

Gender Equality in the Welding Industry

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Abstract

Gender equality is a key component of sustainable national development, particularly in the welding industry, where gender disparities remain prominent. The welding industry is one such sector in which women continue to be underrepresented despite growing awareness and policy efforts aimed at encouraging their involvement. This paper explores gender equality in the welding industry by examining trends, challenges, and structural factors that influence women's participation. Although Malaysia has introduced various policies, educational initiatives, and workforce strategies to promote gender equity, women's involvement in welding remains low due to persistent cultural norms, stereotypes, and societal perceptions that associate welding with heavy physical work and male dominance. Technological advancements such as automation and improved safety measures have reduced the physical demands of welding and created more opportunities for women; however, systemic barriers continue to restrict their progress. These barriers include unequal access to hands-on training, limited exposure to technical tasks, a shortage of female mentors, and subtle forms of workplace discrimination that affect confidence, motivation, and career advancement. Gender equality in welding is essential not only for social fairness but also for increasing the nation's talent pool, strengthening industry competitiveness, and supporting broader economic goals. Greater female participation can enhance workforce diversity, stimulate innovation, and contribute to Malaysia's commitments to the Sustainable Development Goals (SDGs), particularly those related to quality education, decent work, and reduced inequalities. This paper highlights the need for integrated approaches—combining educational reforms, supportive institutional policies, workplace inclusivity, and societal awareness—to create equitable opportunities for all individuals and build a more resilient, future-ready technical workforce.

1. Introduction

Gender equality is an important aspect that must be given due attention in efforts to achieve balanced and sustainable social and economic development. In the context of Technical and Vocational Education and Training (TVET), the principle of gender equality has become increasingly relevant as it involves providing fair opportunities for all individuals to access quality education, training, and technical skills, regardless of gender.

According to UNESCO (2021), gender equality refers to a condition in which women and men have equal rights, responsibilities, and opportunities in all aspects of life, including education, employment, and career development.

In Malaysia, various initiatives have been implemented to empower the role of women in technical fields. Higher education institutions play a crucial role in educating and training a highly skilled workforce through various technical and vocational programmes. One of the fields given particular focus is welding, which is among the technical areas that require advanced skills as well as mastery of both theoretical and practical components.

However, although there has been an increase in women's participation in technical education, the welding field is still perceived as a male-dominated industry (ILO, 2022). This situation is influenced by traditional societal perceptions that consider jobs in this field to be more suitable for men as they involve physically demanding tasks, rugged working environments, and require physical endurance as well as strong mental resilience. Technically, welding is a process of joining metals using heat or pressure and is often associated with heavy industries such as shipbuilding, automotive manufacturing, and structural engineering.

Nevertheless, current trends indicate that more women are beginning to show interest and potential in this field. According to the World Economic Forum (2023), the shift in perceptions regarding the role of women in the technical sector has become increasingly evident, in line with growing awareness of the importance of gender equality and the encouragement provided by government and institutions for women's involvement in fields that were previously considered exclusive to men. The active participation of women in the welding industry not only reflects their courage to venture into new fields but also opens space for broader discussions on the need to create an inclusive, safe, and gender-discrimination-free learning and career environment.

It is essential to recognize that gender equality does not entail providing identical treatment to all genders but rather focuses on ensuring fairness in terms of opportunities, recognition, and support, tailored to the unique needs and challenges faced by everyone (UNESCO, 2021). Therefore, efforts to promote equality in fields such as welding require comprehensive commitment from educational institutions, industry, and society to eliminate gender stereotypes, overcome discrimination, and ensure equitable opportunities for everyone.

