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**ARTICLE**

# Leadership in Technical Fields Through a Gender Lens

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**ABSTRACT**
Although women have fought for labor rights for many years, they continue to be underrepresented at almost all levels of decision-making. The present study aims to provide insights into female leadership in technical fields both in the EU and in Russia. The article examines the principal leadership aspects of women's status and career experiences. To identify the ingredients of successful leadership, the Multifactor Leadership Questionnaire and interviews were administrated to a sample of 200 mining students and 40 senior executives. The research data were processed by means of correlative, regressive, and autocorrelation analyses. To track the consistency of the identified leadership factors, female heads of enterprise divisions and university departments shared their views on career progress. The Mann–Whitney U test was employed to analyze the leadership factors. Studies indicate that the more senior the position is, the fewer women there are in leadership roles. Women's progress in technical careers is hindered both by their own uncertainty and judgments made by others about their abilities. To rectify this situation, practices for encouraging young women to pursue technical careers are recommended along with approaches for maintaining them within the career structure. The research findings also indicate a positive emerging global trend towards increased gender diversity in technical fields.

**KEYWORDS**
female leadership, high-level leadership, technical fields, STEM (Science, Technology, Engineering, and Mathematics), gender aspects, technical university, mineral resource sector, female career development, gender pay gap

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## Introduction

Whether in Russia, New Zealand, Norway, or Iceland, women have always been found on the front lines of a productive economy. Moreover, empowering women in the economy is a key to achieving equality and promoting full and productive employment for all. However, when it comes to their participation in higher levels of decision-making, women continue to be in short supply. While over half of people living in the world are women, men still make up 75% of parliamentarians and hold 73% of managerial positions. In the course of negotiations associated with the end of conflicts, men continue to take the lead role (Economic and Social Commission for Western Asia, 2015). There has never been a female head of the state of the Russian Federation. Of the ministers in the Russian Government, women constitute only 12%. Women hold a mere 16.7% of the seats in the State Duma, Russia's lower house of parliament. While there are two women currently serving as deputy chairpersons in the government of the Russian Federation, in the Cabinet of Ministers itself, there is only one woman, Olga Lyubimova, who became the first woman to hold the position of Culture Minister since Yekaterina Furtseva headed the Soviet Ministry of Culture from 1960 to 1974. Thus, politics is almost exclusively the domain of men, with women making up around 18.3% of national and state legislatures (Members, n.d.; Senior Russian Government Officials, n.d.).

The term "female leadership" divides opinions: some people would not make a distinction whether it is a man or a woman who leads, considering leadership to be gender neutral, while others do not see a problem with using the prefix "female." In the present paper, the word "female" is stressed to emphasise women's particular characteristics and the value of these characteristics to institutions and enterprises in Science, Technology, Engineering, and Mathematics (STEM) fields. The definition of "high-level leadership" or executive staff positions varies; for the study, we considered posts occupied by women involved in managing and directing the course of an organization, including senior or executive vice presidents, chief financial or operation officers, heads of departments at a technical university, etc.

Globally, the proportion of women working in senior management grew to 31% in 2021, marking considerable progress achieved in the last few years. According to a recent study, the number of areas in which women are applying for leadership positions increased to nine (Field et al., 2023; National Center for Science and Engineering Statistics, 2023). The proportion of female leaders is less than a half in such areas as education (42%), healthcare (39%), finance (29%), retail (24%), and real estate (22%). In the mineral resource sector, just as in the political affairs, men control nearly all aspects of decision making. Women are least likely to run companies in the mining, public sector, and security sectors (6%) (Hinchliffe, 2021).

There is a great deal of research into the lack of gender equality in technical fields (Funk & Parker, 2018; Kazanin et al., 2021). Similarly, there is a large body of literature on the lack of gender equality in leadership areas (Women in Business Report, 2021; Yukl & Gardner, 2020). However, there is little statistics-based research into the intersection of women's leadership in technical fields in the EU and in Russia.

The present work focuses on how leadership in technical fields is factored through the gender lens both in the EU and in Russia. In order to champion gender equality in STEM industries, the root cause is to be recognised and addressed. This article analyzes factors influencing women's careers, starting from secondary education and continuing through career development, including socio-psychological and cultural aspects. Such statistical research closes the gender data gap as well as addressing both the suppression of women's achievements and concealment of their experiences in executive or managerial positions.

By examining women's career experiences, female governance, and career barriers, the study aims to identify recommended practices for fostering gender diversity in technical sectors. With its focus on gender in STEM areas, the work seeks to expand the existing studies of female leadership by addressing the following research questions:

- What is the academic background of women leaders in technical fields?
- What are the ingredients of successful female leadership in technical fields?
- How can secondary, tertiary education and STEM industries achieve gender parity in leadership in technical fields?

Two research hypotheses are investigated. The first identifies a trend towards increased numbers of female leaders working in technical fields. The second hypothesis proposed by the study suggests that certain practices can motivate young women in schools and universities to pursue technical careers, thus addressing the current gender disparity in technical fields.

## Materials and Methods

### *Research Design*

The study lying in the intersection of technical fields and female leadership consists of the theoretical and experimental parts covering Russia and EU28 countries.

The research steps comprised: (a) collection of background information on the STEM workforce; (b) research planning; (c) Multifactor Leadership Questionnaire administered to two age groups of respondents (technical students and senior managers); (d) analysis of the questionnaire results using the nonparametric Mann–Whitney U test; (e) semi-structured interview of female leaders; (f) analysis of the semi-structured interview results; (g) formulation of recommendations that can encourage young women at schools and universities to pursue technical careers in order to centre women in technical fields.

After gathering STEM workforce background information, we conducted a comparative analysis on the proportion of women in both academic and senior management positions in technical fields. The revised list included official statistics documents from a 5-year period from 2019 to 2023, Russian and western academic publications, and the most recent data on this topic. Using correlative, regressive, and autocorrelation analyses, we predicted the proportion of women in STEM senior management up to 2025. The selected time period and countries are constrained by the data availability and readiness of female CEOs to share their leadership experiences.

To collect the empirical data, we surveyed technical students and senior managers using the Multifactor Leadership Questionnaire (Bass & Avolio, 1990). The first part of the experiment was initiated at Empress Catherine II Saint Petersburg Mining University, the leading higher technical university in Russia, which provides international integration in issues of training and continuous professional development of mining specialists from all over the world, as well as international accreditation and certification of educational programs for mining engineers. The data were collected on an anonymous basis via an online survey application. All participants were informed about the study and consented to participate.

In the first survey, 200 mining students comprising 100 males and 100 females between the ages of 17–19 were surveyed along with and 40 heads of technical university departments (20 males and 20 females) to identify and compare their leadership qualities. There was no special selection criterion in the student group other than the status of the group monitor in the Mining University. It should be added that the percentage of female and male respondents did not reflect the male-to-female ratio in technical fields as evidenced by statistical data (UNESCO, 2017). The choice of the equal number of respondents was applied randomly to provide equal opportunities for male and female representatives. The students' ages were mentioned only for reference and not taken into account in the calculations.

