Integrating Gender in Digital, Industry and Space Research

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INTRODUCTION

In the ever-evolving landscape of research and innovation, the European Union (EU) has placed a strong emphasis on fostering inclusive and equitable advancements. As a critical component of the Horizon Europe 2020 framework, Cluster 4 – encompassing Digital, Industry, and Space – strives to drive Europe into a future, which is defined by cutting-edge technologies, sustainable industrial practices, and space exploration. Within this context, it is crucial to recognize the imperative of integrating the sex/gender dimension, ensuring that research endeavors are not only at the forefront of innovation but are also actively promoting and advocating for diversity and equality.

This report thoroughly examines and explores the complex relationship between gender-related factors and the main topics or themes covered by Cluster 4 in Horizon Europe 2020. At the outset, the report examines and discuss the main topics addressed by Cluster 4 and sheds light on how the EU guidelines pertaining to the integration of the gender dimension can be manifested in research projects within this Cluster. Also, drawing on interdisciplinary examples, instances where the sex/gender dimension has been successfully integrated are revealed, showing the transformative potential of inclusive research practices.

Furthermore, this report delves into strategies to strengthen the integration of the gender dimension in the design of research projects within Cluster 4. By examining policy recommendations for funding institutions, the report aims to provide actionable insights that could stimulate a significant change towards gender-responsive and equitable research practices. The Gender-In project seeks not only to evaluate the current landscape but to drive Cluster 4 toward a future where technological advancements are not only groundbreaking but also symbolic of a commitment to societal inclusivity and gender equality.

The main topics addressed by Cluster 4 in Horizon Europe 2020

The objective of Cluster 4, Digital, Industry, and Space is to establish a dominant European industry in important sectors, while ensuring that production and consumption practices adhere to the planet's limits. It also aims to generate widespread societal benefits across different European regions and contexts, encompassing various social, economic, and territorial aspects. This will build a competitive, digital, sustainable, and circular industry, ensure the supply of raw materials, and serve as a foundation for addressing and finding innovative solutions to global societal challenges (European Commission, 2023).

The main topics or areas of intervention of Cluster 4 cover manufacturing technologies, key digital technologies, emerging enabling technologies, artificial intelligence, and robotics, next generation internet, advancing computing and Big Data, low carbon and clean industries, and space including earth observation.

With regard to technologies, Cluster 4 is focused on fostering advancements and expertise in areas such as digital and other key enabling technologies that are anticipated to play a crucial role in the future. Development and progress in digital and industrial technologies, including space, formulate all sector of the economy and society. They reshape the way industry produces new products and services, and are critical to any sustainable future.

Recent crises (Covid-19, war against Ukraine) have underscored the need to strengthen Europe's industry, improve technology self-reliance, and secure supply chains, particularly to reduce dependencies on third countries. It has also emphasized the importance of addressing sustainability and inclusiveness, highlighting their importance highlighting their importance (European Commission, 2023; European Commission, 2021b).

Also, as Europe prepares for a stronger, environmental-friendly, and technologically advanced economic recovery, it must maintain a strong presence in digital, industrial, and supply chain domains, as well as safeguard its capacity to explore space. This is critical for global competitiveness, for citizens' well-being, providing top-quality services and products, and preserving European core values and socio-economic model (European Commission, 2021b). Europe not only needs technological development but also technology deployment, transforming its industries and services to adapt to a new reality. This requires investment in workforce upskilling and reskilling, enhancing adaptability, and resilience. Also, the green transition and digital transformation being in their early stages, offer opportunities for Europe to lead in technology and industry during this transition.

On that note, the vision behind Cluster 4 is that of "Europe shaping competitive, secure and trusted technologies for a European industry with global leadership in key areas, enabling production and consumption to respect the boundaries of our planet, and maximizing the benefits for all parts of society in the variety of social, economic and territorial contexts in Europe" (European Commission, 2021b, p. 68). Therefore, the topics of this Cluster highlight the diverse and interconnected nature of Cluster 4, emphasizing the importance of digitalization, technological advancements, and sustainable practices in various sectors, from industry to space exploration.

One of the expected impacts of Cluster 4 is a "human-centered and ethical development of digital and industrial technologies, through a two-way engagement in the development of technologies, empowering end-users, and workers, and supporting social innovation" (European Commission, 2021b, p. 71). It is essential to ensure that the technological advancements are inclusive and do not perpetuate gender disparities. This includes promoting gender diversity in STEM fields, addressing biases in technology and AI, and making sure that the benefits of these advancements are accessible to all genders, with a focus on eliminating gender gaps in technology-related professions and leadership roles.

EU guidelines relating to the integration of the gender dimension (sex/gender analysis) in research projects in this Cluster

The NCP for Horizon Europe, the Gendered Innovations and the Gendered Innovations 2 reports provide comprehensive EU guidelines referring to the integration of the gender dimension in research projects of Cluster 4.

An overview of the EU Guidelines on the gender dimension includes:

- A Human-Centered Paradigm:

Aim for a new human-centered paradigm using collaborative embodied AI to steer people away from unsafe jobs. Prioritize engagement and empowerment of end-users and workers, regardless of gender, age, or background (European Commission, 2021c)

- Technology with a Human-Centered Approach:

Emphasize a human-centered approach in technology development by involving workers, professionals, and relevant experts in human-centered design. Collaborate closely with technology providers and integrators (European Commission, 2021c; NCP for Horizon Europe, 2022)

- Engagement with Social Sciences and Humanities (SSH) Expertise:

Seek engagement with SSH expertise to enhance interaction design, address trustworthiness, and ensure acceptability by workers. Consider the ethical perspective of human-machine collaboration. Include gender and intersectionality dimension analysis in proposals where relevant (European Commission, 2020)

- Increase Robot Acceptance:

Contribute to increased robot acceptance by addressing both human and robotic actions. Utilize human-centric, advanced behavioral, and elaborate planning models. Adopt multidisciplinary approaches, including SSH, and involve end-users in designing solutions addressing human factors and interaction. Include gender and intersectionality dimension analysis where applicable (European Commission, 2020; NCP for Horizon Europe, 2022). Extending to AI technologies, achieving inclusivity is crucial for equitable access that caters to diverse needs/preferences. While AI has the potential to advance gender equality, it is essential to acknowledge associated risks. Research highlights gender differences in how individuals experience virtual environments (European Commission, 2020). Notably, in virtual reality (VR), women are more than twice as likely as men to experience adverse effects such as sweating, and general discomfort (Munafo, Diedrick, & Stoffregen, 2017).

