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1. Introduction

Ever since the publication of the European Technology Assessment Network (ETAN) report (Osborn et al., 2000) and the highlight of the disproportionate role played by gender in the possibilities to enter, remain and succeed in academia, the European Union (EU) institutions have encouraged and taken actions to tackle gender inequalities in universities and research organizations. The main policy tool to achieve gender equality in academia os the Gender Equality Plan (GEP), defined by the European Commission as a "a set of commitments and actions that aim to promote gender equality in an organization through a process of structural change" (EIGE, 2016), to be delivered in any Research & Innovation (R&I) institutions. Specifically, a GEP should set a series of clear and concrete objectives, based on a thorough status quo assessment, and the specific measures that will be implemented to improve gender equality within R&I organizations, plus a timeline of implementation and a monitoring process via indicators.

Since the beginning of the implementation of GEPs in the EU area, progress in increasing gender equality in academia appears to be not enough: despite the rise in female participation in higher education, academic careers continue to be segregated. The proportion of female full professors in the EU rose was 26,2% in 2018, and gender gaps in governance bodies also persist albeit with some progress in recent years, since the proportion of women among heads of higher education institutions in the EU-27 was a mere 23,7% in 2019 (European Commission, 2021), depicting an improvement that still highlights a gendered subordination and segregation in academia. There has been a growing focus on gender segregation in the STEM (Science, Technology, Engineering, and Mathematics) domains. It is evident that girls and women exhibit a significantly lower likelihood of pursuing STEM studies, particularly in fields such as Physics, Engineering, and Computer Science (PECS). Furthermore, when women do enter these fields, they are considerably more likely to leave compared to their male counterparts (Hill et al., 2010).

A significant body of literature has developed evaluating systems for gender equality and diversity measures. However, despite valuable highlights of the transformative potential of GEPs and action

plans, research on these tools remains limited. More specifically, there has been no comprehensive effort to systematically examine and evaluate the current state or emerging trends in GEP provisions across EU universities. Furthermore, there is a relevant lack of attention to STEM academia, not only in the context of mapping and critically assessing common gender equality practices but also **GEPs** within regarding the examination ofSTEM institutions This research paper wants to contribute to the existing body of knowledge concerning policy tools aimed at addressing gender inequality within R&I institutions, by focusing on the assessment of GEPs, in particular in the context of STEM academia, aiming to present a comprehensive overview of the most common strategies in STEM institutions' GEPs. The study endeavors to establish a classification framework for actions within GEPs, drawing inspiration from the literature on organizational change for gender equality. This framework will facilitate the identification of the most commonly adopted practices and approaches in this domain.

The first section of the research paper will provide an overview of the origin and purpose of GEPs developed by EU institutions and relevant literature on the matter, setting then our research questions. Subsequently, the methodology employed to address them will be presented. The second and third sections of the paper will delve into the theoretical underpinnings of the categories and codes that form the foundation of the proposed framework. This will entail a comprehensive examination of the works of Teresa Rees (2001) and insights from the Center for Gender in Organizations (CGO), with particular emphasis on the research conducted by Ely and Meyerson, 2000. The fourth section is dedicated to methodology and building the classification framework for GEPs provisions, which will be subsequently applied to analyze the latest GEPs published by a selection of technical universities affiliated with the Unite! Alliance. Finally, the paper will draw conclusions based on the findings and future research.

2. Relevance of the research

2.1 STEM and Gender Equality Plans: from their introduction up to now

GEPs are a tool for promoting gender equality within R&I organizations, including universities. They are action plans that set out specific objectives and measures for promoting gender equality and addressing gender inequalities within these organizations (EIGE, 2016). As such, they typically involve a gender analysis of the R&I organization's policies and practices to identify areas where gender inequalities exist and a set of policy actions to develop strategies for addressing them. GEPs

can contribute to broader efforts to promote awareness of the importance of gender equality and demonstrate the practical steps that can be taken to achieve it.

