact on the innovative business creation process. This means that the highest GDP of the country the more likely to have STEM businesses created by women. This fact is important for policy makers when designing the expected GDP growth, as this growth could mean increasing the propensity for women to start a business related to STEM areas.

6 Conclusion

The main aim of this research was to identify the main factors influencing women in Europe when deciding to create a company closely related to STEM fields.

In the literature, there is a huge concern about potential gender inequalities, that could eliminate women's economic opportunities and consequently, this could be affecting the European economy. In general, women are underrepresented in the different levels within STEM fields, these are education, science, employment, or management positions (Legewie and DiPrete 2014).

This analysis contributes to the literature in 2 ways. The first contribution is related to validate the model utilized combining different variables at national and at individual level from different European countries to conclude a holistic view of the female entrepreneurship characteristics in Europe. Second, the authors consider that this analysis contributes to extend the existing entrepreneurship literature related to women and generates awareness of the key factors that could potentially increase the propensity of women funding more businesses related to STEM areas. With this fact, policy makers and economic stakeholders could consider this contribution an interesting result for producing estimation related to the female entrepreneurship level.

This analysis is subject to the limitations found during the execution, mainly related to the number of countries in the scope with information available.

As a potential future line of study, it would be interesting to create a particular database containing information related to entrepreneurship and STEM fields, distinguishing the data from the respondents with basic information such as gender, age, or level of education. This would facilitate the possibility of performing new analysis to find evidences of the differences in entrepreneurship in STEM fields between males and women.

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Women Tech Entrepreneurship in India

Mili Shrivastava

Abstract Globally, the underrepresentation of women entrepreneurs in technology is a challenge. Little is known about the nature of women's entrepreneurship in developing countries, as most studies focus on the developed world (Panda, 2018; Roomi et al. 2018). India is a compelling context for studying women entrepreneurship with its diversity, economic power and complex socio-cultural norms. This chapter, in particular, examines women tech entrepreneurship in India to underscore the challenges and opportunities shaping women entrepreneurship. In the process, it initiates a new discourse on women tech entrepreneurship in developing countries.

Keywords India · Women · Entrepreneurship · Tech entrepreneurship · Tech education

1 Introduction

Boosting women entrepreneurship is considered essential by policymakers worldwide as it is a crucial driver for economic growth and gender equality (World Bank 2018). Developing economies have a greater need for women's entrepreneurship. Women entrepreneurs can play a vital role in economic development, poverty alleviation and women empowerment (Korosteleva and Stępień-Baig 2020; Mahmood et al. 2014; De Vita et al. 2014). Although there is a general increase in female entrepreneurial activity, women's entrepreneurial talent and potential remain largely untapped in most countries (Baughn et al. 2006; Kelley et al. 2011; Marlow et al. 2013), and a significantly less proportion of women entrepreneurs are there in developing countries (World Bank 2018).

Policymakers, academics and industry leaders are increasingly underscoring the role of high-tech women entrepreneurs for economic growth, industry dynamics and social change (Rose Review 2019). However, women in technology sectors are significantly underrepresented, with the largest gender gaps existing in developing

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countries (GEM 2017). The World Bank suggests a pertinent need for more women in tech, as the digital divide pushes women away from education, health and financial inclusion (World Bank 2020). GEM (2017) evidences that countries report the most significant gender gap in ICT sectors.

Gartner et al. (1992) suggested that most academic debate underestimates the influence of external factors and overestimates the influence of internal or personal factors when making judgments about the behaviours of other individuals. In this context, women entrepreneurship is a socially constructed and embedded phenomenon construed by a growing body of scholarship (Ahl 2006; Brush et al. 2009; De Bruin et al. 2007). Thus, women entrepreneurship literature emphasises the need for research that focuses on external, societal and institutional influences on entrepreneurship.

Furthermore, little is known about the nature of women's entrepreneurship in developing countries, as most studies have been on the developed world (Jamali 2009; Tambunan 2018; Panda 2018; Roomi et al. 2018). Recent studies suggest that the entrepreneurship literature lacks diverse perspectives and does not fully account for cross-cultural perspectives (Panda 2018; Cochran 2019). Researchers have called for more investigation into women entrepreneurs in non-Western contexts that consider contextual, socio-cultural factors to advance knowledge and deepen understanding of the socially constructed phenomenon of women's entrepreneurship (Ahl 2006; Brush et al. 2009).

India is a compelling context for studying women entrepreneurship with its diversity, economic power and complex socio-cultural norms. The Government of India defines Women Entrepreneurship as an enterprise owned and controlled by a woman having a minimum financial interest of 51 per cent of the capital and giving at least 51 per cent of the employment generated in the enterprise to women (Sharma 2018). Women entrepreneurs in India are underrepresented with 7 female owners out of 100 business owners (Master Card Index 2019). In recent years, the flow of women entrepreneurs in India has been on a roll in the sectors such as health, education, clean energy, women's hygiene, fashion, cosmetics, food, nutrition, garments and textiles, management and human services (Korreck 2019; GAME 2019). However, the ratio of women tech founders in India is less than 10% (Inc42 2019).