- Interdisciplinary Approach to Human Factors:

Encourage an interdisciplinary approach involving technical and SSH researchers to address limitations in robot use due to human factors. Address issues such as interaction design, human factors, acceptability, non-discrimination, and potential biases. Consider gender and intersectionality aspects as appropriate (European Commission, 2021a; European Commission, 2020)

- Human-Centered Approaches for Sustainable Development:

Promote human-centered approaches and multi-stakeholder co-design activities for the sustainable development of new enabling technologies. Prioritize placing people at the forefront, generating novel transformation pathways, proposing feedback loop systems, and engaging human users in developing sociotechnical learning situations and tools (European Commission, 2020)

Examples on how the gender dimension has been integrated in interdisciplinary research relevant for this Cluster

In the intricate intersection of gender considerations and the expansive domains of Digital, Industry, and Space within Cluster 4, this research delves into the multidimensional dynamics shaping these thematic areas in Horizon Europe 2020. The exploration includes a

comprehensive analysis of the integration of the gender dimension in interdisciplinary research related to Digital, Industry, and Space, unravelling the evolving landscape through the lens of EU guidelines. The report meticulously explores various aspects, spotlighting not only the existing gender disparities but also showcasing instances of progress and initiatives that contribute to a more inclusive and equitable future. It closely examines the intricate relationship between gender and diverse topics within Cluster 4, affirming the commitment to fostering innovation that is not only cutting-edge but is also reflective of diversity, inclusivity, and gender equality.

Within this context, the selected studies shed light on the challenges and opportunities within Digital, Industry, and Space, reflecting the broader spectrum of gender-related issues in these areas. The research navigates the complex network of gender biases, highlighting disparities in digital skills, leadership gaps, and societal perceptions, providing a holistic understanding of the gender landscape within Cluster 4.

In sum, the gender dimension has been integrated into interdisciplinary research relevant to Digital, Industry and Space domains, shaping Cluster 4. There has been a growing number of studies investigating the relevance of the sex and/or gender dimension in interdisciplinary research that focuses on digital technologies, industry, and space exploration. Therefore, the research landscape has witnessed a surge in the number of studies investigating the importance of gender biases, promoting gender inclusivity, and ensuring equitable outcomes in these domains.

Digital

Gender and Digital Skills

Interdisciplinary research in the digital domain explores the gender dimension in the context of digital technologies. Research investigates gender equality in digital technologies by including a range of issues, such as potential digital skill gaps between men and women. To this end, Martínez-Cantos and Luis (2017) provide a comprehensive analysis of the Eurostat database on digital Economy and Society to examine how the gender gap in digital skills has evolved in the EU from 2007 to 2014. The study reveals that while there are minor disparities between men and women in basic and widespread digital skills, significant gaps exist in more complex and specialized tasks. Although there has been a slight reduction in these disparities over this period, the changes are minimal, indicating that the gender gaps in digital skills remain relatively stable. Furthermore, the study highlights that the gender gaps on digital skills are even more marked in highly educated individuals and younger generations. The findings indicate that digital skills gaps by gender are still significant and are likely to endure across various levels of society. On that note, it is important to note that as the demand for specialists in information and communication technologies increases, these gender disparities become more significant. Therefore, the study underscores the significance of addressing the gender gap in digital skills to ensure equal opportunities for future employment prospects.

Confirming the digital skill gaps between males and females, Klinger and Svensson (2021) examines gender in relation to the creation, design, and maintenance of algorithms and platforms that shape digital communication. The paper examines how algorithms and platforms are created, designed, and maintained, the affordances provided to users and how they govern the ways users communicate with each other, has a significant impact on digital communication. However, the authors highlight that most individuals involved in creating these technologies are men. The study adopts a socio-cultural approach to understanding technologies, departing from the concept of network media logic. Empirically, it is based on the review of a diverse body of literature from the history of programming, sociology, and computer science, as well as on 64 semi-structured expert interviews conducted with male and female programmers in 7 countries over a time period of 4 years. Results revealed a deep-rooted gender gap, which is discusses across 4 dimensions: professional culture, pervasive stereotypes, lack of role models, and typical career paths.

The findings of these studies reveal that digital skills gaps by gender are significant and are likely to endure across various levels of society. It is important to note that, in addressing these disparities, consideration of other variables beyond gender is crucial. Factors such as age, socio-economic background, and educational level play integral roles in shaping the overall landscape of digital skills. As the demand for specialists in information and communication technologies increases, it becomes increasingly crucial to comprehend and address these diverse influences.

Gender ICT disparities in Greece:

Conversely, the findings when it comes to gender and digital skills seem to be different in the Greek context. More specifically, the study of Tzafilkou, Perifanou, and Economides (2022) focuses on the development and validation of a comprehensive digital competence scale for higher education students, aiming to evaluate and enhance their digital skills in the context of transitioning to blended and remote education. The researchers created a scale covering various digital skills crucial for online learning, collaboration, social media usage, proficiency with smart and mobile devices, safety practices, and data protection. In terms of gender, the study revealed that there were no significant differences observed. In other words, the digital competence of students did not show a notable variation based on gender. The study likely examined the performance or responses of male and female students across the digital competence components and found that any differences between the two groups were not statistically significant.