2. Gender Equality in Malaysia

Malaysia has demonstrated a sustained commitment to advancing gender equality through the formulation and implementation of national policies, development plans, and institutional monitoring mechanisms. Gender equality has been embedded within key national frameworks, including the Twelfth Malaysia Plan (12MP) and the Malaysia Education Blueprint (PPPM), which emphasize inclusive growth, equitable access to education, and the enhancement of women's participation in the labour market. According to the Department of Statistics Malaysia (2023), the national gender gap index improved by 0.2 percent in 2022, reflecting gradual progress in women's participation in economic activities, education, and leadership roles. These developments indicate positive structural shifts; however, disparities persist, particularly in technical and skill-based sectors.

Within the education system, the Malaysia Education Blueprint (PPPM) underscores the government's commitment to providing equitable and fair access to education for all learners, including those enrolled in technical and vocational education and training (TVET) programmes (Ministry of Education Malaysia, 2022). TVET has been widely recognized as a strategic pathway for enhancing employability, supporting economic transformation, and addressing skills mismatches. Despite this recognition, women remain underrepresented in certain TVET fields, especially those traditionally associated with physical labour and masculine identities, such as welding, machining, and heavy engineering trades.

Women's low participation in the welding industry can be attributed to deeply rooted gender-based cultural norms, social stereotypes, and societal perceptions that frame welding as physically demanding, hazardous, and unsuitable for women. These perceptions often influence educational choices from an early stage, discouraging female students from pursuing technical fields even before they enter TVET institutions. As highlighted by Mohd Noor and Abdul Wahab (2022), although vocational education and training hold significant potential to empower marginalized groups, including women, entrenched structural and cultural barriers continue to limit female participation in male-dominated occupations. Such barriers are not only social but are also reinforced through institutional practices and labour market expectations.

In addition to socio-cultural constraints, challenges within industrial sectors such as welding include the lack of women-friendly infrastructure, inadequate safety and welfare facilities, and limited institutional support systems. Many training centres and workplaces are not designed with gender inclusivity in mind, resulting in environments that may be uncomfortable or unaccommodating for female trainees and workers. Furthermore, the absence of female mentors, instructors, and role models within the welding sector reduces visibility and weakens aspirational pathways for women who may otherwise consider entering the field. This lack of representation perpetuates a cycle in which women's participation remains minimal, and their voices underrepresented in technical decision-making processes.

From an economic and policy perspective, increasing women's participation in technical fields is essential for achieving national workforce and productivity goals. The government aims to raise the women's labour force

participation rate to 59% by 2025 (Economic Planning Unit, 2021), recognizing that women's economic inclusion is a key driver of sustainable development. However, achieving this target requires more than broad policy statements; it necessitates targeted interventions that address gender-specific barriers within education, training, and employment ecosystems. In male-dominated sectors such as welding, gender-neutral policies may be insufficient to overcome historical inequalities and systemic exclusion.

Therefore, strengthening women's participation in the welding field requires progressive, evidence-based, and gender-responsive policy interventions. These include the provision of inclusive and safe training facilities, the introduction of structured female mentorship and peer-support programmes, and the integration of gender-sensitive teaching and learning approaches within TVET curricula. Additionally, promoting female role models and success stories in technical sectors can help challenge prevailing stereotypes, reshape societal perceptions, and enhance confidence and motivation among female students. A coordinated effort involving policymakers, training institutions, industry stakeholders, and communities is essential to create an enabling environment that supports women's sustained participation and advancement in the welding industry.

3. Gender Equality in the Welding Industry

Gender equality refers to a condition in which individuals of all genders are afforded equal rights, responsibilities, and opportunities across social, educational, and economic domains. Within the context of technical education and training—particularly in specialised fields such as welding technology—gender equality entails ensuring that both male and female learners have equitable access to training, resources, assessment, and career progression, free from discrimination and gender-based stereotypes (UNESCO, 2020). This includes not only formal access to programmes but also the creation of inclusive learning and working environments that support participation, retention, and advancement for all genders.