The widely recognised underrepresentation of women entrepreneurs in technology is a global challenge. However, in the Indian context, the underrepresentation of women entrepreneurs in the technology sector makes a curious case as the girls' entry into tech is relatively higher in India than in many western countries (British Computer Society 2016). Around 32% in engineering education are women in India compared to 20% in the US and 28% in Europe (Rathor et al. 2020). Women represented 46.8% of the postgraduates in IT and Computing during the academic year 2014–2015 in India (Raghuram et al. 2017).

In this light, the chapter examines women tech entrepreneurship in India. It underscores the challenges and opportunities shaping women entrepreneurship in tech sectors in the Indian context. To accomplish this, the following section sets the context by examining the background of women in technology in India through historical perspectives. The third section examines the factors influencing the entry of women into technology entrepreneurship. The final section draws the conclusions and discusses the next steps to promote women tech entrepreneurship in the Indian context. In the process, the chapter initiates a new discourse on women high-tech entrepreneurship in developing countries.

2 Contextualising Women in Technology in India: Historical Perspectives

2.1 Nascent Phases of the Technology Sectors

India, on the verge of independence in 1945, was bursting with agents of change who fiercely advanced the rationale for higher technical education (Bassett 2009). The Government of independent India promoted this cause, leading to the establishment of the now world-renowned Indian Institute of Technologies (IITs). The IITs produced graduates who turned into world-leading innovators, entrepreneurs and CEOs of tech firms around the globe. The IITs also assumed a crucial role in shaping technology education in India and the role of computers in engineering studies (Subramaniam 2006; Bassett 2009, 2016). India got its first computer IBM 1620, delivered to a military airbase in Kanpur in 1963 for the Indian Institute of Technology, Kanpur (Bassett 2009). The experts flew from the US to teach computer courses to specially selected students. These incidents led to the spread of computing technology in India. Indian students who graduated from IITs flocked to MITs and other institutions in America for further studies and opportunities. Thus, India embarked on producing talent and began playing an instrumental role in advancing the fields of engineering and technology. In the meantime, software became a separate business globally and efforts scaled up in India to promote software exports and capture international markets in the late 1980s (Sharma 2015). However, software as an industry gained significant footing with economic liberalisation policies in 1991. The IT sector placed India for the first time in the centre place in a globally competitive industry (Kapur 2002).

2.2 The Indian IT Sector

Soon after liberalisation, the Indian IT industry became a billion-dollar sector of which two-thirds of roles belonged to software and one-third to hardware. On the one hand, the booming IT sector led to a sharp upward demand for graduates in technology. On the other hand, the Indian education sector matched the increasing human capital demand with investments in tech education (Sohoni 2012; Sharma 2015). These developments led to the birth of private engineering colleges across

India. Along with computer science, engineering education became a dream destination for students as it could offer them good jobs. However, the infrastructure and R&D labs were more concentrated in clusters like the American model in the six cities, Bangalore, Pune, Mumbai (Bombay), Chennai (Madras), Hyderabad and New Delhi.

India soon turned into a large producer and exporter of human capital for the software industry. This profile was initially built based on the graduates of the IITs graduates, many of whom migrated to America to pursue higher degrees and settlement. The growing demand for technology graduates accelerated the rise of private engineering colleges in India. By the late 1990s, India had produced around 65,000 engineers and 95,000 diploma-holders annually in engineering and technology through an extensive network of public and private colleges (Kapur 2002). The IITs accounted for 3% of the graduating engineers by then. More recent data suggests that around 880,000 students are in the computer science engineering discipline alone in the academic year 2019 (Statista 2019).

The bright prospects in employability and premium wages in the IT sector made computer science a lucrative career goal for students. The demand for—and supply of—education sharply increased in the 1990s, accelerating growth in the country's human capital, despite stagnating public expenditure (Arun Kumar 2008). This generation of engineers and software professionals came from middle-class families, where parents were college-educated salaried professionals, managers and employees in Government and the public sector (Upadhya 2011). Their entry and starting up in the tech sector led to firms such as Infosys, which further defined the tech entrepreneurship scene in India (Mastakar and Bowonder 2005). Their entrepreneurial firms became global firms quickly.

2.3 *Women in Technology Sectors*

India has traditionally been a patriarchal society. In India, women lead their lives with traditions and values clubbed with social norms in rural and urban areas. Women perceive their socio-cultural contexts as a given, causing self-perpetuating behaviours and reproducing contexts. For example, many rural communities in India often feature traditions and values where women are repositories of honour and a good reputation for their families. Their sanctity must be preserved (Kantor 2002). To uphold these values and the fear of social rejection, women restrict their engagement with male members to those in their immediate family, thereby reinforcing the social norms. In ancient times, women rarely used to step outside the home for education. Such social norms have significantly changed, although some differences remain. For example, Cheney et al. (2005) suggest that 98% of Indian parents believe that education is necessary for boys while 89% believe that education is necessary for girls.

The IT boom and the rise of tech education witnessed the entry of girls into the tech sector. The tech sector posed a lucrative environment with white-collar jobs, mobility, high salaries, gender-neutral policies and an indoor work environment (Kumar 2001; Upadhya 2006; Shanker 2008). Higher and technical education opened the gateways of getting into this sector. As such, the entry of women into professional, technical and higher education resulted in a growing female participation rate in this sector. The high employment potentiality in this sector inspired many girls to go for professional education, especially for the computer engineering courses.