In the second part, women leaders taking part in the professional workshop programme for engineers held in the Leningrad Oblast on the Day of the Metallurgist in 2023, along with female heads of technical departments at Empress Catherine II Saint Petersburg Mining University in the 2022–2023 academic year, were interviewed to analyze perceptions of women holding managerial posts in the mineral resource sector to identify the drivers of women's career growth in STEM, along with their suggestions of how to advance and increase the number of women leaders in technical fields. We collected data via both semi-structured interviews and anecdotal testimony collected between 2022 and 2023. This part of the study relies on a qualitative research design focusing on the experiences and perceptions of the informants.

### *Statistical Data Processing*

Statistical data processing and graphical representation of the data obtained were performed by IBM SPSS 17 and Microsoft Office Excel 2016. Skewness and kurtosis indices characterising the distribution curve were used to assess the attribute type. Numerical values are presented as $M \pm SD$, where $M$ is mean, $SD$ is standard deviation. The qualitative attribute values are displayed as observed frequencies and percentages. Since factors 6 and 7 in the two groups lacked a normal distribution of the sample, the group comparison was based on the nonparametric Mann–Whitney U test. The values measured in point scales were analysed. The linear regression analysis with calculation of the coefficient of determination ($R^2$) was used to assess the temporal dynamics. Pearson's linear correlation coefficient was utilised to conduct correlation analysis, followed by testing for significance. Statistical significance was determined at $p < .05$, where $p$ represents the probability of Type I error. All cases adhered to the use of two-tailed criteria. The Bonferroni correction for multiple comparisons was used to compare the average values for several groups.

## Results

Based on the statistics analysis, we identified that both Russian and European women are highly educated, but begin to lag behind in technical fields starting at the PhD level. Analysis of societal, organizational, and individual factors reveals that women's advancement in managerial careers depends on tackling gender stereotypes, which result in psychological obstacles and misconceptions about their professional abilities.

The results of the correlative, regressive, and autocorrelation analyses presented an increasing global trend in the percentage of female executives in STEM is forecast. Our research findings revealed a pay gap mainly due to the gender imbalance in technical fields across both Russian and EU-based engineering organizations. The research results indicate that male students outperform female students on the leadership quality test in terms of reasoning skills, suggesting they excel in critical thinking and providing logical justification for actions and decisions. Efforts of secondary and tertiary education providers to attract more girls to STEM are analysed along with the initiatives of the technical industries to retain female specialists.

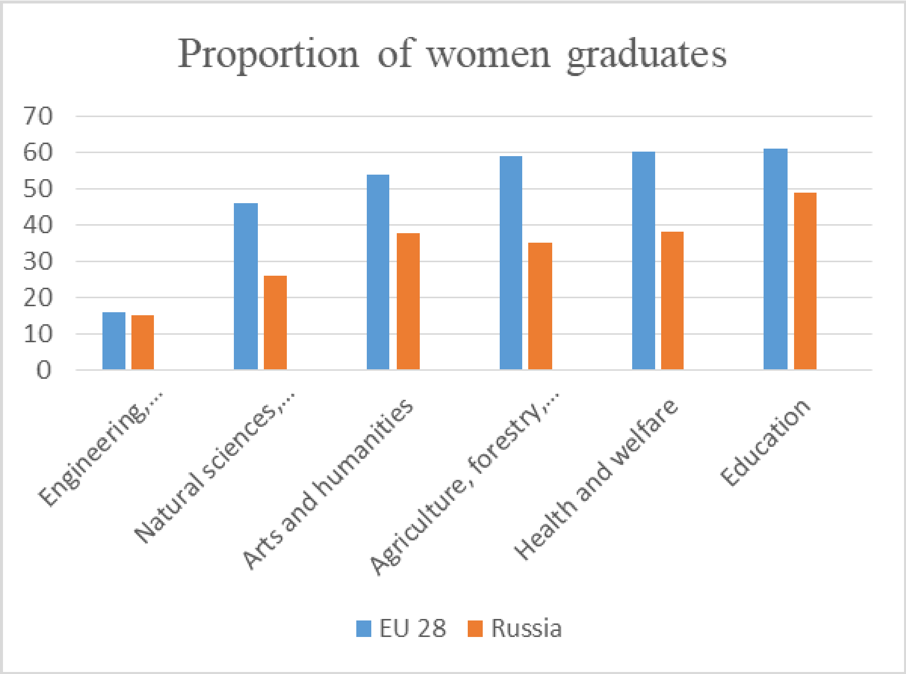
***Outcome 1: Overview of Women in Senior Technology Roles***

*Women in Tech Statistics.* Since an interest and motivation toward technical sciences may begin early in human formation and development, we considered all levels of education in our research. According to a recent UNESCO study, 91% of females worldwide completed secondary school, while males were slightly behind at 90% (UNESCO, 2017). Turning to higher education, it can be noted that 89% of women have higher education, while the figure for men is lower at 75%. Since the early 1990s, a massive generational shift has seen more women than their male counterparts attaining bachelor's degrees in universities in 60 countries (Economic and Social Commission for Western Asia, 2015; Times Higher Education & the UNESCO International Institute of Higher Education in Latin America and the Caribbean, 2022; Varlamova et al., 2023). In this regard, one of the epochal events took place in 2010. Since it was in that year that more women than men obtained advanced degrees for the first time.

In the EU's 28 member states, 60% of university graduates were women last year (Eurostat, 2024). However, if taking into account the field of study, the enrolment of female students is particularly low in ICT (3%), natural science, mathematics, and statistics (5%), and in engineering, manufacturing, and construction (8%). Only 29% of all female students opt for STEM-related fields in higher education (Golovina & Grebneva, 2021; UNESCO, 2017).

The varying proportion of women among doctoral graduates across fields of education is also reflected in Russian statistics. In the EU, women ranged from 61% of social and related scientists to 16% of engineers among the college-educated employees in 2021 (Figure 1). As can be seen from the figure, Russia has fewer university graduates than the EU in all spheres.

**Figure 1**
*Female Doctoral Graduates by Field of Study, 2021*




*Note.* Source: compiled by the authors based on Times Higher Education & the UNESCO International Institute of Higher Education in Latin America and the Caribbean, 2022; Varlamova et al., 2023.