Another research study by Perifanou and Economides (2020) shows that when examining gender dynamics in Science, Technology, Engineering, and Mathematics (STEM)-related education and employment in Greece, a more complex picture emerges. Despite the relatively smaller gender gap in digital skills, broader disparities in STEM-related areas, such as unemployment rates, job positions, and salaries, remain substantial. The study recommends actions and indicators to address these challenges, highlighting the need for comprehensive measures to achieve gender equality across various dimensions in STEM fields in Greece.

Greek statistics confirm the information found in most of the Greek literature, suggesting that, in terms of digital skills among the Greek population, the gender gap is relatively small.

According to Eurostat's 2021 data, 63% of women use the internet daily, slightly less than the 66% of men. In addition, 22% of Greek women possess digital skills beyond a basic level, in comparison to 25% of men. Significant gender segregation is evident in education and the job market, particularly within the Information and Communication Technology (ICT), research, and engineering sectors. In 2018, only 39% of ICT graduates were women, while the majority, 61%, were men. Within high-technology sectors, such as science and engineering, women made up a mere 21%, while men represented 79% of the workforce.

However, in 2022, the proportion of Greek female ICT specialists stands at 21%, surpassing the European Union average of 19%. Similarly, when examining fundamental digital skills, the Gender Equality Index for 2022 reveals an interesting trend: among individuals aged 25 to 29, women exhibit a higher level of digital proficiency compared to men, with 46% for women and 37% for men.

A number of initiatives and policy actions have been implemented to tackle the gender disparity in the ICT sector, enhance the digital competencies of Greek girls, women, and the younger individuals as a whole, and guarantee women's access to digital employment and skill enhancement opportunities. The specific efforts are also aligned with the goals of the EU Digital Decade, which seeks to achieve 20 million ICT professionals and make sure that 80% of the population possesses fundamental digital skills by the year 2030.

On this note, one of the best practice efforts/examples in the Greek context is the creation of the Innovation Centre for Women (Presidency of the Hellenic Government, 2022). The center is a collaborative initiative involving 20 entities, including ministries, research centers, universities, chambers, and private companies. Aligned with the United Nations Sustainable Development Goals, the Centre aims to promote sustainable development in Greece. A detailed Action Plan, outlining a series of interventions to empower Greek women in the face of the 4th Industrial Revolution, includes the following objectives: i) designing innovative strategies to attract more women to STEM fields and enhancing their participation in companies, ii) establishing a platform to foster female entrepreneurship, particularly in high-tech sectors, ensuring optimal conditions for women's involvement in the evolving professional landscape, iii) evaluating the impact of gender-based policies on women's participation and progress, iv) the European Centre for Women and Technology (ECWT) will contribute to the development of the center by sharing expertise from countries such as Norway, recognized for its promotion of women in innovation and entrepreneurship (Presidency of the Hellenic Government, 2022). The ECWT, comprising over 130 organizations and a growing number of individuals, collaborates across government, business, academia, and non-profit sectors to significantly increase the representation of girls and women in technology and ICT fields.

Gender and AI recommendations

In the realm of artificial intelligence (AI) and its intersection with gender, developers play a critical role in ensuring inclusivity and representation in digital assistants and chatbots, steering clear of reinforcing gender stereotypes such as the unwarranted feminization of these AI entities. The potential biases embedded in datasets and algorithms used in these

technologies can perpetuate existing forms of discrimination, underscoring the need for meticulous examination and rectification (NCP for Horizon Europe, 2022).

A study by Ahn, Kim, and Sung (2022) investigates how gender stereotypes impact the evaluation of artificial intelligence (AI) recommendations. The researchers hypothesize that gender stereotypes influence human-AI interactions, leading to different persuasive effects of AI recommendations for utilitarian vs hedonic products. The study's findings indicate that participants who interacted with a male AI agent gave higher competence scores than in the female AI agent condition. Conversely, participants perceived higher warmth in the female AI agent condition compared to the male AI agent condition. This shows the nuanced ways gender stereotypes can shape user attitudes toward AI. Moreover, a significant interaction effect between AI gender and product type emerged. Participants showed more positive attitudes toward AI recommendations when the male AI agent suggested a utilitarian product, whereas a hedonic product received more positive evaluation when recommended by the female AI agent. This underscores the importance of developers being attuned to the potential biases in AI systems. The study implies that both the design of the system and the nature of the recommendations it provides should be considered in tandem. Ongoing efforts are necessary to reduce biases in datasets and algorithms, ensuring the cultivation of fair and unbiased AI interactions in diverse contexts.

The workplace

Gender diversity in leadership positions

Interdisciplinary research has examined gender disparities in the industry, particularly by considering aspects such as workforce composition and leadership roles. In terms of workforce composition and their representation in leadership positions, several studies have showed that the presence of women on corporate boards has several positive organizational outcomes, such as a positive effect on firm performance.

On this note, many Member States and associated countries have developed national legal and policy frameworks, and institutional-level policies, to advance gender balance in decision-making. Despite the implementation of policies aimed at promoting gender equality, the EU indicates that there is still underrepresentation of women in business, entrepreneurship (European Commission, 2020), in academic, and in decision-making positions in universities and research European institutions (European Commission, 2021a). Achieving gender balance in decision-making requires more than an increased representation of women in these positions. The goal is to create an environment where women are present in leadership positions and have the power to shape decisions that impact gender equality. This involves a number of steps: providing gender equality training to leaders, adapting selection processes, using gender quotas, enhancing committee transparency, supporting female employees with leadership programs, and ensuring that leadership roles are recognized in evaluations, including research funding (European Commission, 2021a).

Several studies support the positive correlation between gender diversity on corporate boards and organizational outcomes. For instance, Conyon and He (2017), using annual data

from 3000 US firms from 2014 to 2017, demonstrated that the participation of women on the board has a significantly larger positive impact in high-performing firms compared to low-performing ones. Overall, the study shows that there is a positive correlation between firm performance and board gender diversity. Similarly, Arvanitis, Varouchas, and Agiomirgianakis (2022) examine the relationship between board gender diversity and financial performance in 111 Greek listed firms from 2008 to 2020. The main empirical findings suggest a positive relationship between board gender diversity and firm performance, which remains constant across different measures of gender diversity and performance. The researchers found that there is an inverted U-shaped relation between the proportion of female directors and firm performance indicating that there might be an optimal level of gender diversity. More specifically, performance is maximized when female representation in boards reaches 33%, rejecting the imposition of 25%, dictated by a new national Law on corporate governance.