There have been investigations into what led to this shift in preferences, overcoming stereotypes and biases to promote entry for girls in tech education. These students were typically from families in urban areas but some were also from rural areas (Upadhya 2011). Thus, the relatively progressive environments of urban areas enabled these shifting preferences. As family tends to be one of the closest contexts of socialisation in childhood and adolescence, extant studies suggest that parental guidance is influential in non-traditional careers (Dryler 1998). Students can also get directly influenced if their parents chose IT careers or tech education and are in technical jobs (Dryler 1998). A closer investigation into girls' career choices suggested that many factors enabled the entry of girls into tech education in India. The most pertinent are exposure to the outside world, gaining a say in the marriage marketplace, peer observation and role models, having educated parents and the opportunity to earn higher wages. For example, Caldwell et al., (1983) suggest that Indian parents with education had changed attitudes towards the concept of childhood and dependence of girls on parents. Exposure to new ideas from the outside world transformed them. In rural areas, as Beaman et al. (2012) suggest, following the 1993 law that reserved leadership positions for women in village councils in India, the gender gap in aspirations closed by 20% in parents and 32% in adolescents in a village assigned a female leader. Such impact of women leaders primarily reflects the role model effect. These views are consistent with UNESCO (2017), which suggested that the increase in women undergraduates in engineering is due to changes in the perception about engineering in the country and changed attitudes of parents as they expect advantages in marriage and job prospects.

The social backdrop in India embeds the norm of marrying daughters as per the groom's families' expectations. In this context, increasingly, families hope that through the technical education and good job, they will be able to bargain in the marriage marketplace to find a better groom (Yakaboski et al. 2013; Adams and Andrew 2019). Furthermore, the rise of role model girls and peer families could afford more bargaining power in society. A better lifestyle motivated even traditional families to encourage their girls to pursue tech education. Also, tech jobs, classified as clean jobs, encouraged middle and upper-middle-class families to opt for tech education for their daughters. A recent report suggests that about 35% of the Indian IT sector workforce is female, significantly higher than 25% in the USA and 17% in the UK (Raghuram et al. 2018). Compared to developed countries, a greater proportion of girls are getting into STEM, IT and computing in India (BCS 2016; WES 2018).

3 Women Tech Entrepreneurship

The findings from the recent Global Entrepreneurship Index (GEI) report suggest that product innovation is the highest strength possessed by the entrepreneurial ecosystem in India (Acs et al. 2017). This insight challenges the notion of necessity entrepreneurship in the Indian context. Furthermore, women in India are slightly more likely than men to perceive opportunities (GEM 2018). GEM also suggests that more women than men see entrepreneurship as a positive career in India, almost 2.4 times greater. However, these are not necessarily translating into women high-tech entrepreneurship. This leads to a compelling question as to why women are entering tech education and tech employment but not tech entrepreneurship? This calls for investigation into the factors that inhibit women with a technical background from venturing into entrepreneurship in tech sectors. These factors can be of two types: structural and normative factors. The key structural factors include economic laws, support mechanisms for entrepreneurs, administrative obstacles, bureaucracy in business support systems, information structures and new markets (Niazkar and Arab-Moghaddam 2011).

3.1 Structural Factors

In the Indian context, industry, Government and academic research suggest that structural factors deter entrepreneurship of both men and women. However, women face disproportionately more structural challenges in their resource mobilisation efforts that severely limit their entrepreneurship prospects (Lindvert et al. 2017; Panda 2018). For example, the Mastercard Index of Women Entrepreneurs (MIWE) 2019 ranks India as the lowest at 52nd amongst the 58 countries to provide an unconducive environment for women entrepreneurs. The Global Entrepreneurship Index Report 2018 suggests put India at 68th amongst 137 global countries. The study mentioned that the "underlying conditions" for women entrepreneurs in India are less favourable when compared to countries that got a high index score. There are calls for enterprise support specifically for women and boost the availability of social and financial capital to foster their entrepreneurial intention and behaviour (Lindvert et al. 2017; Neumeyer et al. 2019). Such support includes networking events with entrepreneurs and venture capitalists (Ekinsmyth 2011). As entrepreneurship in the tech sector is capital intensive, knowledge-intensive and resource intensive, lack of conducive support can deter women entrepreneurs in the tech sector. As Prasad et al. (2013) suggest, both human and social capital factors determine business growth for women entrepreneurs in India. They find that social capital factors related to the size of individuals' business networks and the support received from family members play a significant role in the Indian context for women entrepreneurs.

Starting up in the tech industry is resource intensive resulting in a need for various financing solutions. India has experienced significant progress in Venture capital and financing for entrepreneurs. The year 2019 was a milestone year for the Indian VC industry, with $10 billion in capital deployed in Indian startups (Bain 2020). However, there seem to be apparent gaps in the impact reaching to the women entrepreneurs in tech sectors, although lack of finance is a critical issue for entrepreneurial support irrespective of gender. The disproportionate impact seems to be on women entrepreneurs who have to deal with a lack of working capital and equity finance that pose significant threats to women entrepreneurship (Ganesan et al. 2002). O'Connor et al. (2006) suggest that technology-based firms, independently whether the founder is male or female, work in a volatile, fast, dynamic environment and struggle with the scarcity of capital. Potential women entrepreneurs in tech are prone to shutting down their ideas because of a lack of financing (MIWE 2018). Thus, finance is one of the key deterrents for Women Tech entrepreneurship in India.