Traditionally, the welding industry has been characterised as a male-dominated field, largely due to its association with physical strength, hazardous working conditions, and demanding work environments (Gabriel & Schmitz, 2007). These perceptions have historically discouraged women from entering the profession. However, recent advancements in welding technologies—such as automation, robotic welding systems, improved ergonomic equipment, and enhanced occupational safety standards—have significantly reduced dependence on physical labour. As a result, technical competence, precision, and problem-solving skills have become more critical than physical strength, making the field increasingly accessible to individuals of all genders. Consequently, many of the traditional barriers limiting women's participation in welding can now be addressed through technological innovation and progressive workplace practices.

Promoting gender equality in the welding industry offers substantial benefits beyond social inclusion. From an industry perspective, greater female participation expands the available talent pool, helps address skills shortages, and enhances workforce competitiveness. Diverse teams have been shown to contribute to improved productivity, creativity, and innovation, particularly in technical and industrial settings (World Economic Forum, 2023). For women, participation in welding provides opportunities for economic empowerment, stable employment, and upward social mobility, while also challenging entrenched gender norms within the broader labour market.

Despite these positive developments, the implementation of gender equality in welding and other technical sectors continues to face significant challenges. According to the Human Rights Commission of Malaysia (SUHAKAM, 2024), although gender-related policies have progressed, persistent issues remain, including workplace discrimination, gender-based violence, limited access to leadership roles, and gaps in legal protections for women. In addition to overt forms of inequality, more subtle barriers—such as psychocultural attitudes, non-inclusive institutional policies, and deeply rooted social stereotypes—continue to undermine women's confidence, sense of belonging, and long-term participation in technical professions.

Furthermore, structural limitations within training institutions and industrial workplaces, such as the absence of women-friendly facilities, limited mentoring opportunities, and a lack of female role models in welding-related occupations, further reinforce gender disparities. Without targeted support mechanisms, women who enter the field may face higher attrition rates and limited career progression, perpetuating the perception of welding as an unsuitable profession for women.

Therefore, sustained and coordinated efforts are required to advance gender equality in the welding industry. These efforts should include gender-responsive policy reforms, increased public and institutional awareness, the provision of inclusive training infrastructure, and the establishment of robust support systems such as mentorship and peer networks. Integrating gender-sensitive approaches into TVET curricula, industry training standards, and workplace policies is essential to ensure that gender equality in welding technology is not only promoted in principle but realised in practice. Ultimately, such initiatives contribute to the creation of a more equitable, progressive, and inclusive educational and occupational ecosystem that benefits individuals, industries, and society.

4. Challenges for Female Workers in the Welding Industry

Although an increasing number of women are showing strong interest in venturing into technical fields, particularly welding, the reality is that they continue to face complex and layered challenges. These challenges not only affect women's participation in the field but also impact their career development and long-term retention within an industry traditionally dominated by men.

One of the key issues identified is the existence of long-standing gender stereotypes deeply rooted in societal culture. The welding industry is often associated with heavy tasks and challenging work environments and thus perceived as more suitable for men. This perception is not only prevalent among the public but is also reflected within educational institutions, including among instructors and peers. As a result, female students frequently encounter a lack of social support, emotional strain, and reduced motivational encouragement, all of which can influence their academic performance and interest in continuing their studies in this field (UNESCO, 2021).

Additionally, inequality in access to practical training and skill development remains a significant challenge. In some situations, male trainees are more frequently prioritised to handle equipment or undergo intensive workshop training compared to their female counterparts, who are often perceived as less competitive or unsuitable for technical tasks. This imbalance in opportunities makes it difficult for female trainees to fully master essential skills and undermines their confidence as they transition into the workforce (World Economic Forum, 2023).

In the job market, women often face difficulties in securing equal employment opportunities, as well as limited pathways for promotion. In industries that tend to prioritise men for technical and managerial roles, women are frequently viewed as less competent despite having qualifications and training equivalent to those of men (World Economic Forum, 2023).

Furthermore, the relatively low level of awareness and acceptance regarding women's involvement in the welding industry among peers and some management personnel creates an unsupportive environment. Skeptical attitudes towards women's capabilities may lead to subtle forms of discrimination (microaggressions), which can have long-term psychological and emotional effects (Kim & Meister, 2023). Such experiences can diminish the motivation, commitment, and resilience of female workers or students in male-dominated learning environments.