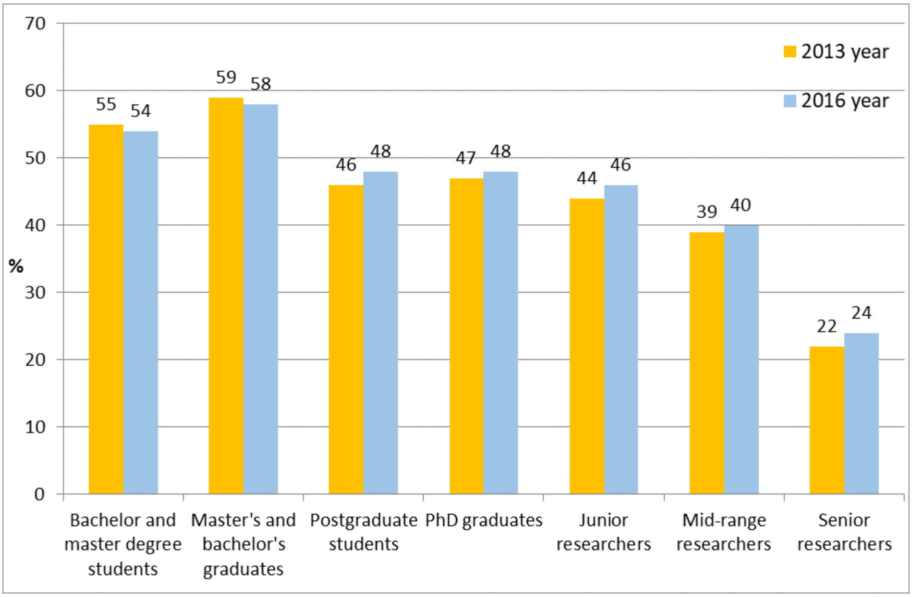
In the mineral resources sector, which is a key driver of the health and vitality of the economy over time, while there are many examples of outstanding leaders, nearly all of them are men. When studying the high-ranking positions, the imbalance is even more apparent. Even in European Union countries where equality policies are implemented, the proportion of women in high academic positions is 24% (European Commission, 2019; TeamStage, n.d.). Moving to the top of the career pyramid, the decline in women's representation, sometimes referred to as the "leaky pipeline", is observed in almost all countries (Figure 2).

According to the statistics, nearly two-thirds of women working in STEM jobs had at least a bachelor's degree education compared with less than half (43%) of men in STEM jobs in 2021 (The UNESCO Institute for Statistics, 2021).

In 2019, the percentage of women researchers in top-level positions in science and engineering was 39.6% in Russia (Rosstat, 2021). When it comes to university professors in Russia, women are still very much a minority, comprising only 6%. In the European Union, while the proportion of female researchers accounted for 29%, the share of full professors was only 18% (Table 1).

**Figure 2**

*Proportion of Women at Different Stages of Academic Career*




*Note.* Source: compiled by the authors.

**Table 1**

*Participation Percentage of Women Among Academic Staff in STEM in Russia and the EU in 2019*

| Academic staff | Proportion of women in academia (%), *n* = 100 | |
|---|---|---|
| | Russia | EU-28 |
| Researchers | 39.6 | 29.0 |
| Full professors | 6.0 | 18.0 |
| PhD | 45.0 | 47.9 |
| Academicians | 9.4 | 5.1 |

*Note.* Source: compiled by the authors based on Bondarenko et al., 2020; European Commission, 2021.

Female engineers outnumber male ones in Lithuania (57%), Bulgaria (53%), Portugal (53%), Russia (52.4%), and Norway (54%). In the Russian Federation, this trend has not changed over the years since more than half of Russian women scientists work in technical fields. Nevertheless, the share of women among researchers has not approached 50% in some economically developed European countries (The UNESCO Institute for Statistics, 2020; Times Higher Education & the UNESCO International Institute of Higher Education in Latin America and the Caribbean, 2022). The proportion of women scientists and engineers in the EU and Russia is listed in Appendix (Table A1).

In her report, Irina Donnik, Vice-President of the Russian Academy of Sciences, indicated that 52.4% of women scientists in the Russian Federation work in technical fields, while 23.6% work in natural sciences. Social sciences take the third place in popularity among women; here, female scientists constitute 8.0% of the total number of researchers (Vitse-Prezident RAN, 2021).

Female participation in the top-management (CEO and directors reporting to the CEO) differs from year to year (Table 2).

**Table 2**
*Women's Participation in Senior Management in STEM*

| Year | **Percentage of women, %** **$n$ = 100** |
|---|---|
| 2022 | 29 |
| 2021 | 31 |
| 2020 | 28 |
| 2016 | 24.4 |
| 2015 | 14.7 |
| 2014 | 13.7 |
| 2013 | 12.9 |
| 2012 | 11.3 |
| 2011 | 10.3 |
| 2010 | 9.6 |

*Note.* Source: compiled by the authors based on Kalinina, 2022; Leibundgut, 2022; Women in Business Report, 2021.

The share of female senior managers employed in the STEM sector varied significantly between selected regions, ranging from 39% in Africa to 28% in the Asia Pacific. Appendix contains data on the representation of women in senior STEM management across various countries (Table A2).

Overall, statistical data show that both Russian and European women are highly educated, often surpassing men in secondary education, bachelor's and master's engineering studies. However, the situation takes a turn for the worse starting from the PhD level of technical studies. There are correspondingly fewer women in top-management in technical fields both in Russia and in the EU. While an increased appetite within companies to appoint more women into technology roles can be observed, this apparently does not apply to senior positions.

### *What Do Female Leaders in Technical Fields Earn?*

Since salary serves as the basis of the population's source of income, researchers examined remuneration for equal types of work in the labour market. Despite the fact that equal payment for work of equal value is declared in the UN Sustainable

Development Goals (SDGs), such as Goal 5 “Achieve gender equality and empower all women and girls” and Goal 8 “Promote progressive, inclusive and sustainable development”, women earn 77 cents of every dollar made by men who fulfil the same jobs, comparable jobs, or equivalent functions.

In the European Union, the gender pay gap, which has been narrowing quite slowly over the last decade, averages 14.1% as compared to 15.7% in 2014 (European Commission, 2023; Eurostat, 2024). The permanent workforce in the UK office in April 2022 was 33% female, with 17% of women in senior management positions (Gender Pay Gap Reporting, 2023) (Table 3).

**Table 3**

*Pay Gaps Across UK Organizations*

| Pay quartiles | Men, % | | | | Women, % | | | |
|---|---|---|---|---|---|---|---|---|
| | 2019 | 2020 | 2021 | 2022 | 2019 | 2020 | 2021 | 2022 |
| Top quartile | 89 | 88 | 90 | 89 | 11 | 12 | 10 | 11 |
| Lower quartile | 52 | 45 | 49 | 49 | 48 | 55 | 51 | 51 |

*Note.* Source: compiled by the authors based on Gender Pay Gap Reporting, 2023; Women in Management, 2022.

In Russia, the average hourly wage of women was at the level of 70%–77% of men’s wages. Due to the implementation of programmes on public employment, women’s pay has gradually improved. In 2019, the Russian gender pay gap was 27.9%, which still significantly exceeds the global average (Rosstat, 2021). In 2021, the pay gap between male and female specialists working in scientific and technical fields averaged 30 percent. Meanwhile, the largest pay gap between men and women in the professional group “top managers” is in the mineral resource sector, where men earn, on average, 32.7% more than women (Table 4).