3.2 Normative Factors

There is an emerging consensus that entrepreneurship intertwines with gender and the normative context (Marlow and Martinez Dy 2018; Meliou and Edwards 2018; Henry et al. 2016; Ahl and Marlow; 2012; Brush et al. 2009). Rules and obligatory dimensions enshrined in established discriminatory practices embedded in a country's social, economic and religious environment affect women entrepreneurs (Roomi 2013). Societies see women as wives, mothers and carers and determine their career choices (Rehman and Roomi 2011). Thus, society's larger socioeconomic role system governs normative support for women entrepreneurs (Baughn et al. 2006). Here, access to resources and support is not a sufficient condition for women entrepreneurship. External contexts influence entrepreneurial intention (Farashah 2015), and normative factors are crucial to understanding women entrepreneurship. They influence the agency to start, develop and grow the business (Roomi et al. 2018).

In India, in both rural and urban areas, women lead their life with traditions, values clubbed with social norms. Entrepreneurship requires a commitment beyond the regular wage employment and women would need tremendous support and agreement from husbands and family members to discharge the unusual demands of entrepreneurship. Family and friends can also show resistance towards female entrepreneurial activities, belittling them, doubting their capacity and may want them to stick to usual working life patterns (Kumbhar 2013). In a country like India, which has traditionally been a highly patriarchal and traditional society, there are many normative constraints, such as religious beliefs, amongst many other factors (Panda 2018). The MIWE report further indicates that women in India have less inclination towards business ownership because of such biases. In 2017, the Niti Ayog reported on a section of women refusing challenging career opportunities in science. The IITs are amongst India's best institutes and regularly rank high in global surveys but are plagued by a small number of women students, reflecting Indian society's belief that men are more suited for technical jobs. These societal beliefs and norms about gender roles adversely impact the entrepreneurial opportunities of women.

Entrepreneurship does not always provide flexibility and could be demanding (Jennings and Brush 2013). It places additional pressure on women as they struggle to achieve work-family balance and fulfil the role society expects of them. The burden of household responsibilities poses a severe challenge to women entrepreneurs of India (Das M 2000). NITI Ayog (2017) suggests that the timings and workload are essential factors in the career continuity of women in STEM education in India.

Women need to plan their marriage, family and motherhood according to their career decisions. Kuschel (2019) suggests two groups of "mumpreneurs" in technology ventures, one of them is women who create startups while young and childless, postponing maternity until the business is "stable". Another one is mothers who created a technology venture to gain higher levels of flexibility and autonomy than they experienced in the corporate world. The first group is highly work-role salient, while the second is highly family-role salient. It suggests entrepreneurship is based on family decisions by women founders in the technology industry.

Media significantly influences perceptions through its favourable or unfavourable treatment of entrepreneurship. The GEM 2019 report examines the extent to which media coverage is positive or negative for entrepreneurship across countries. It suggests that India is one of the countries where women reported gender gap favourable media coverage (GEM 2018). Farashah (2015) suggest that social persuasion through media is a significant source of entrepreneurial self-efficacy. Thus, media has a role to play in promoting or discouraging women entrepreneurs.

The Funnel Effect: The number of women in tech constitutes a pool of entrepreneurial talent and potential. Women have less success in entrepreneurship because they are less likely than men to have education and experience in technology. However, India observes a relatively higher intake of women in tech education. Thus, the challenge found with the entry of women in tech is not a problem for India. Still, the country is missing out on potential women entrepreneurs in tech because of structural and normative reasons. The funnel effect widely observed in the western countries in women tech entrepreneurship is replicated in India, although India has relatively more students in tech and science. There is an inflow of women into tech education in India but there is low entry of women into tech entrepreneurship because of a combination of structural and normative factors.

4 Conclusions Looking Forward

There is momentum to promote and support women entrepreneurship in India. Women entrepreneurs are likely to grow up by 90% in the next five years (Economic Times 2021). India is likely to observe a phenomenal rise of women entrepreneurs, particularly in sectors such as Food and Education (Financial Express 2019).

However, ecosystem stakeholders are still sceptical about women tech entrepreneurs. For example, MAKERS India report (2020) suggests that only 22% of investors invested in the startups led by at least one woman founder. Indeed, women investors may offer hope for more investments in women entrepreneurs following GEM (2017) report which suggests that in a few countries women invest in friends and neighbours at a greater rate than men, with the highest rates noted in India, Taiwan and the United States at about 40%.

There is a need to ease out of infrastructural bottlenecks and robust institutional and business support. Peer to peer mentoring can encourage more women to take up entrepreneurship in technology-based sectors. Mentoring support can also embed women into networks events with other nascent entrepreneurs and venture capitalists (Ekinsmyth 2011). Women Tech entrepreneurship is new in India, but it can thrive in a buzzing environment that supports nascent entrepreneurs. Such support can come in the form of boosting the availability of social and financial capital for shaping their entrepreneurial intention and behaviour (Leitch et al. 2018; Lindvert et al. 2017).

The Government of India, NGOs and private organisations have taken initiatives to support women entrepreneurship (Niti Ayog 2017). However, women entrepreneurship in technology sectors is not on the radar for most of the narratives. However, some initiatives, such as the SAP Lab India initiative with the Niti Ayog and Atal Tinkering Laboratories (ATL), promote STEM education amongst secondary school children across India (SAP 2019).