Taking an additional step in previous analyses, Reguera-Alvarado, de Fuentes, and Laffarga (2017) support that from an economic but also from an ethical perspective it is increasingly important to recognize the benefits of having gender diversity on corporate boards. The context of this study is focused on the country of Spain, which became the second country to mandate gender quotas in boardrooms, despite historically low female participation in the workforce. By analyzing data from 125 non-financial firms listed on the Madrid Stock Exchange between 2005 and 2009, the study showed a significant increase of over 98% in the number of women on boards during that period. This indicates that the implementation of mandatory legislation effectively aligns with the recommendation of Spanish codes of good governance, leading to a greater representation of women on corporate boards. Moreover, the research reveals a positive correlation between the increased presence of women on the boards and improved economic results.

Gender in Career Development

Research has also focused on investigating the differences between genders in terms of career advancement. The study of Festing, Knappert, and Kornau (2015) examines gender-specific preferences in global performance management (GPM), a crucial human resource management practice that can impact the career progression of women. The research was conducted in five countries belonging to various cultural clusters: China, France, Germany, South Africa, and the United States. The results reveal significant variations in preferences between male and female managers regarding different aspects of the GPM system, such as actors' roles, evaluation methods, feedback procedures, and GPM purposes. The study confirms that female managers are generally less satisfied with existing GPM procedures, which align more with male-oriented practices. Surprisingly, these gender differences do not vary according to cultural background, but rather display the same patterns in all countries. These findings shed light on the factors that may contribute to limited career advancement for women and have implications for multinational firms striving to retain talented female employees.

Gendered Career Development within the Greek entrepreneurship landscape:

The underrepresentation of women in managerial roles is also confirmed in the context of Greek boards. This highlights a disparity in their professional advancement compared to

men (General Secretariat for Demography and Family Policy and Gender Equality, 2021). However, in Greece, the participation of women in senior management was 29% for 2022 and 37% for 2023, an increase of 9 percentage points, reaching the highest level ever recorded, since the "women in business" survey was first undertaken in 2004. Simultaneously, the proportion of firms lacking women in senior management roles experienced a significant drop, decreasing from 22% the previous year to 11%. This showcases the second-lowest level observed since 2004 (Grant Thornton Greece, 2023).

Gender, Career and Cultural Aspects

On the other hand, Woodhams, Xian, and Lupton (2015) support that women in China face distinctive pressures, challenges and barriers to their career progress emerged from patriarchal and collectivistic aspects of the Chinese cultural tradition. The authors suggest that there is limited knowledge regarding how these aspects impact on women's orientations towards their careers and whether influential Western career theories are adequate in interpreting their experience. Drawing on interviews with 20 female managers in China, the study examines how their adherence to traditional gender roles and collectivistic values shapes their career orientations. The study proposes a fourfold taxonomy, categorizing women's orientations as "conformist", "revolutionary", "soloist", or "dissident". It also suggests that Western career theories do not fully capture the collectivism dimension, and therefore do not fully account for the range of experience and orientation of Chinese female managers that are captured in the taxonomy. The authors focus on several recommendations on how management and career development policies might be developed in Chinese firms in order to address the diverse needs and preferences of female managers.

Ingrained gender stereotypes in Greek entrepreneurship:

Similar to many European countries, in Greece, there is still need to overcome barriers and combat deeply ingrained biases and stereotypes. However, in recent years, significant progress has been recorded regarding the participation of women in entrepreneurship and in senior management positions. An increasing number of companies are investing in building a modern culture that embraces diversity, encourages, and promotes female talent as a source of competitive advantage. The government has started taking steps to promote equality in terms of women's access to and retention in the labor market, training opportunities, and the balance between professional and family life (Grant Thornton Greece, 2023).

Gender and Wage Disparities

Management researchers have also shed light on gender differences in relation to wage gaps, and employee benefits. The work of Quadlin, VanHeuvelen, and Ahearn (2023) investigates the evolution of gender wage inequality over the past six decades, observing a shift from historical concentration among lower-paid and lower-educated workers to a current prominence among the highest-paid and highly-educated workers. Using Census and ACS data, coupled with unique decomposition models, the study specifically examines two higher education mechanisms: the field of study at the bachelor's level and the attainment of advanced degrees. The analysis aims to comprehend how these higher education factors contribute to the gender wage gap across various wage levels. While these mechanisms effectively account for gender wage gaps in lower and middle-income segments, their impact

diminishes among the highest-paid college workers. The study concludes that women's pursuit of education in "different" fields or obtaining "more" education through advanced degrees may not adequately address the gender wage gaps that have the greatest impact on contemporary wage inequality, especially at the top end of the distribution. The research also underscores the potential role of discriminatory pay practices at the higher levels of the wage distribution and suggests avenues for future investigation in this area.

In addition to the insights provided by Quadlin, VanHeuvelen, and Ahearn (2023) on the evolution of gender wage inequality, other management researchers have also delved into the complexities of this issue, highlighting gender differences in relation to wage gaps and employee benefits. While Quadlin and colleagues (2023) specifically focused on the shift in wage gaps across different educational levels, the study of Turner, Cross, and Murphy (2020) takes a more nuanced approach. This study explores the impact of gender, education, part-time working, and sector on earnings for men and women across various occupational groups and age groups. The findings of this study suggest a segmented labor market with primary and secondary jobs, revealing lower earnings returns for education among women compared to men. Importantly, women working in the public sector experience more favorable conditions, including a diminished earnings gap for both full-time and part-time employees, along with higher returns for education compared to women working in the private sector. The study discusses policy implications, providing a comprehensive perspective on the multifaceted nature of gender wage disparities.