GEPs were first introduced as a requirement for EU-funded research projects in 2014, with the adoption of the EU's Horizon 2020 program. In March 2021, the EU adopted a new framework program for research and innovation, Horizon Europe, which includes a requirement for research organizations to develop and implement GEPs in order to receive funding. The Gender Equality Strategy 2020-2025 of the EU Commission also emphasizes the importance of GEPs in promoting gender equality in research and academic organizations. The strategy sets out a number of measures to support the development and implementation of GEPs, including providing guidance and best practices, offering training and capacity-building, and promoting networking and exchange of good practices.

Specifically, Horizon Europe has defined eligibility criteria for GEPs of universities and research organizations to be funded by the program, that include recommended building blocks of provisions. Each institution has the flexibility to personalize or incorporate sections that are deemed necessary to address specific gender-related challenges within their unique context and circumstances. Even though the Horizon Europe guidance on gender equality plans (European Commission, Directorate-General for Research and Innovation, 2021) do recommend to tailor the GEP on the specific characteristics of the R&I organizations, there are no detailed guidelines on the type of actions that should be included for a STEM-focused university. The choices are left to the expertise and dedicated resources of the organization, while complying to the general mandatory requirements and recommendations. In recent years, there has been a substantial body of literature that has emerged, aiming to evaluate and categorize gender equality interventions within R&I organizations. Some of these efforts have focused on developing frameworks for assessing such interventions (Clavero and Galligan, 2021; Grzelec, 2022; Burkinshwa and White, 2017). Nonetheless, there is a notable gap in the current body of research pertaining to GEPs, encompassing both identifying prevalent current trends and evaluating and critically assessing these plans. Furthermore, the previously mentioned literature has rarely concentrated on strategies aimed at addressing gender disparities within STEM universities. This paper seeks to address both of these gaps by introducing a theory-driven framework for mapping and assessing GEPs actions, with a specific emphasis on STEM academic institutions.

3. Contribution

The research study aims to address the following research questions:

- 1. What are the predominant types of actions found within GEPs implemented by STEM universities?
- 2. What is the prevailing approach to gender equality measures reflected in GEPs employed by STEM universities?

This research not only aims at filling a gap in our understanding of GEPs within STEM universities, but also serves as a foundational stepping stone for further investigations into the state of the art of gender equality measures. Additionally, it offers insights into the effectiveness of such measures and provides guidance on implementing organizational change towards gender equality through GEPs. The paper will provide a comprehensive classification framework for GEPs actions. Drawing upon the Horizon Europe guidance as a source, I will integrate theory-based classifications derived from the most significant literature and practices encompassing: a) various types of policy actions designed to address gender equality, and b) different approaches to promoting gender equality within organizations.

4. Method

4.1 The evolution of type of policy measures to tackle gender inequality

In the commentary to the ETAN report in 2001, Teresa Rees listed three types of public policy tools to tackle gender issues in work organizations and mainstreaming gender equality in science in the EU: Equal Treatment, Positive Actions, and gender mainstreaming. *Equal Treatment* (ET) refers to all the provisions that aim at establishing equal conditions and rights for men and women, such as equal pay - first codified by art. 119 of the Treaty establishing the European Economic Community (EEC), then updated in art. 157 of Treaty on the Functioning of the European Union (TFEU) - and the subsequent adoption of a series of Directives on equal treatment on the workplace provisions. ET provisions are necessary but inadequate by themselves, because they fail to tackle forms of indirect and informal discrimination and power imbalances between men and women, at the root of gender inequality.

Positive Actions (PAs) are introduced to bridge this gap as measures that aim to address the underrepresentation or disadvantage of women. When implementing PAs, the focus shifts from ensuring equal access to fostering conditions that are more conducive to achieving equal outcomes. These actions may take the form of positive discrimination or gender preferences for the recruitment

or promotion of women, but also training and development programs, mentoring and network programs and flexible work arrangements specifically for women, to help them overcome the gendered barriers that arise from informal discrimination, biases and power relations that cannot be targeted by ET measures.