**Table 4**

*Average Salary of Men and Women in the Russian Federation in 2021, per Month*

| Employees categories by major activities | Average salary of men, rubles | Average salary of women, rubles | Gender gap in average salary, % |
|---|---|---|---|
| Heads of enterprises and their structural subdivisions | 201,590 | 135,664 | 32.7 |
| Specialists of the highest-level qualification | 124,066 | 86,736 | 30.0 |

*Note.* Source: compiled by the authors based on Haan, 2024; Roshchin & Yemelina, 2022; Rosstat, 2021.

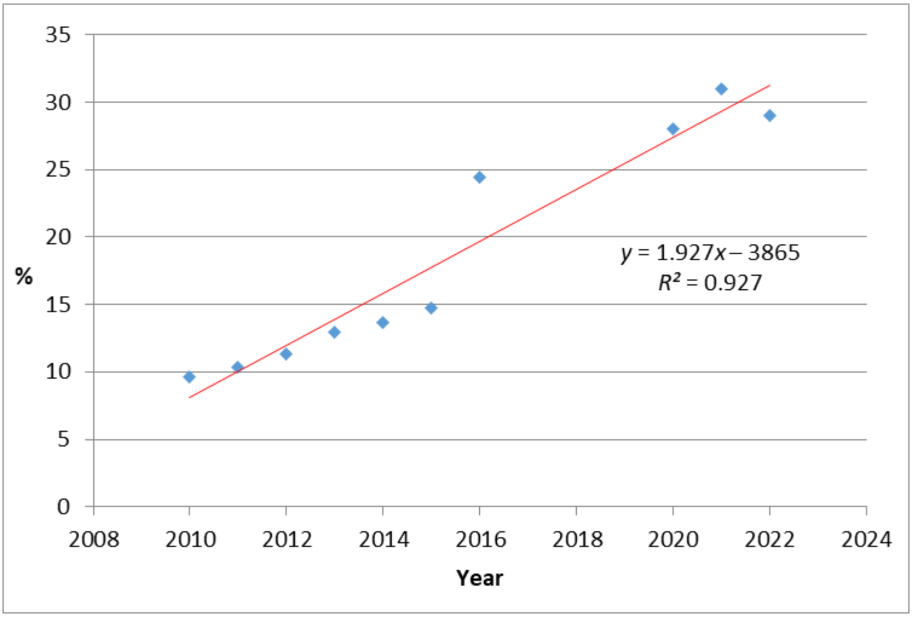
From Tables 3 and 4, it is evident that earnings for male and female senior managers showed significant differentials, notably at the very top.

***Outcome 2: Trend Towards Gender Diversification in Technical Fields***

Using correlative and regressive analysis, we have revealed a linear, strong, direct, statistically significant ($p < .05$) correlation between the observation years and the percentage of female CEOs in the mineral resource companies. The high consistency of the results is evidenced by the chief values of both determination coefficient ($R^2 = 0.927$) and Pearson's linear correlation coefficient ($R = 0.963$). In the process of statistical analysis, a linear regression equation was constructed: $y = 1.927x - 3865$, forming a basis to predict the proportion of female managers ($y$) in subsequent years ($x$). Thus, we can estimate that the share of women leaders will reach 37.2% in 2025 (Figure 3).

**Figure 3**

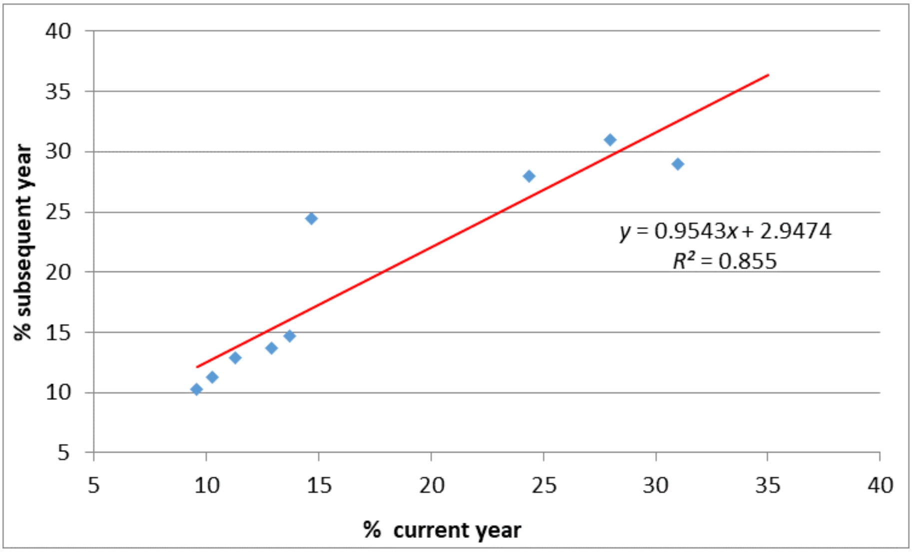
*Dynamics of the Share of Women in Senior Management in Companies From 2010 to 2022, %*




*Note.* Source: calculations by the authors.

Using autocorrelation analysis with a shift by one observation period, representing an alternative method for estimating the dynamics of a time series, a similar result was obtained. The determination coefficient having a value of 0.855 ($R^2 = 0.855$) and Pearson's autocorrelation coefficient ($R = 0.925$) were calculated to be high. The share of female managers ($y$) in technical fields in subsequent years in relation to the value of this share in the current period ($x$) was forecast based on the linear autoregressive equation ($y = 0.954x + 2.947$). For example, in 2025, the share of female managers will amount to 35.0% based on the autoregressive model (Figure 4).

**Figure 4**
*Autocorrelation of the Dynamics of the Share of Women in Senior Management From 2010 to 2022, %*




*Note.* Source: calculations by the authors.

Thus, between 2010 and 2022 there was a pronounced, statistically significant increasing trend in the percentage of the female CEOs being substantiated by two methods of analysis of dependence.

***Outcome 3: Ingredients of Successful Female Leadership***

The principal features of female governance and women's career setbacks in Russia and in EU were compared and analysed. In order to understand the female approach to decision-making, management style, challenges, and sources of inspiration, we surveyed production foremen, metallurgical workshop supervisors, and heads of technical university departments. The statistical tables are based on the information supplied by female leaders and data from the statistical sources.