Wage and work benefits gaps between genders in Greece:

As gender remuneration and employee benefits gaps persist also in Greece, Galanaki (2020) seeks to investigate the effectiveness of employee benefits for men and women in the context of the recent economic recession. Employee benefits may include private insurance services, products/goods at a discounted price, or job-related tools that may be used outside working hours. The study's objective is to highlight how the recession indirectly impacted employment conditions and gender equality in the workplace. The paper draws on the findings of three repeated extensive surveys conducted during the period of the Greek crisis from 2012 to 2015, with a total of 3,498 participants. According to employee feedback, the economic recession has led to a reduction in the availability of employee benefits. Moreover, women expressed higher level of satisfaction and usefulness in these benefits compared to men. However, women were found to be affected more than men by decreases in employee benefits allocation. Therefore, the author suggests that employers wishing to sustain their competitive advantage by fostering and promoting inclusion and diversity or those with a significant proportion of female employees, are advised to consider increasing their employee benefits portfolio.

In terms of the pay gap between genders in Greece, statistics confirm the gender disparities found in most Greek studies when it comes to renumeration and benefits. More specifically, ELSTAT data for 2018 reveal that the average annual salary of women is 20.6% lower than that of men. In fact, the proportion of women earning low wages in different sectors of the Greek economy is notably high. Additionally, women dedicate a greater amount of time to unpaid labor compared to men, a trend that persists regardless of their employment status, educational background, or whether they have children (General

Secretariat for Demography and Family Policy and Gender Equality, 2021). The gender pay gap is, in part, ascribed to employers' discriminatory behavior based on gender and, partly, to factors, such as the sector in which individuals work and the nature of their occupations.

The National Action Plan for Gender Equality (ESDIF) includes several actions and measures that support the integration of work and personal life, advance wage equality, address gender stereotypes in the workplace, encourage female entrepreneurship, and enhance women's education and training in research and technology across all educational levels. These initiatives aim to reinforce gender equality in the labor market and are anticipated to positively influence economic growth through various mechanisms (General Secretariat for Demography and Family Policy and Gender Equality, 2021).

Gender and the working class

The comprehension of gender dynamics in workplaces goes beyond leadership and boards, encompassing the broader spectrum of the working class. Exploring how gender disparities manifest in roles that constitute the backbone of industries and economies becomes imperative, particularly in recognizing the distinctive and profound challenges faced by the working class, especially women. This holistic perspective sets the stage for a closer examination of new working-class youth as a significant social group contributing to domestic economic development. In this regard, the study of Bocharov and Gavrilyuk (2021), conducted through quantitative methods, focuses on the intersection of class, gender, and age within this heterogeneous group. Grounded in the theory of working and free time balance, the research employs factor analysis to identify factors influencing the perception of work and personal-life balance. The analysis reveals three distinct labor behavior models among working-class youth: "earning", "surviving", and "adapted" types. This typology informs targeted social investment strategies for each social type, emphasizing the need for tailored municipal programs that consider territorial, sectoral, gender, and age specifics. The study underscores the importance of support and social investment programs, particularly for young women in the new working class, addressing vulnerabilities in their labor market position and economic well-being compared to men.

Shifting the focus, Smeraldo Schell and Silva (2020) shed light on how white working-class women navigate disruptions to traditional femininity amidst economic changes, providing insights into coping strategies and their implications for gender identity. More specifically, with the decline of blue-collar jobs, there is a suggestion that both men and women in this demographic face isolation and hopelessness, contributing to a culture of despair. While previous research has delved into how working-class white men cope with challenges to traditional masculinity, gender considerations for working-class women have been somewhat overlooked. Drawing from 37 in-depth interviews in a former coal-mining town in northeastern Pennsylvania, the study identifies three main strategies employed by women to cope with disruptions: embracing pain for personal growth, dispelling shame, and striving for equality, and enduring suffering. These strategies, observed in the context of relationship changes, independence from men, and general hardship, provide women with a sense of hope and worthiness. The study explores the implications of each strategy on the recreation of gender identity and considers how these strategies may either shield women from or reinforce feelings of despair.

AI in recruitment practices

International research has also revealed that AI-driven recruitment algorithms can have discriminating effects in working life (Howcroft & Rubery, 2019). In Norway, the workforce is currently experiencing a digital transformation marked by the increased use of AI and automation, which is changing the nature of employees' job roles. However, research indicates that the social consequences of AI in the workplace, particularly concerning aspects such as gender and equality, have received limited attention in the Norwegian context (Korsvik, Hulthin, & Sæbø, 2020).

In the domain of AI technology, facial recognition systems (FRSs) take center stage, especially in recruitment. Beyond their essential role in hiring processes, these systems are also utilized in payments, security, and surveillance. Their capabilities include analyzing emotions and identifying critical attributes such as age, gender, and race, positioning them as pivotal elements in transforming recruitment methodologies. Despite ongoing efforts to improve reliability, recent studies suggest that these systems can exhibit biases, notably in relation to race and gender (Howcroft & Rubery, 2019). In response, governments, companies, and academics are engaging in discussions about the ethical and legal dimensions of facial recognition. This involves not only improving accuracy and fairness but also implementing responsible deployment policies (European Commission, 2020). However, challenges persist. Studies show a 76% decrease in facial recognition accuracy when individuals wear makeup (e.g., Chen, Dantcheva, & Ross, 2015). Automatic gender recognition systems may struggle with transgender individuals, and generally, facial recognition performs better on men's faces and lighter skin tones (NCP for Horizon Europe, 2022). These issues emphasize the need for ongoing efforts to enhance fairness and accuracy in the deployment of facial recognition systems.