As these initiatives have been relatively new, India may observe an upward entrepreneurial activity of women in tech with some time lag. Celebration of successes of role model women entrepreneurs in tech and campaigns targeted at improving awareness of women entrepreneurs about various schemes and programmes can accelerate women tech entrepreneurship. For future research, evidence-based studies on women tech entrepreneurship can shed light on how structural, normative and personal factors are dynamically affecting women entrepreneurship in India.

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Public Policies and Private Efforts to Increase Women Entrepreneurship Based on STEM Background

Aldo Alvarez-Risco and Shyla Del-Aguila-Arcentales

Abstract This chapter makes a novel contribution analyzing the first studies of entrepreneurship by women. Then, it is described the STEM education components that are so relevant for the understanding of the current educational approach, detailing the overall level of advancement and some specific cases for reference. Great content explains the existing barriers in STEM education regarding gender, the remains to achieve greater access. Finally, the aspects that must be ensured were highlighted so that more women are an active part of STEM education and that this STEM education is an integral part of the knowledge and skills to develop entrepreneurial activities successfully.

Keywords STEM · Entrepreneurship · Women · Entrepreneur · Education

1 Introduction

Current entrepreneurship by a woman still is a big challenge. Academia efforts must focus on understanding the elements behind women's knowledge and skills needs for successful entrepreneurship. In this way, this chapter is looking to create a framework for creating strategies that make it easier to incorporate more women as entrepreneurs. Firstly, women's first studies of entrepreneurship are initially presented; these articles show, since the beginning, an essential limitation of conditions and knowledge for the entrepreneurship initiatives. This analysis is fundamental because it can be recognized as the "first picture" of women's development. Subsequently, it is described the components of STEM education, mentioning the level of implementation, and some examples are described to be followed by educational institutions in different levels. After that, one crucial issue is discussed: the barriers in gender terms for

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STEM education which analyzed how STEM education does not create the same knowledge and opportunities. Then, it is shown the outcomes of some initiatives of the current development of girls and women in STEM education. Finally, it is highlighted the need to ensure that more women are an active part of STEM education and that of support due to the knowledge and skills to develop entrepreneurial activities. Some specific steps are shown.

2 Methodology

The research uses a documentary research method to the analysis regulation of entrepreneurship and woman. For the collection of articles, it was used searching of the following terms: "entrepreneurship + woman", "entrepreneur + woman", "entrepreneurship + STEM education", "STEM education + woman", "entrepreneur + STEM education + woman". It was used the articles and indexed in Scopus from 1990 until 2021.

3 Evidence of Entrepreneurship by the Woman

One of the first reports focused on writing the leading role of women in entrepreneurship was carried out by Lee-Gosselin and Grisé (1990), who described that the interviewed women were interested in "small and stable business"; also mentioning that they seek recognition for such action. Kraus-Harper (1991) 30 years ago stated that women received help to develop entrepreneurship because their poverty conditions served her and her family to survive. Historically, aid in developing countries focused on entrepreneurship development programs; also, García (1995) reported that entrepreneurship was vital for the woman's family's future.

Other initial reports of women's entrepreneurship describe women's actions in rural areas and the need for strategies to include increasing participation of women (Nair 1996). Carin (1997) asked a thoughtful question regarding entrepreneurship by women. Is it a compliment to entrepreneurship, or is it another type of entrepreneurship? This question offered a possibility to show that women may need other conditions to develop entrepreneurship. The report of Buttner and Moore (1997) evidenced why 129 executive and professional women left large organizations to become entrepreneurs, finding that these reasons were centered on the desire for challenge and the need to balance family and work responsibilities. Subsequently, investigations were carried out that showed the entrepreneurial performance of women in various countries such as (Soetan 1997), India (Sethi 1998), Zimbabwe (Chitsike 2000), China (Kao and Choon Chiang 2001), and Italy (Blim 2001).

It has been recognized that women are linked to entrepreneurship for different reasons, with survival being historically reported as one of the reasons, mainly in

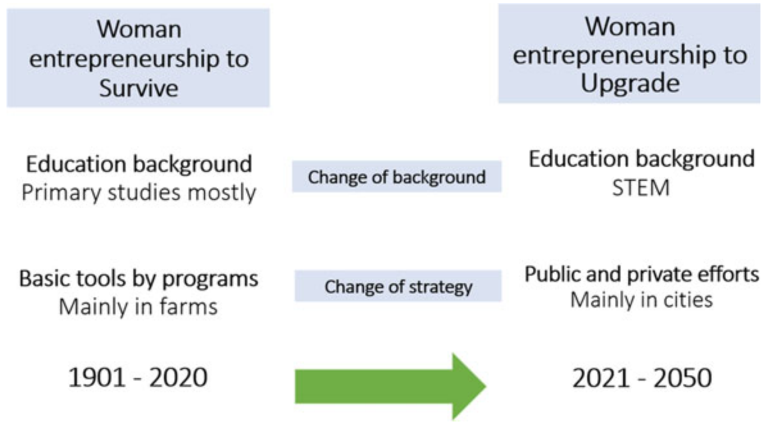

Fig. 1 Changed of strategies and background for women entrepreneurship

communities with limited access and minimal resources. However, entrepreneurship has also been recognized as an alternative for a better personal development of women, which allows them to develop their business ideas and better manage their work and personal/family life. For this type of enterprise that seeks greater independence from women and a more sophisticated proposal, other types of knowledge are required.