Finally, gender mainstreaming indicates a strategy or approach that seeks to ensure that gender perspectives and analysis are integrated into all aspects of policy and practice. The goal of gender mainstreaming is to promote gender equality and address gender discrimination by incorporating gender into the design, implementation, monitoring, and evaluation of policies, programs, and services. This has been rapidly adopted and promoted by the EU and other international institutions (Booth and Bennett, 2002; EIGE, 2023). EIGE outlines the gender mainstreaming cycle, which consists of four sequential stages: define, plan, act, and check. The "Define" stage serves as the initial in identifying the specific policy area that requires attention through public intervention. It often involves the collection of sex-disaggregated data and information. The "Plan" stage entails the process of developing a gender-inclusive perspective for implementing policies or programs. The "Act" stage encompasses all actions aimed at enhancing the capacity to integrate a gender equality dimension within the organization. It also involves promoting visibility of gender issues, which may include providing gender-sensitive training, among other strategies. Finally, the "Check" stage involves monitoring activities conducted to assess whether the established goals and measures are being achieved. These actions ensure ongoing evaluation and verification of progress made towards gender equality objectives.

In relation to gender mainstreaming and its actual effects, on its direct impact both on gender equality and on the effectiveness of other policy tools, some scholars have raised critiques. While gender mainstreaming has become a dominant paradigm in development policy, it has been weakened by its success. The increasing focus on gender mainstreaming as a technical exercise, rather than a political project, has led to a neglect of the structural inequalities. The challenges of implementing gender mainstreaming are also discussed, including the need for strong leadership and adequate resources, as well as the importance of building a shared understanding of the concept among policymakers and practitioners (Benschop and Verloo, 2006). The effectiveness of gender mainstreaming and PAs is argued to be contingent upon their complementarity and the need to strike a balance between them, as they operate at distinct levels.

4.2 Four frame of approaches to organizational change towards gender equality

Along with the research conducted by the Center for Gender in Organizations (CGO), Ely and Meyerson (2000) have presented a comprehensive framework that sheds light on the intersection of gender and organizational change. They have established four distinct approaches, three of which are considered conventional, while one stands out as more innovative. These four frames of approach are grounded in distinct perspectives on gender, the definition of the problem of gender inequality, and the approaches to fostering change. These frames are also associated with different types of managerial and policy interventions aimed at addressing and reducing gender inequality within organizations.

The initial approach, the "Fix the women" approach, represents a perspective in addressing gender equity that is rooted in liberal political theory. It revolves around an individualistic understanding of gender and the socialization process it entails, combined with a strong belief in meritocracy. Interventions based on this approach operate under the assumption that if women acquire the appropriate traits and skills, they will be better equipped to compete with men. Consequently, executive training programs and networking workshops have been developed to assist women in cultivating the skills and styles deemed essential for success. However, these interventions often leave existing organizational policies and structures intact. Extensive literature has scrutinized the limited and occasionally adverse effects of this approach. The opposite approach is referred to as the "Value the feminine" perspective, wherein women's distinctiveness from men, specifically their inclination towards communal behaviors, traditionally seen as incompatible with the task-oriented nature of the workplace, is recognized as a valuable and necessary management style. Interventions derived from this framework aim to empower and amplify the voices of women, embracing their unique perspectives and styles, such as awareness-raising initiatives and training programs designed to increase awareness of the disparities between women's and men's styles, skills, and viewpoints. Nevertheless, this approach has faced criticism, because it does not challenge or modify existing organizational policies and structures and carries a significant risk of perpetuating gender stereotypes, as it values women primarily based on their adherence to prescribed feminine norms (Benschop and Verloo, 2011).

The third approach represents a shift to a systemic perspective. Termed as the "Create Equal Opportunities" approach, it acknowledges that unequal opportunities for men and women within organizations stem from structural disparities in power and opportunities. The primary objective is to shatter the glass ceiling that obstructs women's advancement into top positions and the multitude of barriers to gender equality within organizations. This is pursued through extensive policy-based interventions, including PAs, anti-discrimination measures, and structural reforms. In recent years,

this approach has gained considerable prominence: while these interventions have undoubtedly contributed to improving the material circumstances of women's lives, their impact appears to be constrained, considering the sluggish progress in terms of quantitative indicators measuring women's representation in specific areas and hierarchical levels (Timmers et al., 2010).