Employment polarization

Research also indicates that increased automation can result in economic inequalities among employees, leading to a phenomenon known as employment polarization. The "platform economy", where individuals provide services via digital platforms, has given rise to new service-related jobs. However, it has led to a decline in permanent employees, to an increase in freelance, self-employed, and casual workers, referred to as "precariat". This shift has weakened trade unionization. Insecure job conditions and the exclusion of individuals with lower educational levels and poor health from the labor market may amplify social disparities, potentially undermining both public health and gender equality (Korsvik, et al., 2020). This research might be even more relevant in the Greek context where employment is less regulated than in other countries, such as in Norway.

Gender in Technology and AI professions

There are some sectors, such as the Technology sector, which showcases strong underrepresentation of women in the field. Based on research by the World Economic Forum and the LinkedIn Economic Graph Team, a gender disparity is evident in relevant professions, especially in the AI. Specifically, 22% of AI professional globally are women, while the majority, accounting for 78% are men (World Economic Forum, 2018). The countries which have the most significant gender gaps in AI professionals are: Germany, Brazil, Mexico, and

Argentina, with Italy, Singapore and South Africa exhibiting the smallest gaps. The statistics show a persistent structural gender gap within the AI profession, which reflects the broader gender disparities observed in computer science, IT and STEM fields. In addition, there is a possibility that sectors traditionally related to women, such as healthcare, to become male-dominated due to the lack of female expertise in AI (World Economic Forum, 2018).

Gender gaps in technology related professions in Greece:

In Greece there is also a significant gender gap in the technology sector, especially within high-technology sectors, such as science and engineering. Women represent the minority in these fields, and their underrepresentation is a notable concern.

However, there has been several efforts to significantly increase the representation of girls and women in technology and ICT fields in Greece, such as the Innovation Center for Women, mentioned above.

Importantly, in the 2022 Gender Equality Index by the European Institution for Gender Equality, Greece showed progress in the "work" domain, with a score of +0.3. However, the country still falls behind the EU average in this domain and all others, ranking last in the EU with a score 15.2 points below the EU's average. Nevertheless, for 2023, Greece has made significant progress in gender equality. It now holds the 24th position out of 27 EU member states on the Gender Equality Index, with a score 12.2 points below the EU average. Notably, Greece has improved its standing since 2020 in the "work" domain, achieving an increase of +3.1 points.

Space

Space exploration

Interdisciplinary research has also integrated the gender dimension in the context of space exploration, with several researches showing that there is gender disparity in terms of support in this context. There can be many factors that may contribute to the observed gender gap in support for space exploration, such as historical gender roles. Traditional gender roles and societal expectations may influence perceptions of certain domains, including space exploration, as being more aligned with stereotypical masculine interests. If women are less likely to identify with or be encouraged to engage in these areas, it can result in lower support. Also, historically, women have been underrepresented in STEM fields, including space exploration. A lack of visibility and representation of women in these domains may contribute to a lower level of interest and support among women. In addition, women may prioritize societal needs differently than men, leading to varying levels of support for spending on space exploration. If women perceive other pressing issues that require funding, they might express lower support for allocating resources to space-related endeavors.

An interesting research (Whitman, 2020) reveals that there is a gender gap in terms of support for increased spending on space exploration, with women exhibiting lower levels of support compared to men. To address the gap gender in terms of support for increased spending on space exploration, National Aeronautics and Space Administration (NASA) has implemented targeted efforts to engage women, including naming the United States' moon return program after the twin sister of Apollo, Artemis. The study examines the underlying

attitudinal influences driving this gap and finds that the foundations of support for space spending differ between men and women. Specifically for women, knowledge, as measured by a science knowledge index and number of college science classes they have taken, is a significant predictor of increased support for spending on space exploration. The authors confirm that increasing scientific knowledge and educational opportunities among women can effectively boost their support for space initiatives.

Conversely, for men, implicit attitudes regarding science in general play a larger role in shaping their support for space spending. These findings indicate that different approached may be necessary to generate greater levels of support for space exploration among women compare to men. Tailored methods could include promoting Science, Technology, Engineering, and Math (STEM) education and providing science literacy programs to enhance women's scientific knowledge. Additionally, highlighting the contribution and achievement of women in the field of space exploration can help inspire and engage women in supporting space initiatives. Also, by understanding the attitudinal influences that affect men and women differently, NASA and other organizations can develop strategies to bridge the gender gap in support for space spending, fostering inclusivity and garnering broader support for space exploration.

Similarly, Entradas, Miller, and Peters (2013) conducted at two space outreach events in the UK aimed to understand the characteristics of the public attending of such events and measure public support space exploration. The study used attitude towards space exploration and policy preferences as indicators of public support. The sample of the study consisted of 744 respondents, primarily adults between 25 and 45 years old, with a slightly higher representation of men compared to women. Findings revealed that males appeared to be stronger supporters than females. Men had a more positive attitude towards space exploration and expressed stronger preferences for space-related policies. The authors suggest that this gender difference in support may be attributed to the composition of the sample and the nature of the outreach events. Since mixed-gender groups tend to attend these events together, it is proposed that men, who may be more actively engaged and interested in space exploration, bring along a less interested public, including women. In summary, the study suggest that men showed higher levels of support for space exploration and stronger policy preferences compared to women, based on the survey conducted at space outreach events in the UK. The researchers speculate that this difference could be due to the dynamics of mixed -gender attendance at these events, with more interested and engaged men potentially influencing the participation of less interested individuals, including women.

However, both the studies provoke implicit assumptions that frame lower support from women as a problem, reflecting underlying gender norms and biases. Implicitly treating lower support from women as a problem suggests an assumption that women should share the same level of interest as men in space exploration. It is crucial to challenge these implicit biases and recognize that diverse interests may exist within genders. On this note, instead of framing lower interest from women as an issue, it is more beneficial to celebrate and value diverse interests. Encouraging inclusivity involves acknowledging and respecting the variety of passions and pursuits across genders.