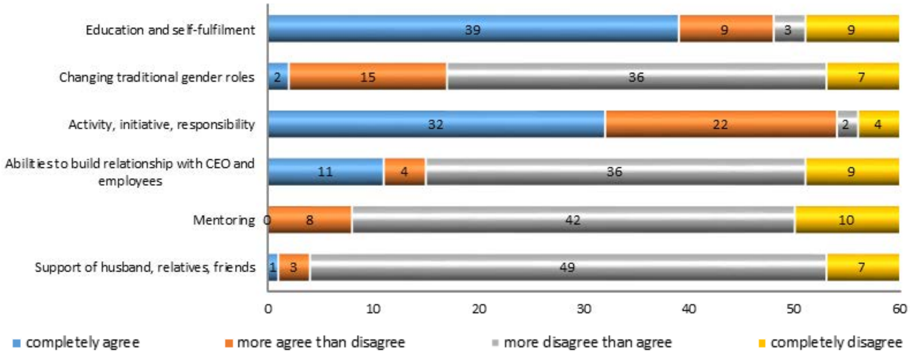
In the first part of the survey, individual, societal, and organizational factors were appraised to analyse women managers' views on their career development. The surveyed executives have a lengthy managerial background, with 10% holding their positions for one to five years, 10% for more than five years, and 80% for over 10 years. The periods of holding a leadership position are listed in Appendix (Figure A1).

The motivation of women to obtain a managerial position is viewed as an important attribute. Most surveyed respondents were offered a post based on their fruitful work either at the technical university or at an industrial enterprise. However, some women were obligated to shoulder the responsibility due to possessing a distinct competency over others and the company's need for this competency. Only 1% said it had been their own drive to improve on existing university performance.

The next questions concerned women's career advancement approaches and obstacles to acceding to higher management positions (Figure 5).

**Figure 5**

*Results of 20 Women's Self-Assessment of the Ways of Female Career Promotion*




*Note.* Source: compiled by the authors.

As stated by 39% of respondents, excellent education and skills are deemed crucial for career development. The proactivity formula viz. activity, initiative and responsibility rank the second in the degree of prevalence in the list of career-enhancing factors. A great deal of information about the barriers to career growth had been made available in a self-critical manner, especially concerning household responsibilities leading to time constraints. The main structural and qualitative reasons preventing women from climbing the career ladder were identified based on the analysis of the female leaders' responses (Table 5).

**Table 5**

*Main Barriers to Career Advancement*

| Individual | Cultural | Workplace | Structure/policy |
|---|---|---|---|
| Wrong choice of educational institutions | Perception of women's commitment | Inflexible work schedule | Lack of shared parental leave |
| Sector choices | Double standards | Staff rather than line role promotions | Lack of childcare assistance |
| Pipeline availability | Role of spousal / relatives | Lack of training (coaching) | Differentiated taxation |
| Risk aversion disparity | Work-life balance priorities | Promotion rates | Enterprises/university departments designed for men |

*Note.* Source: compiled by the authors.

The next issues connected with female career advancement were analysed based on both interviews with women leaders and by studying statistical data. Upon being asked about obstacles women may face in pursuing a career, some private and educational factors were identified. Many women meet discouragement when choosing occupations in which women have not traditionally worked, for example, in technical fields (Table 6).

**Table 6**
*Impediments to Career Growth*

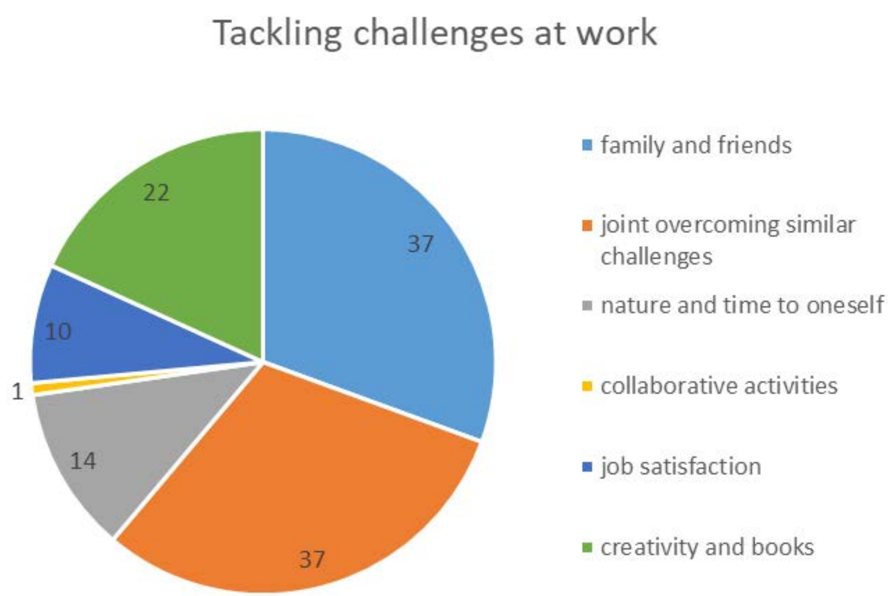
| Barriers to women's career development | Respondents, % *n* = 100 | |
|---|---|---|
| | Statistical sources | Survey data |
| Lack of confidence in their professional skills and career goals | 24 | 21 |
| Inadequate perception of professional skills and career goals by others | 19 | 18 |
| Shortage of time because of running the home and childcare | 15 | 16 |
| Limited access to self-development opportunities | 13 | 14 |
| Paid less than men | 12 | 12 |
| Little support from others | 9 | 10 |
| Insufficient professional education | 8 | 9 |

*Note.* Source: compiled by the authors based on the survey data and the data from national statistical sources: Breakdown of Women Holding CEO Positions, 2020; Dawson et al., 2014; TeamStage, n.d.

As can be seen from Table 6 above, the survey data almost coincided with the statistical data. Many women struggle with psychological difficulties concerning a lack of confidence in their leadership potential and professional skills, as well as inadequate perceptions of women's professional skills and career goals on the part of others.

Figure 6 shows that about 70% of respondents placed support from family or friends and overcoming similar challenges together at the top of the list.

**Figure 6**
*Facilitating Challenges at Work*




*Note.* Source: compiled by the authors.

Factors having an impact were classified as individual, cultural, professional, and structural. Through the course of their examination, it was determined that advancement of women in managerial careers on a global scale depends on traditional gender roles, organizational culture, women's perceptions, and professional competencies. While the majority of respondents face work-related challenges, they have been able to work out some strategies for overcoming workplace issues in order to better manage their leadership roles.

The differences between male and female styles of leadership are presented in Table 7.

**Table 7**

*Features of Female/Male Leadership Styles*

| Leadership style | Respondents, % *n* = 100 |
|---|---|
| Women's multitasking and men's goal-oriented | 16 |
| Women negotiate, men order | 20 |
| Women's flexibility and men's conservatism | 19 |
| Women's softness, men's aggressiveness | 18 |
| Men are result-oriented; women are process-oriented | 14 |
| Men are more rational when making decisions | 13 |

*Note.* Source: compiled by the authors.

As can be seen from Table 7, female senior-level executives have more developed skills associated with encouraging and supporting, while men are considered better at decision-making and problem-solving.

Based on the respondents' views, we summarised the proposed benefits for an industrial sector if its leaders were women (Table 8).

**Table 8**

*Benefits of Female Leadership*

| Benefits for organizations | Respondents, % *n* = 100 |
|---|---|
| Improving organization efficiency and quality | 15 |
| Financial return | 10 |
| Gender does not play any role | 55 |
| Promotion of the mining engineering profession among women | 20 |

*Note.* Source: compiled by the authors.