In addition to the three conventional approaches towards gender equality and associated measures, the CGO introduced a fourth frame known as "Assess and Revise Work Culture." This approach adopts a structural perspective, but places greater emphasis on identifying the subtle and underlying factors contributing to gender inequalities, rather than solely focusing on structural and formal barriers that impede women's progress and achievement. This frame targets organizational social practices that are often perceived as gender-neutral but play a pivotal role in upholding a gendered social order where certain forms of masculinity and men predominately prevail. These practices include organizational language and symbols, networking and socialization norms, as well as informal channels of information access. To address this, the framework primarily focuses on long-term actions and tools aimed at instigating a cultural shift in the existing norms and values within organizations. This approach has demonstrated effectiveness, however implementing this framework can be particularly challenging due to the tendency to overlook the practices it seeks to address, as well as the extended time required for successful implementation (Timmers et al., 2010).

4.3 Data and methodology

Drawing upon our theoretical foundation, the framework we will develop encompasses three distinct categories. The first category is derived from the GEPs blocks. Each action or measure within these blocks will be categorized based on the type of measure, classified into three categories of ET, PA, and gender mainstreaming and relative subcategory, using the indications provided by EIGE (2016; 2023). After that, for each action it will be identified: if the issue tackled is generically speaking increasing gender equality or diversity or inclusion within the organization, of the measure addresses a specific issue related to these domains; the perspective on identity, to see if the measures focuses on gender equality, diversity or inclusion; the target group within the organization; finally, the source of expertise for implementing the action. A Qualitative Document Analysis (QDA) will then be performed on the selected data. To categorize each measure, a deductive approach will be employed, wherein the text of each GEP action will be systematically coded. Constructed codes will be utilized to associate each action with the theorybased categories established earlier. Given that each action can encompass multiple types of measures

and each measure may align with a distinct approach, the coding analysis will be conducted line by line. This approach ensures the identification of different measures even when they are contained within a single action. To discern the approach taken toward gender equality and organizational change as reflected in the actions, we employ a qualitative assessment along with corresponding color-coding:

- Fix the women: If the measure aims to address perceived deficiencies or skills gaps in women compared to men.
- Value the feminine: If the measure aims to educate and celebrate stereotypically feminine characteristics and perspectives, giving voice to women's viewpoints.
- Create Equal Opportunities: If the measure seeks to redistribute opportunities and power structures among genders.
- Assess and revise work culture: If the measure targets the transformation of sexist organizational culture, social norms, and practices.

The data on which the QDAs will be performed will be taken from the most recent GEPs from the universities affiliated with the Unite! Alliance, an alliance comprising nine European universities focused on innovation, technology, and engineering, with connections to regions of economic potential, entrepreneurship, and innovation across Europe. The partner universities in this study include Aalto University in Espoo/Helsinki, Graz University of Technology, Grenoble INP-UGA, KTH Royal Institute of Technology in Stockholm, Politecnico di Torino, Technical University of Darmstadt, Universidade de Lisboa, Universitat Politècnica de Catalunya - Barcelona Tech, and Wroclaw Tech. For each of these universities, the most recent GEP available before September 1st, 2023, will be selected. Each GEP will then undergo a comprehensive analysis within our research framework. Subsequently, the findings from each GEP analysis will be compared to identify prevailing trends and address the research questions posed in this study. In the following section, we will elaborate on the results obtained from applying this framework to the Gender Equality Plan of Politecnico di Torino for the period 2021-2024.