In this context, it can be recognized that STEM training is a formative component that provides strength for developing activities based on entrepreneurship. It has been recognized that women are linked to entrepreneurship for different reasons, with survival being historically reported as one of the reasons, mainly in communities with limited access and minimal resources. However, entrepreneurship has also been recognized as an alternative for a better personal development of women, which allows them to develop their business ideas and better manage their work and personal/family life. For this type of enterprise that seeks greater independence from women and a more sophisticated proposal, other types of knowledge are required.

In this context, it can be recognized that STEM training is a formative component that provides strength for developing activities based on entrepreneurship. Figure 1 is shown the process expected to create more opportunities for women in entrepreneurship.

4 STEM Education

One of the most critical OECD guidelines in education is those oriented towards STEM disciplines linked to a country's well-being due to innovation, competitiveness, and economic outcomes (de Brey 2019). It is interesting to know that graduates in STEM careers at the tertiary level come from different geographical areas

(OECD 2019); thus, in business, most graduates are from Colombia, Luxembourg, Costa Rica, Australia, and France. In engineering, most graduates are from Russia, Korea, Germany, Portugal, and Austria. In health, the countries are Belgium, Sweden, Finland, Chile, and Denmark. Finally, for education graduates, the countries are Indonesia, Argentina, Costa Rica, Poland, and Spain.

On the other hand, in the USA, a higher percentage of women (58%) than men (42%) who received bachelor's degrees was reported, but the data in STEM fields have a lower percentage of women (36%) than men (64%) (de Brey 2019). In Europe, specifically in Germany, among university students, females reported a lower perception of their competencies related to future success was found compared to their male colleagues (Sobieraj and Krämer 2019). In Peru, only 32% of STEM graduates are women (SUNEDU 2016). Also, it was found that female researchers with high scientific productivity need more resources (related, financial funds) to reach the same results as their male colleagues (Aguinis et al. 2018). UNESCO recently released a report showing about 27% of countries had achieved gender parity (values between 45 and 55% between men and women (UNESCO 2019). Also, the report mentions that the representation of women decreases as they advance in their careers, which means that the gender gap widens the higher the level reached in the ladder, which is typified as vertical segregation.

These results show that even though there are various efforts to achieve more women's involvement in STEM disciplines, there are still gaps. It is therefore required to know the different reasons why this gap exists; thus, it is mentioned that the unpleasant interaction of female scientists and their male colleagues or advisers discourages their continuity (Greider et al. 2019).

All this scenario motivates this narrative, which will show evidence of female graduates' STEM levels, including computer science where historically the gap is more significant, gender differences in the information distributed on social networks to disseminate professional activities. Likewise, companies' efforts from different sectors to reduce the gap at the time of hiring will be presented, which will result in universities that will be able to see more significant opportunities in their female graduates. It is essential to know the training and promotion strategies for women scientists, from primary and secondary education, and continue studying at the university level.

5 STEM Education in the World: One Example from Peru

In Peru, various efforts have been made from the private sector so that students from their first years in the educational field achieve a comprehensive education such as that achieved with the STEM methodology for education. Thus, Peru is part of the Latin American STEM Network, supported by Siemens Stiftung, to generate collaborations and exchange of experiences in implementing STEM education. The website of the network is https://educacion.stem.siemens-stiftung.org/red.

Tuva Vega et al. (2019) showed some reports from research that showed in elementary school students that the STEM education methodology predicted the achievement of comprehensive education. Likewise, Tuva Vega et al. (2019) showed in high school students that the STEM methodology of education was strongly related to critical thinking, communication, and collaboration, and creativity and research.

However, among the most relevant to describe is the strategy from Peru's government to promote STEM education. For this, the Council of Science, Technology and Technological Innovation (CONCYTEC, its acronym in English) provides helpful information on educational projects in Science, Technology, Engineering, and Mathematics (STEM, for its acronym in English). Also, there is an available distance education modality. CONCYTEC launched the STEM Education Observatory, aimed at students and teachers of kindergarten, primary and secondary school, and the general public. This platform will find a list of the leading educational projects that allow an interactive distance learning experience, taking advantage of the tools provided by information technology.

In the current scenario, COVID-19 has generated various impacts on people in the health environment but also in the educational field, both teachers and students were affected, having calculated by UNESCO that more than 850 million students in the world stopped studying. Because of this, the Observatory becomes more relevant to meet the educational needs of boys and girls. The Observatory can be visited at the following link: www.stem.concytec.gob.pe.

Different initiatives are focused on providing tools to students, teachers, and parents for education. In Table 1, we can recognize the initiatives most important.

Table 1 Initiatives of STEM education

Name of education project	
Khan Academy	https://es.khanacademy.org
Cisco Networking Academy	https://www.netacad.com/es
Science Bits	https://www.science-bits.com/site/es/index.html
Intel Education	https://www.intel.la/content/www/xl/es/education/intel-education.html?countrylabel=Peru
Code	https://code.org/learn
Fun Brain	https://www.funbrain.com/
Aula 365	https://www.aula365.com/
Matemáticas cercanas	https://matematicascercanas.com
Fisicalab	https://www.fisicalab.com
Educatina	https://www.educatina.com/

6 Barriers and Enablers for Gender Balance of STEM Education

Each country is promoting the implementation of STEM education with different strategies; however, it is essential to mention the barriers that have been identified and, according to this analysis, formulate the strategies to overcome these barriers. Specifically, Goos et al. (2020) were able to identify, based on the literature review, the critical barriers to the greater participation of girls in STEM education and the most effective interventions reported.