In determining factors that female leaders bring to an industrial sector (STEM), 15% of the female respondents placed increasing productivity and creativity at the top of the list, while 10% accentuated financial benefits as the main driver behind promoting gender equality. Among the respondents, while 20% specifically highlighted the need to promote mining engineering to women, a majority (55%) did not consider men and women differently.

In sum, the ingredients in successful female leadership are confidence in the leadership potential, appropriate educational level, well-developed professional skills, and specific personal abilities such as activity, initiative and responsibility.

***Outcome 4: Traits of Female and Male Leaders***

The Multifactor Leadership Questionnaire was employed to explore their leadership potential of 200 student leaders and 40 executives. To evaluate each statement, a five-point Likert scale was employed. From the processed results of the test, seven major factors associated with transformational leadership allows identified (Table 9).

**Table 9**

*Description of the Leadership Factors*

| Factors | Interpretation |
|---|---|
| Factor 1<br>Acting with integrity (formerly Idealised Influence—Behaviors) | Abilities to inspire based on authority |
| Factor 2<br>Building trust (formerly Idealised Influence—Attributes) | Abilities to build trust |
| Factor 3<br>Encouraging innovative thinking (formerly Intellectual Stimulation) | Abilities to encourage employees' creativity, as well as to develop their innovative potential in solving occupational tasks |
| Factor 4<br>Coaching & developing people (formerly Reasoning Factor) | Abilities to find an approach to a particular person, even an unfamiliar one |
| Factor 5<br>Encouraging others (formerly Inspirational Motivation) | Abilities to create an attractive image of the goal clearly outlining criteria and expectations |
| Factor 6<br>Management by exception | Abilities to manage the process of achieving the goal; desire to make the group work as effective as possible, not just to ensure the formal achievement of indicators |
| Factor 7<br>Empowerment | Abilities to organize the group work to effectively achieve goals |

*Note.* Source: compiled by the authors.

The results of the comparative analysis of the questionnaire data using the nonparametric Mann–Whitney U test showed the total seven-factor mean was statistically significantly ($P_{st\text{-}ex} < 0.05$) higher for the female executives than for the female students. The difference (d%) between them ranged from 73.2% to 108.0% in favor of female executives. The similar differences were calculated between the male executives and male students ($P_{st\text{-}ex} < 0.05$). The difference (d%) ranged from 58.7% to 83.6% in favor of male leaders.

The results of the statistical data analysis by the nonparametric Mann–Whitney U test indicated gender differences in Factor 4. We define reasoning factors as the rationale, motivation, and preferences people use to guide others.

The male students showed predominance in this factor by 11.9% ($P = 0.019$). They have a tendency to motivate using a sensitive approach towards personal requirements. Statistically significant differences were also calculated between male and female executives only for the mean of Factor 5 (Encouraging others). The female executives showed 10.9% predominance in this factor ($P_{f\text{-}m} = 0.026$) (Table 10).

**Table 10**

*Results of Descriptive Statistics and Comparative Analysis of Respondents of Different Gender and Social Status*

| Parameters | Factor 1 Acting with integrity (formerly Idealised Influence—Behaviors) | Factor 2 Building trust (formerly Idealised Influence—Attributes) | Factor 3 Encouraging innovative thinking (formerly Intellectual Stimulation): | Factor 4 Coaching & developing people (formerly Reasoning Factor) | Factor 5 Encouraging others (formerly Inspirational Motivation) | Factor 6 Management by exception | Factor 7 Empowerment |
|---|---|---|---|---|---|---|---|
| Female students ($n = 100$) | | | | | | | |
| $M$ | 5.5 | 5.6 | 5.2 | 5.0 | 5.5 | 6.2 | 5.0 |
| $\pm SD$ | 1.3 | 1.3 | 1.1 | 1.5 | 1.3 | 1.1 | 1.4 |
| Female executives ($n = 20$) | | | | | | | |
| $M$ | 10.5 | 10.5 | 10.0 | 9.5 | 10.6 | 10.7 | 10.3 |
| $\pm SD$ | 1.3 | 1.2 | 1.4 | 1.5 | 0.9 | 1.2 | 1.1 |
| $P_{st\text{-}ex}$ | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 |
| d% st-ex | 88.7% | 87.6% | 92.2% | 90.5% | 92.8% | 73.2% | 108.0% |
| Male students ($n = 100$) | | | | | | | |
| $M$ | 5.6 | 5.8 | 5.5 | 5.6 | 5.7 | 6.3 | 5.2 |
| $\pm SD$ | 1.0 | 1.0 | 0.7 | 0.9 | 1.1 | 0.9 | 1.0 |
| $P_{f\text{-}m}$ | 0.996 | 0.739 | 0.130 | 0.019 | 0.693 | 0.941 | 0.471 |
| d% f-m | 1.1% | 3.1% | 6.4% | 11.9% | 3.5% | 2.0% | 5.6% |
| Male executives ($n = 20$) | | | | | | | |
| $M$ | 9.7 | 10.1 | 9.4 | 9.2 | 9.4 | 10.0 | 9.6 |
| $\pm SD$ | 1.2 | 1.1 | 1.0 | 1.4 | 1.5 | 1.1 | 1.1 |
| $P_{st\text{-}ex}$ | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 |
| d% $_{st\text{-}ex}$ | 72.3% | 74.2% | 69.7% | 64.9% | 66.1% | 58.7% | 83.6% |
| $P_{f\text{-}m}$ | 0.160 | 0.472 | 0.366 | 0.874 | 0.026 | 0.143 | 0.135 |
| d% $_{f\text{-}m}$ | −7.7% | −4.3% | −6.0% | −3.2% | −10.9% | −6.5% | −6.8% |

*Note.* Source: calculated by the authors.

Summarising the statistical analysis data represented in Table 10, the male and female executives in technical industries outscored the technical students in all leadership factors. The female executives outperformed male ones on the inspirational factors (Factor 5) demonstrating better developed leadership potential and strong business focus. Male students demonstrated superior critical thinking and logical justification in personalised leadership compared with their female counterparts.

***Outcome 5: Initiatives Aimed at Improving Gender Diversity in Technical Fields***

*Practices to Encourage Young Women at Secondary Schools and Universities to Pursue Technical Careers*

Below, we summarise the efforts of secondary and tertiary education to attract and retain more girls in STEM. The most common initiatives are aimed at school-age girls who are about to make a choice for their future profession. According to the statistical results, while 58.1% of girls expressed a desire to attain to STEM professions (Times Higher Education & the UNESCO International Institute of Higher Education in Latin America and the Caribbean, 2022; Varlamova et al., 2023) more than half have doubts about their capability to excel in technical subjects. Seminars and interventions of informing girls about gender stereotypes are integrated into the educational process or held as separate events to overcome girls' uncertainty about their future technical career choice.