5. Preliminary results: Politecnico di Torino's GEP Section 1 and 3

	Gender mainstreaming			Participants
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		ET	PA	Defi ne	Plan	Act	Chec k	Categorizati on	Issue tackled	Identity perspec tive	Target group(s)	Source of expertise
Work life balance and organizati onal culture	1.1.1			X				Gender statistics	Generic	Gender equality	Organizatio n	Internal
	1.1.2					X		Gender statistics	Generic	Gender equality	Organizatio n	Internal
	1.1.3					X	X	Gender statistics Updating program	Generic	Gender equality	Organizatio n	Internal
	1.1.4 a				X			Gender analysis	Generic	Gender equality	Organizatio n	Internal
	1.1.4 b				X			Action Plan	Generic	Gender equality	Organizatio n	Internal
	1.1.5				X			Gender budgeting	Generic	Gender equality	Organizatio n	Internal
	1.1.6					X		Organizational transformation	Human capital	Gender equality	Personnel	Internal
	1.2.1			X				Gender analysis	Generic	Gender equality Inclusion	Organizatio n	Internal
	1.2.2			X				Gender analysis	Parenthood and care work	Gender equality Inclusion	Organizatio n	Internal
	1.2.3					X		Awareness- raising	Parenthood and care work	Gender equality Inclusion	Organizatio n	Internal
	1.3.1			X				Gender analysis	Parenthood and care work	Gender equality Inclusion	Organizatio n	Internal
	1.3.2					X		Awareness- raising	Parenthood and care work	Gender equality Inclusion	Personnel	Internal
	1.3.3			X				Gender analysis	Parenthood and care work	Gender equality Inclusion	Personnel	Internal
	1.3.4			X				Gender analysis	Parenthood and care work	Gender equality Inclusion	Organizatio n	Internal
	1.3.5			X				Gender analysis	Parenthood and care work	Gender equality Inclusion	Academic staff	Internal
Gender equality in recruitme nt and career progressio n	3.1.1					X		Awareness- raising	Recruitme nt	Gender equality	Academic staff (Women)	Internal
	3.1.2					X		Training	Recruitme nt	Gender equality Inclusion	Academic staff	Mixed (internal/ext ernal)
	3.1.3		X					Reserved positions	Recruitme nt	Gender equality	Academic staff (Women)	Internal
	3.1.4					X		Awareness- raising	Recruitme nt	Gender equality	Academic staff (Women)	Internal

3.2.1				X	Training	Career progressio n	Gender equality Inclusion	Organizatio n	Internal
3.2.2	X	X			Gender analysis Reserved benefit	Parenthood and care work	Gender equality	Academic staff (Women)	Internal
3.2.3		X	X		Gender analysis Organizational transformation	Career progressio n	Gender equality	Academic staff	Internal
3.2.4				X	Incentives	Career progressio n	Gender equality	Academic staff	Internal
3.2.5		X			Gender analysis	Career progressio n	Gender equality	Academic staff	Internal
3.2.6		X			Gender analysis	Career progressio n	Gender equality	TAS	Internal
3.3.1		X			Gender statistics Gender analysis	Career progressio n	Gender equality	TAS	Internal
3.3.2				X	Incentives	Career progressio n	Gender equality	Academic staff	Internal

Figure 1 - Politecnico di Torino's GEP section 1 and 3 classification according to the framework

Figure 1 presents the preliminary findings from the analysis of the 2021-2024 Edition of the GEP of Politecnico di Torino. The GEP consists of the five blocks recommended by the Horizon Europe guidance, alongside an additional section titled "Gender balance in STEM studies", tailored to address the unique challenges faced by Politecnico di Torino as a technical university. In this paper, we will only present the results of the application of the framework to the first section - Work life balance and organizational culture - and the third one - Gender equality in recruitment and career progression. In both sections, a majority of the actions fall under the gender mainstreaming umbrella. More specifically, the framework reveals that the initial section predominantly emphasizes "Define" and "Plan" actions, with fewer actions related to the latter stages of the gender mainstreaming cycle, particularly only one "Check" action is identified. Notably, there are no actions falling under the categories of ET or PA) in this section. The actions within this segment primarily target the achievement of gender equality or inclusion at a general level or concentrate on issues related to parenthood and caregiving responsibilities. Importantly, there is a notable absence of actions directed towards addressing organizational culture. Nevertheless, there is one action aimed at enhancing human capital with the objective of advancing gender equality through organizational transformation. Most of the actions are targeting the organization as a whole or the personnel. In the second section under scrutiny, which is the third section within the examined GEP, a notable presence of gender mainstreaming actions persists. However, it's worth noting that this section introduces two PAs, primarily designed to reserve access to specific positions or benefits for women as a marginalized

category. Notably, the majority of actions in this segment are categorized as "Act," with a particular focus on addressing issues related to recruitment and career progression. Conversely, there is a lack of "Check" actions in this section. Most of these actions are designed to impact either the academic staff as a whole or specifically target women academics. Additionally, two actions are directed toward the Technical-Administrative Staff. Of particular interest is one "Act" action that involves a training program, where the source of expertise is a blend of internal and external to the organization. In contrast, the remaining actions predominantly rely on internal expertise.