Regarding the identified barriers, it was possible first to find the same students in whom it was possible to find barriers related to language and spatial skills, self-efficacy, self-perception, stereotypes, STEM identities, interest in STEM subjects, engagement with STEM subjects, motivation for STEM subjects, and enjoyment with STEM subjects. The family was also identified as a barrier due to parenting, educational stimuli, and role models. The school was also recognized as one of the barriers through the forms of evaluation that are usually used, the absence in many cases of mentoring and accompaniment of students, and the models that are sought to promote in students. There are also the teachers who play a crucial role in promoting STEM courses as of greater interest and future usefulness in the school. Society was also recognized that they do not facilitate STEM education for girls through its specific policies and regulations.

About the strategies to generate greater participation of women in STEM education that they describe Goos et al. (2020), the following are specifically mentioned:

(1) Provide career coaching and information to students, teachers, parents, and close friends.
(2) Provide constantly mentoring and role models.
(3) Encourage and support parental and friendly engagement with children or schools.
(4) Attend to teacher/student interaction and language.
(5) Provide vital/disruptive/inquiry-based/developmental academic curriculum
(6) Use mastery-oriented assessment.
(7) Develop and promote positive school culture.
(8) Offer all year out-of-school programs (e.g., sports teams, summer camps, coding clubs).
(9) Build science capital.
(10) Challenge dominant representations of science.

The development of science capital is the new wealth of countries. To assess the progress in the training of science capital students, DeWitt et al. (2016) raised an index of science capital. This index of science capital describes 14 statements that really should be in everyday use in colleges and universities to evaluate female students on how much they are being trained with vital STEM components and modify or adjust the strategies developed in the educational center.

The questions to be answered by students are next:

1. Whom students speak with about science
2. Whom they know who has a job using science
3. A science qualification can help you get many different types of jobs.
4. When you are NOT in school, how often do you talk about science with other people?
5. One or both parents think science is fascinating.
6. One or both parents have explained to me that science is helpful for my future.
7. I know how to use scientific evidence to make an argument.
8. How often do you go to an after-school science club?
9. When not in school, how often do you read books or magazines about science?
10. When not in school, how often do you go to a science center, science museum, or planetarium?
11. When not in school, how often do you visit a zoo or aquarium?
12. My teachers have specifically encouraged me to continue with science after GCSEs.
13. My teachers have explained to me science is helpful for my future.
14. It is helpful to know about science in my daily life.

However, if we see in an expanded way the need to evaluate students to establish whether they are "capital", it is necessary to think that only science has been evaluated in this index. (S from STEM). So, what about technology, engineering, and mathematics? It will be interesting to think that this index can transform it into an Index of STEM capital.

That way, it will have questions like:

a. A mathematics qualification can help you get many different types of jobs.
b. When you are NOT in school, how often do you talk about technology with other people?
c. One or both parents think engineering is exciting.
d. One or both parents have explained to me that mathematics is helpful for my future.
e. I know how to use technological evidence to make an argument.
f. How often do you go to an after-school mathematics club?
g. When not in school, how often do you read books or magazines about technology?
h. When not in school, how often do you go to an engineering event?
i. When not in school, how often do you watch YouTube content of mathematics?
j. My teachers have specifically encouraged me to continue with engineering for my graduate education.
k. My teachers have explained to me mathematics is helpful for my future.
l. It is helpful to know about technology in my daily life.

7 STEM Education for Girls and Women

According to the National Girls Collaborative Project (2021), women make up half of the total U.S. college-educated workforce but only 28% of the science and engineering workforce. Why so few? The American Association of University Women mentions that the number of women in science and engineering is growing, but men continue to outnumber women, especially at the higher levels of these professions. In elementary, middle, and high school, girls and boys take math and science courses in roughly equal numbers. Among first-year college students, women are much less likely than men to say that they intend to major in science, technology, engineering, or math (STEM). Upon graduation, men outnumber women in almost every science and engineering field, and in some, such as physics, engineering, and computer science, the difference is dramatic, with women earning only 20% of bachelor's degrees. Although there is not a single way, it can be had as a consensus that stereotypes and biases should be fought, emphasize social relevance, cultivate a sense of belonging. Also, as a transcendent aspect, change the dynamics in schools and workplaces to generate a new habitat where women can have the opportunity not only to receive STEM education but also to be interested in and deepen their learning after school, at university, and with postgraduate studies that may even lead to permanent links to the research on STEM topics.

The literature shows various reports on the evidence and proposals at the global level of STEM education for women. Ertl et al. (2017) evaluated the impact of gender stereotypes on female students' self-concept in STEM subjects. They found that parents' direct support can hurt female students' self-concept activity is designed to directly support students can be counterproductive and generate and accentuate stereotypes. This situation emphasizes the need for indirect support during socialization, such as providing opportunities for them to have positive experiences or allowing them to meet role models so that female students remain enthusiastic about their STEM careers.