Many girls rate their intellectual abilities lower and show more insecurity than boys. Videos and articles about brain plasticity and ability to develop over the course of a lifetime are presented within the practices of "growth mindset" developed the theory of stereotype threats (Reilly et al., 2022; Steele & Aronson, 1995).

Another approach is active learning via a set of pedagogical approaches to encourage the involvement of students in learning through discussions and role-playing games, solving professionally oriented cases (Hartikainen et al., 2019; Gerasimova et al., 2022).

Placing an emphasis on the public benefit of a career in STEM serves as a practice for increasing girls' engagement with STEM subjects. Increasing the confidence of students that their future profession is beneficial to society will contribute to attracting more girls into STEM (Diekman et al., 2017).

An alternative practice of attracting girls to STEM is through the Service Learning programme, which combines the educational process with socially useful activities. For example, in the United States, Brazil, Argentina, Venezuela, Chile, Spain, students and schoolchildren are involved in local professionally oriented community organizations (Cheryan et al., 2015).

Efforts have been made to create targeted school programmes with government-led funding and the involvement of employers expressing their commitment to gender equality. The School Leader Contest programme run by the Empress Catherine II Mining University is aimed at motivating talented students of both genders to choose technical universities. As well as comprising one of the mechanisms for integrating secondary and higher education, this programme represents an important step towards developing the popularity of engineering professions.

To identify potential leaders among students and create conditions for their realisation, there are special training programmes in the Mining University, for example, as scientific assistants. This course provides numerous opportunities for the academic development and advancement of assistant scientists. Thus, the technical university serves as a platform for their continuing personal and professional development.

As well as weekend training sessions, summer schools for girls involving immersion in technical sciences are annually held to strengthen girls' psychological readiness to learn technical sciences. At the Mining university, psychological support is provided to students in the form of a comprehensive programme of psychological and pedagogical support of the professional training and educational process.

As well as taking measures to expand opportunities for girls in STEM education, it is also important to promote female participation in the STEM labor market. To increase incentives for women's employment in technical fields, partnerships between leading technical universities and industrial enterprises are developed to support gifted students. Scholarships and grants for research and development in technical sciences are established in partnership with business organizations to support female scientists. An alliance of business companies has been formed to support universities, women's organizations and school principals in pilot regions that have committed to developing STEM programmes to train women in technical fields.

We suggest that such influence may be conducted through "role models" based on portraying women professionals in technical industries. In the Mining university, the female senior executives who work in the traditionally male-dominated STEM fields are invited to share their views of successful career with students. If girls see more women in prominent STEM roles, they are more likely to start to picture themselves there.

### *STEM Industries' Initiatives to Achieve Gender Parity in Technical Fields*

According to the statistics, in the last five years, there has been assertive action from technology companies to alter the makeup of their senior leadership team as a means of ensuring that they become more diverse, especially in terms of senior female appointments (Table 11).

**Table 11**

*Most Common Actions Being Taken by STEM Industries to Achieve Gender Parity*

| Initiatives for gender parity | STEM industries, % *n* = 100 |
|---|---|
| Ensuring equal access to career development | 14 |
| Creating an inclusive culture | 25 |
| Enabling flexible working hours | 11 |
| Providing coaching | 20 |
| Reviewing recruitment approaches | 6 |
| Linking senior management's reward to progress on gender | 3 |
| Setting quotas for gender balance at leadership levels | 16 |
| Specific approaches based on gender | 5 |

*Note. Source: compiled by the authors.*

Considering the research data, we revealed the standard actions taken by STEM industries to get more women into senior management worldwide. These are coaching, setting quotas, and the creation of an inclusive culture (Kersley et al., 2021; Women in Business, 2020).

Globally, such countries as the Netherlands, Italy, France, Germany, Norway, and India have applied quotas to scale up women's presence in managerial positions. In 2019, more than 20% of board members were women worldwide, representing an increase of almost 2% from 17.9% in 2018 (UN Women, 2024; Women in Business, 2020). A bill that adopts quotas for the number of female leaders is being prepared in Spain. The guideline states that the proportion of women on boards of directors in medium and large companies, government agencies, and the country's government must be at least 40%. In Russia, there are only 6.5% of women among the leaders of the top 200 largest Russian companies (UN Women, 2024; World Development Report, 2012). CEOs in STEM industries should actively mentor women to support a more inclusive workplace. In Russia, coaching is provided, along with the development of an inclusive culture.

International events like STEM Forum Russia and STEM+E forum, which are aimed at popularising STEM careers among girls, are already being organized in Russia.

## Discussion

The present study focused on how leadership in technical fields is factored through the gender lens both in the EU and in Russia. The topic of the presented research is important in connection with the implementation of the UN Sustainable Development Goal 5 (SDG 5) on gender equality, as well as the increasing demand in the labor market for representatives of technical professions not only in Russia, but also in Europe (European Commission, 2016, 2023). The comparison between the EU and Russia reveals similar challenges concerning the underrepresentation of women in technical fields. Despite the many campaigns in support of gender equality, there is still a lack of competent female specialists in technical fields, especially in the top management.

The practical outcomes of this research include a statistical overview of women leaders in technical fields, identification of key features of female governance, as well as factors and initiatives for achieving gender equality in the economy. We have confirmed the hypotheses on the rising global trend of female leaders in technical fields and need for initiatives capable of promoting women leaders in technical fields. We estimate that the share of women leaders will reach about 35.0%–37.2% in 2025.

The present study results confirm the data about the underrepresentation of women in decision-making bodies in STEM (Edwards et al., 2020; Kersley et al., 2021; Women in Business Report, 2021); thus, male scientists constitute 72% of the world's technical researchers. We fully endorse research findings stating that gender equality in technical fields is not yet a reality (National Center for Science and Engineering

Statistics, 2023). While women now enjoy excellent education and are ready to take responsibility at work, they continue to face unexpected obstacles after entering the workforce and looking forward to promotions. In general, the higher a company's revenue is, the less likely it is to have a female CEO.

Our findings about career counselling coincide with the data presented in the *STEM Statistics: Workforce* (2023). For example, potential female leaders are more drawn to those companies that build teams on the principles of co-operation and empathy (Largest Listed Companies, 2024; Rudnik et al. 2023).

A STEM degree serves as a tool to perform jobs and move into peak leadership roles (Bazhin et al., 2021; Pashkevich & Bykova, 2022; Syrkov et al., 2021). Our findings are in line with research stating that career development is influenced by a multitude of factors, including education, psychology, sociology, economics, that shape an individual's career path over their lifetime (Helgesen & Goldsmith, 2018; Sveshnikova et al., 2022). If fortunate, women may find their passion and excel in their chosen field, acquiring skills and values that drive them to explore, establish, and maintain their career development.