Regarding the approach taken towards gender equality, the prevailing approach in both sections is "Create Equal Opportunities." However, it's important to note that the first section exclusively comprises actions aligned with this approach, whereas the third section begins to exhibit a more diversified approach, particularly in the context of the "Assess and revise work culture" framework. Actions that align with the "Assess and revise work culture" approach tend to emerge primarily within the gender mainstreaming framework, especially during the "Plan" and "Act" stages. Remarkably, only one action reflecting the "Value the feminine" approach was identified in the third block, and it was part of an awareness-raising program aimed at increasing the recruitment of women within the academic staff.

6. Conclusions and future research

The objective of this research paper is to identify the most prevalent types of actions and approaches to gender equality measures and organizational change within GEPs. This analysis aims to present an up-to-date overview of the current state of the field and serve as a foundation for evaluating the comprehensiveness and effectiveness of this tool. The focus of this study is on STEM universities, which represent a distinctive case of segregated academic environments, as extensively discussed in a wide range of scholarly literature.

A comprehensive framework for classifying GEP actions is constructed, encompassing distinct action blocks, types of actions implemented within GEPs, and approaches to gender equality and organizational change as outlined in the work of the Center for Gender in Organizations. The efficacy of this framework was evaluated through an examination of two blocks taken from the most recent GEP from Politecnico di Torino, and the preliminary results of this analysis were presented.

The implementation of the framework allowed us to identify the primary types of actions employed in these two blocks, namely gender mainstreaming followed by PAs. The lack of ET actions can be attributed to the fact that such measures, which establish formal gender equality, are often mandated by national or transnational legislation rather than being institution-specific provisions. Furthermore,

the analysis of the gender mainstreaming stages uncovered discrepancies within the action blocks in terms of how thoroughly these stages were addressed. In both of them, there is a lack of "Check" actions. Horizon Europe's mandatory process-related requirements for GEPs encompass the continuous analysis and updating of data and outcomes as a general practice. However, the absence of explicit "Check" actions and tools may undermine the effectiveness of gender mainstreaming efforts, as monitoring is crucial not only at a general level but also at the level of individual projects and actions (EIGE, 2023). It is noteworthy that the initial section contains a greater number of "Define" actions. This could be attributed to the organization's need to delve deeper into their comprehension of certain segregation and discrimination mechanisms or potential actions, rather than immediately "Act".

It becomes evident that, within these two sections, Politecnico di Torino embraces a systemic perspective when it comes to addressing gender equality and instigating organizational change. The adoption of both the "Create equal opportunities" and "Assess and revise work culture" approaches is viewed as complementary in fostering enduring transformation towards gender equality within an organization. While these initial findings offer valuable insights, they are insufficient to provide a comprehensive understanding of the overall situation. However, the application of this assessment framework to the entire GEP can offer the organization a valuable perspective for evaluating the actions taken and the approach adopted. This also allows the management to determine future courses of action, identify areas that require attention, and pinpoint practices worth replicating or incorporating.

Regarding the research questions addressed in this paper, the upcoming stages of this research will encompass a comprehensive evaluation of the entire set of GEPs implemented by the Unite! Alliance partners. Additionally, there will be an exploration of the possible incorporation of a variable focused on measuring the effectiveness of the actions, such as Key Performance Indicators (KPIs). Following the completion of QDA on the collected data from all the universities, a trend analysis will be conducted as the final step in this research. This analysis aims to identify prevalent patterns in both the types of actions undertaken and the approaches employed in promoting gender equality.

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