Health in space activities

Also, there is limited research on neurological differences between men and women during and after spaceflight. This is primarily due to the underrepresentation of women in the astronaut corps, which has hindered comprehensive studies. However, existing research indicates that here are general neurological and sensory differences between the sexes. These differences include variations in amygdala activity, visual processing sensitivity and discrimination, and neuronal cell death pathways. In spaceflight, sex differences may include a higher incidence of entry and space motion sickness and of postflight vestibular instability in female as opposed to male counterparts. Additionally, studies have shown that hearing thresholds differ between men and women, with female astronauts exhibiting better hearing thresholds. However, longitudinal observations suggest that age-related hearing decrements occur normally for both sexes, and no evidence of sex-related differences resulting from spaceflight has been observed. To gain a deeper understanding of the impact of sex and gender differences on neurological responses in space, it is crucial to make spaceflight more accessible and increase the number of female astronauts. Only through a more diverse astronaut population can researchers assess whether longer-duration missions elicit significantly different neurophysiological responses in men and women.

Gender and space exploration in Greece:

Finally, in the Greek context, there is a limited research and activity in incorporating gender in the field of space exploration. Greece has not been a major player in space exploration or satellite technology compared to other European countries with more established space programs.

Strengthening the integration of gender in the design of research projects in Cluster 4

Incorporating gender considerations from the beginning of a research project should be a common practice for all Clusters and research areas. Therefore, in this section, I have chosen to begin with a general list that surpass the research topics of Cluster 4. This approach allows me to establish a comprehensive overview of key principles and practices, emphasizing a holistic perspective on integrating gender analysis into research and innovation efforts. By laying out overarching recommendations initially, I aim to provide a solid foundation for understanding the broader implications and applications of gender analysis. Following this general framework, I explore into two examples within Cluster 4. The specific examples reflect the tailored application of the previously mentioned general principles, offering tangible instances of how these recommendations can be effectively employed in a focused research context.

In a general frame, to strengthen the integration of gender in the design of research projects in the Cluster of digital, industry, and space, researchers can consider the following approaches (European Institute for Gender Equality, 2019; United Nations, 2016) :

A. Formulating the aims of research:

1. Incorporate gender analysis into research objectives
2. Prioritize gender equality and inclusivity as research goals, addressing gender biases and promoting fairness

B. Raising research questions:

1. Develop research questions on gender within digital, industry, and space domains, addressing impacts, disparities, and biases.
2. Incorporate intersectionality to understand gender experiences comprehensively, including race, ethnicity, and socio-economic factors.

C. Collecting relevant statistics

1. Collect sex-disaggregated data.
2. Include gender-related variables, such as gender identity or gendered experiences, for a nuanced understanding.
3. Use qualitative methods, such as interviews for richer gender narratives in this research.

D. Integrating gender perspectives:

1. Involve diverse voices in research, such as gender non-conforming individuals
2. Integrate gender-related scholarship in literature reviews.
3. Use gender-sensitive methodologies for robust analysis.

E. Disseminate research findings:

1. Communicate gender findings clearly in publications of all audiences.
2. Collaborate with stakeholders and policymakers to integrate gender considerations into decisions and policies based on research outcomes.

Accordingly, following the above-mentioned steps, one example could be:

A. The aim of the research to be focused on gendered artificial intelligence (AI). The intention is to analyze gender disparities within the context of AI from a feminist perspective. Considering that gender stereotypes may impact the evaluation of AI in several ways, the goal of the research is to highlight the need to address gender biases and promote equitable outcomes. For instance, AI tools in employment or education may unintentionally reinforce gender biases. Through a feminist perspective, the research can reveal these subtleties and propose strategies for creating more inclusive and gender-fair AI systems.
B. The research questions revolve around the way firms ensure responsible and ethical practices in the development and deployment of AI. In other words, we need to find

out how firms establish rules and guidelines for the creation and utilization of AI. We could focus on human resource department and explore the recruitment and selection processes that employers use. On that note, our main question could be: i) do recruiters use AI when selecting competitive resumes? And if they do, do they ensure non-biased selection of candidates? and, ii) does the top 2,3 candidates' country of origin (if known) play a role in the final decision of hiring? Also, beyond recruitment, the study could examine how AI tools are used in employee performance evaluations, and decisions related to promotions or compensation. Research questions might also consider the implications of AI on diversity and inclusion within firms and its impact on talent acquisition.

C. In order to generate an in-depth understanding of this complex issue, a case study of a big, multinational firm could be used as the study's research approach. The data collection of the study may be based on conducting semi-structural interviews with the information technology (IT) personnel of the firm under study, as well as taking interviews with diversity or gender equality experts of the firm. If the firm has dedicated diversity or gender equality experts, their interviews can prove insightful. These experts can offer a strategic perspective on how AI aligns with diversity and gender goals. They can describe the policies or training initiatives in place to ensure AI fairness and gender equity. However, if such experts are unavailable, interviews with recruiters offer an alternative to examine AI's effect on gender disparities, as recruiters are directly involved in employee selection. Interviews with both IT employees and diversity experts or recruiters, will make it easier to grasp any discrepancy between the two, showcasing signals of discriminatory AI.

D. It is important to include inclusive language and terminology throughout the research process, avoiding assumptions and stereotypes related to gender. In addition, make sure to take advice from specialists in gender. However, if such specialists are not available within the firm, the researcher could consider take advice from external experts in gender studies or inclusion. Focus groups could be a good strategy to accomplish this goal. These discussions can include employees from a variety of backgrounds, experiences, and genders. To enhance the research's design and establish a comprehensive and robust conceptual framework, conducting a literature review that incorporates gender-related theories can be valuable. This literature review can inform the study's design and analysis. Additionally, it may be essential to consider the application of gender-sensitive methodologies.

E. Effectively communicate gender-related findings in conferences, reports, research publications enriched with extensive implications for scholars and practitioners. Scholarly implications can create avenues for future research, encouraging academics to thoroughly examine the intersection of AI and gender disparities. Practical implications provide guidance for practitioners within the firm, offering feasible steps to address and eliminate gender biases in AI systems. This dual focus can not only drive scholarly inquiry but also make a real-world change. Also, we need to ensure cooperation with AI experts of the company under study or individuals who create algorithms in order to make sure that gender perspectives are incorporated into the decision-making procedures, utilizing our findings as a basis for these efforts.