A revealing fact was found by Brenøe and Zölitz (2019), who showed in Denmark that the gender composition of high school affects students' participation in STEM at university. Specifically, having a higher proportion of female peers was shown to reduce the likelihood of women enrolling and graduating from STEM programs. In the long term, women exposed to more female peers are less likely to work in STEM occupations, earn less, and have more children. However, Riegle-Crumb and Morton (2017) revealed that exposure to a higher percentage of confident female peers in the science classroom positively predicted such intentions, supporting the importance during school training and in universities of having successful professionals in class. Also, there is a balance between males and females so that female student can have an important contact and point of inspiration to initiate their interest in the STEM courses or increase the interest.

van den Hurk et al. (2019) carried out a systematic review to find in the literature what could be the alternatives to reduce the drop in STEM courses. About the social context, studies of Stoeger et al. (2016) and Stout et al. (2011) showed that a strategy is enhancing women's motivation and attitude by providing them with female role models (as mentors). Regarding the school context, the increased use of ITC (Kara and Yeşilyurt 2008) or more practical experiences inside and outside the classroom (Lee and Erdogan 2007; Prokop et al. 2007) and the use of online training programs for women aimed at retaining attention in STEM topics (Bekki et al. 2013; Schultz et al. 2011).

Everything described allows us to explain STEM education's connection between the type of essential entrepreneurship that women with very few resources (survival) did and how to achieve qualified entrepreneurship (upgrade) based on STEM training. Thus, the importance of implementing strategies that allow more women to access STEM education can be recognized, and that based on this broader training, an enterprise with more significant impact and more significant personal and work benefits can be achieved for the women who undertake it.

8 STEM Education for Entrepreneurship of Women

Shahin, Ilic, Gonsalvez realized a recent study that sought to explore the effects of a female-oriented STEM-based entrepreneurship program and its effect on 193 female high school students' entrepreneurial intent. This program encouraged girls to develop and implement creative computational solutions to socially relevant problems, with an Internet of Things (IoT) component using the micro: bit device. It was found that a critical factor in the development of entrepreneurial attitudes in young students is associated with the development of soft skills, particularly in the areas of creative thinking, risk-taking, problem-solving, and leadership development. These areas make us think that the creation of interest in female students to develop entrepreneurship is based on peers and mentoring that can allow them to materialize ideas.

Another relevant finding is brought by Armuña et al. (2020), who found that there would be no differences between men and women in entrepreneurship intention. It was also confirmed that a positive relationship between STEM-based competencies and greater intention of entrepreneurship. This finding supports the approach that we have developed in this chapter, and that requires many joint efforts from the different actors in the system, including families, schools, universities, teachers, parents, and, without a doubt, the environment of friends. In the same orientation, Colombo, and Piva (2020) evaluated the impact of university education on entrepreneurial entry. They find that entrepreneurial entry is more likely if graduates exhibit a more specialized university curriculum; also, they find that entrepreneurial entry is positively associated with the attendance of courses in economics and management.

It is pending for future research to find if the evolution of STEM with the incorporation of the arts, turning it into STEAM, also generates a contribution to the development of entrepreneurship in women. There is preliminary evidence (Anisimova et al. 2020; Dolgopolovas and Dagienė 2021; Kang 2020; Siddique et al. 2021; Weaver et al. 2020), but it should be considered that intense work is being done to bring women closer to STEM education in order to have more tools that can promote the development of enterprises on a large national and international scale. However, it can be seen that STEAM education is being promoted more and more, with which it is relevant to anticipate change and from now on begin to incorporate the Arts into education since the evolution of STEM is the one who will finally prevail in the curricular planning.

9 We Need to Be Understood and Do in the Future

The evidence that has been published for 30 years shows that the problem of entrepreneurship was carried out by women in ancient and that these articles should be read by all those who carry out entrepreneurship analysis to understand the origin and subsequent evolution. Figure 1 shows the changes in strategies and background for women entrepreneurship, which allows us to summarize the change in the training needs and orientation of entrepreneurship, highlighting the great need for STEM education. It is also precisely necessary that STEM education be fully understood, with its components and evolution (towards STEAM), so that the efforts made and those that must be made in the immediate future can be shown for education to reach its fundamental objective: transform everyone without distinction.

Specifically, some examples of initiatives in Peru have been shown. However, we are sure that each country has been developing various initiatives, so it is helpful to continue collecting experiences to share between stakeholders and educators to build science capital among both sexes' students. Finally, women's entrepreneurship requires that it be based on a STEM education, which must also be built with an inclusive orientation towards women and also incorporates a focus on entrepreneurship activities, which are crucial as in the current times of pandemic, where many people have lost their jobs and can find an alternative for personal and family development in entrepreneurship.

10 Conclusions

Women's entrepreneurship requires much attention to ensure that the most significant benefits can be achieved for women, their families, and society. Giving them a more excellent and better education is essential and will make a difference in the enterprise's development plans. It is known that there is little representation of women in STEM courses, but it has been possible to analyze the various strategies to be implemented that will help achieve uniform access to STEM education and at the same time provide crucial tools for the existing hypercompetitive world. Subsequent studies should consider the effect of STEM in the development of entrepreneurship intention. Finally, work should be done so that the arts enter the STEM model and through STEAM a real comprehensive education is achieved, the same that will see a path in entrepreneurship feasible and safe for personal and professional success.

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