Considering the concept of leadership in relation to the mineral resource sector, it is worth mentioning that companies employing multi-gender teams are up to a third more effective (Kersley et al., 2021; Litvinenko et al., 2023). Companies having women in high-administration positions are estimated to be 18% to 69% more profitable and competitive than their peers. They also perform better over time, generating 10% more cumulative revenue over a 5-year period (De La Rosa et al., 2021; Makhovikov et al., 2023). However, as reported by Hunt et al. (2018), National Center for Science and Engineering Statistics (2023), women tend to be segregated into a small number of productive sectors, which translates into gaps in their earnings and productivity with respect to men.

We also endorse research stating that the great challenges of our time cannot be solved using the same kind of thinking we used to create them (Boyadjieva et al., 2024; Dorofeev et al., 2023; Mikeshin, 2022).

Our study also validated the finding that, both in the EU and Russia, women tend to be employed in education, health and agricultural sectors, where wages are often lower (National Center for Science and Engineering Statistics, 2023). Globally, the largest pay gap between men and women in the professional group of "top managers" is in the mineral resource sector, where men earn, on average, 32.7% more than women. Several possible explanations for this gender pay gap include occupational segregation, missing out on valuable work experience caused by childbirth and childcare responsibilities, differences in working hours and the tendency of men to take risks and compete (Gillard & Okonjo-Iweala, 2020; Panov, 2014; Unadjusted Gender Pay Gap, 2022).

Impediments to achieving gender parity in senior leadership posts and corporate boards remain. However, one of the key factors behind women's economic empowerment is social pluralism within corporate management teams (20 Women Tech Leaders, 2023; de Kleijn et al., 2020).

Further research suggests the following steps: (a) a case study of female engineers and their careers; (b) gaining insight into career advancement opportunities; (c) development of more comprehensive and accessible cross-gender mentoring practices to promote and reinforce female leadership.

## Conclusion

The research findings indicate that women believe their inability to advance in the technical careers stems from both their own doubts and others' negative judgements concerning their capabilities. Such doubts and negative judgements can be explained in terms of gender stereotypes. In general, the proportion of women in management decreases in increments of seniority: the higher up the corporate ladder you go, the fewer women there are.

By examining the statistical data, we now have a better understanding of the current state of women in STEM, both in terms of education and employment. While Russian and European women frequently outperform men in secondary education, as well as in bachelor's and master's level technical studies, a "leaky pipeline" for PhD-senior researchers has been confirmed. Thus, the proportion of women in technical fields, including PhD students, researchers, and senior managers, remains below 50% in both Russia and the EU.

Our research findings shed light on female characteristics that are valued in technical fields. The key ingredients of successful leadership are confidence in leadership potential, quality education, honed professional skills, personal abilities such as activity, initiative and responsibility, as well as the capacity to foster relationships with both CEOs and employees. The main attributes of female leadership, such as multitasking, process-orientation, negotiation skills, flexibility, and softness have been identified.

Our analysis of practices provided by the secondary and tertiary education to bring more girls into STEM careers, as well as STEM industry initiatives for facilitating female leadership in technical fields, revealed the importance of the following aspects:

- Mindsets, role models, active learning, service-learning projects (practices of secondary and tertiary education).
- Coaching, setting quotas and the creation of inclusive culture (STEM industry initiatives).
- Leadership obstacles can also be addressed by means of support from family and friends, including the joint overcoming of similar challenges.

The authors of the present study actively participated in the "role model" practices. So-called gender trainings are traditionally organized in the Mining University in order to demonstrate that female careers in technical fields is a present reality. According to the research results, while a gender imbalance in technical fields remains, there is an emerging trend towards increased gender diversity.

To sum up, addressing the gender gap in leadership in STEM industries promotes women's participation and creates career pathways for women. Gaining insights into trends in gender parity in leadership can elicit high-level attention and know-how on the part of the scientific community as a means of elevating women's careers.

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## Appendix

### *The Representation of Women in Senior STEM Management*

**Table A1**
*Proportion of Women Scientists and Engineers in the EU and Russia*

| Country | Proportion of women, % |
|---|---|
| Lithuania | 57 |
| Bulgaria | 53 |
| Portugal | 53 |
| Russia | 52.4 |
| Denmark | 50 |
| Sweden | 49 |
| Ireland | 49 |
| Poland | 48 |
| Spain | 48 |
| Croatia | 46 |
| Cyprus | 46 |
| Slovenia | 43 |
| Belgium | 43 |
| Romania | 42 |
| The UK | 41 |
| France | 41 |
| The EU | 41 |
| Estonia | 39 |
| Czech Republic | 39 |
| Greece | 38 |
| Malta | 38 |
| The Netherlands | 38 |
| Slovakia | 38 |
| Italia | 35 |
| Austria | 34 |
| Germany | 33 |
| Finland | 29 |
| Luxemburg | 25 |
| Hungary | 25 |
| Norway | 54 |
| Iceland | 36 |
| Switzerland | 33 |

*Note.* Source: calculation by the authors based on de Kleijn et al. (2020); Rosstat (2021).

**Table A2**

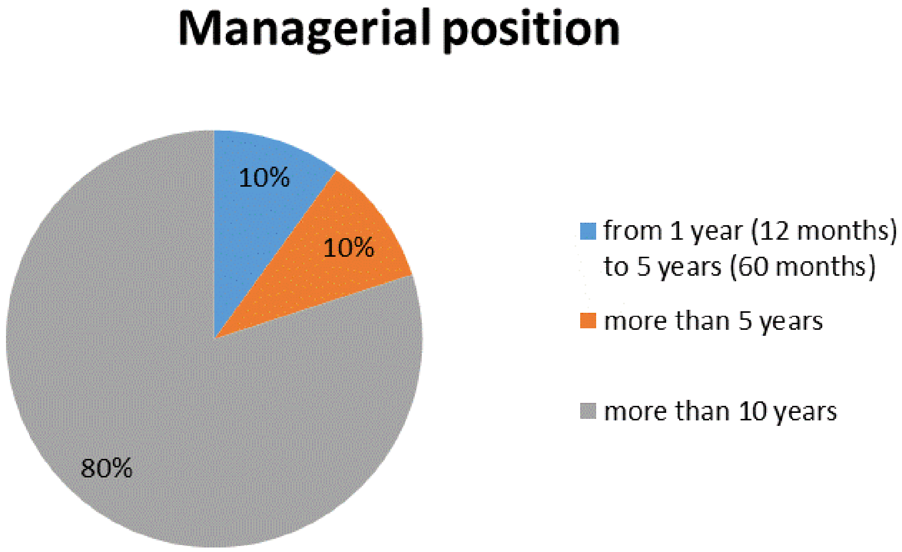
*Proportion of Women in Senior Management in STEM*

| Region | Percentage of women, % *n* = 100 |
|---|---|
| Africa | 39 |
| Southeast Asia | 38 |
| European Union | 34 |
| North America | 33 |
| Asia Pacific | 28 |

*Note.* Source: Dawson et al. (2014); Field et al. (2023).

**Figure A1**

*Period of Holding a Leadership Position*




*Note.* Source: calculation by the authors.