Also, from the industry perspective or workplace dynamics, during the past few years, many firms have introduced several strategies for diversity programs and inclusion (McKinsey & Company, 2022). However, despite recruiting equal number of male and female employees, many firms fail in executing these strategies effectively. The reason why many firms use diversity programs without achieving desired outcomes lies at the fact that these firms consider diversity more as a quantitative measure and less as a qualitative one, i.e., making female employees feel involved and included (McKinsey & Company, 2022). Lack of inclusion means that, despite having equal number of men and women as an active workforce, many times women are not encouraged to contribute or are not given the opportunity to take leading roles or top-management positions in the firm's hierarchy. On that note, even if women do manage to reach a good position in the hierarchical ladder, they do not actual receive actual power in decision-making processes.

Therefore, another example could be:

A. The examination of the effects of gender biases on decision-making processes. This involves a thorough analysis of how gender biases impact and formulate decision-making processes.

B. The research question(s) will concern all the barriers and facilitators to gender equality in specific areas. The research question(s) could be does gender play a role in determining leadership opportunities, career progression, or the ability to maintain a work-life balance?

C. For data collection, a combination of methods can be used to provide a comprehensive view of the context. The primary approach could include semi-structured interviews conducted with the head of HR or HR manager of a large firm, as well as with all female employees within the organization. This case study method enables in-depth insights into the firm's policies and practices that are related to gender equality issues. We could also conduct statistical analysis to validate the views of HR managers and female employees. This could include compensation or/and promotion rates, as well as employee turnover statistics, to provide quantitative evidence to confirm or to reject the qualitative findings.

D. It is also crucial to include inclusive language and terminology throughout the research process, avoiding potential stereotypes related to gender. It is also equally significant to engage with participants in a sensitive and respectful manner, taking into account potential power dynamics and potential biases that may affect their responses. Another consideration is to create a research environment that encourages and facilitates open dialogue and the sharing of diverse views to obtain a more thorough grasp of gender-related issues.

E. It is of paramount importance to seek partnerships with organizations or initiatives focused on gender equality to leverage their expertise and access to resources. Finally, scholars are recommended to share research findings with stakeholders and provide actionable recommendations to foster gender equality and create more inclusive work environments. Another aspect for consideration is building a community of researchers and practitioners dedicated to these goals, enabling the exchange of best practices and continuous collaboration.

By following these steps, researchers can enhance the integration of gender in the design of research projects in the Cluster of digital, industry, and space, leading to a more comprehensive understanding of the gendered dynamics and promoting greater gender equality in these domains.

Main policy recommendations for funding institutions

Incorporating gender analysis into research and innovation efforts enhances their value by contributing to excellence, creativity, and business opportunities, while simultaneously fostering fairness, social inclusion, and a more equitable distribution of benefits across diverse demographic groups. The following recommendations for funding institutions focus on research content that addresses gender considerations and fosters inclusivity and innovation within Cluster 4 (European Commission, 2021c; European Commission, 2020).

Gender Bias in Algorithms: AI and Big data should be free of bias. Funding institutions should challenge gendered technologies, that means requiring research projects that investigate and address gender bias in digital technologies, including AI and machine learning algorithms. This research can help prevent bias in decision-making processes.

Digital Accessibility for All Genders: Funding institutions should require research projects within the digital Cluster to prioritize the development of accessible digital technologies that cater to the needs and preferences of all genders. This includes projects that focus on user-friendly interfaces, cybersecurity, and data privacy with gender inclusivity in mind.

Gender-Inclusive Industry Workforce Initiatives: Recommendations should support innovative solutions to increase gender diversity within the industrial sector. This may involve supporting projects that investigate the barriers to entry for underrepresented genders in industrial fields and develop strategies to address them.

Gender-Equal Representation in Leadership: Establish policies that require organizations, including government agencies, firms, and research institutions, to strive for gender-balanced leadership at all levels, including boards of directors, executive teams, and department heads. In addition, encourage and fund research that examines the barriers preventing women from attaining leadership positions in the tech, STEM, and space sectors. Use these insights to develop strategies for increasing female representation in leadership. Require organizations to provide regular reports on their initiatives related to gender diversity and inclusion, including data regarding the representation of women in leadership positions. This transparency can drive accountability and improvement.

Upskilling and Promotion of Women in Tech Startups: Support programs that specifically fund and mentor female entrepreneurs in the tech startup ecosystem. Thus, to reduce gender gaps in entrepreneurship, apply female leadership upskilling programs (which can equip women with the skills and knowledge needed to excel in leadership roles) and encourage female-led startups to apply for grants and provide resources to help them succeed.

Space Exploration and Gender Health: Promote research within the space sector that investigates the physical and psychological well-being of individuals of different genders during space missions. This includes addressing gender-specific health concerns and needs related to long-duration space travel and exploration.

Space-Based Gender Inclusive Solutions: Fund research in space that focuses on developing gender-inclusive technologies and strategies for space missions. This may involve projects that design spacesuits and equipment suitable for individuals of diverse genders and physiological characteristics.

Conclusion

Cluster 4 of Horizon Europe 2020 presents a dynamic landscape for technological innovation within the domains of Digital, Industry, and Space. The integration of the sex/gender dimension is crucial, aligning with ethical principles and fostering diversity. Guided by EU recommendations, examples within the Cluster demonstrate the need for a multifaceted approach to address gender biases. Strengthening gender integration, as outlined in the report, ensures more comprehensive and equitable outcomes. Policy recommendations emphasize challenging bias in technology and big data, promoting digital accessibility, supporting/fostering gender-inclusive workforce initiatives, among others. Embracing these principles not only drives technological advancement but also signifies a commitment to diversity and social responsibility in Cluster 4's research and innovation endeavors.

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