This situation demonstrates that significant gender inequality gaps still exist in technical fields, particularly within the welding industry. Therefore, collective efforts are essential in reducing negative perceptions toward women's abilities in performing welding-related tasks, and in increasing the number of women entering careers within the welding sector.

5. The Importance of Gender Equality in the Welding Industry

Gender equality is not only a fundamental human rights principle but also a critical enabler of sustainable development at both global and national levels. The empowerment of women and girls is intrinsically linked to the achievement of the Sustainable Development Goals (SDGs), particularly SDG 4 (Quality Education), SDG 5 (Gender Equality), SDG 8 (Decent Work and Economic Growth), and SDG 13 (Climate Action) (UN Women, 2020). Ensuring equal opportunities for women across education, training, and employment sectors strengthens social justice while supporting long-term economic resilience and inclusive growth.

From an economic perspective, women's participation in the labour market has been widely recognised as a key driver of productivity, innovation, and competitiveness. Empirical evidence demonstrates that gender-diverse workforces contribute positively to organisational performance and national economic growth (World Bank, 2021). In Malaysia, studies suggest that increasing women's participation in the workforce could potentially contribute more than USD 50 billion to national GDP by 2025 if institutional, structural, and socio-cultural barriers are effectively addressed (McKinsey Global Institute, 2020). This projection highlights the substantial economic costs of gender exclusion and underscores the urgency of mainstreaming gender equality across all sectors, including technical and industrial domains.

In male-dominated industries such as welding, gender inequality represents not only a social challenge but also a missed opportunity to expand the talent pool and address skills shortages. The welding industry plays a strategic role in national development, particularly in manufacturing, construction, oil and gas, and infrastructure sectors. However, persistent gender imbalances limit workforce diversification and innovation (Stamarski and Son Hing, 2015). Encouraging women's participation in welding can help mitigate labour shortages, enhance skills sustainability, and support Malaysia's broader industrial and technological advancement agendas.

Beyond economic outcomes, gender equality contributes to stronger governance and more inclusive decision-making processes. Equitable representation of women in leadership and policy-making roles improves institutional accountability, transparency, and responsiveness to diverse societal needs (UNDP, 2021). Institutions such as Parliament play a pivotal role in enacting gender-responsive legislation, allocating resources, and providing oversight to ensure that public policies address gender disparities effectively. According to SUHAKAM (2024), four key gaps continue to hinder gender equality in Malaysia: unequal economic participation and opportunities, gender-based violence, challenges related to marriage and family institutions, and the lack of

comprehensive gender-disaggregated data and analysis. These gaps have direct and indirect implications for women's participation in technical and industrial sectors, including welding.

Furthermore, limitations in policy implementation, coupled with insufficient societal awareness of gender issues, contribute to the persistence of gender gaps within the welding industry. Workplace cultures that normalise gender stereotypes, inadequate enforcement of labour protections, and limited access to career progression pathways further marginalise women in technical roles. As argued by Peralta-Jaramillo (2025), addressing such multifaceted challenges requires a holistic approach that integrates early educational interventions, organisational culture transformation, and community-level empowerment initiatives. Early exposure to technical skills, combined with gender-sensitive career guidance, can play a crucial role in reshaping perceptions and broadening participation in welding-related pathways.

Gender equality also has a direct impact on workforce quality, productivity, and social cohesion. In the welding industry and other technical fields, women's participation can reduce unemployment, enhance workforce diversity, and promote innovation through varied perspectives and problem-solving approaches (ILO, 2021). Moreover, inclusive and discrimination-free work environments enable employees to be assessed based on competence, skills, and performance rather than gender. Such environments foster professional confidence among women, support equitable career progression, and contribute to healthier organisational cultures and sustainable work-life balance for all workers.

In summary, promoting gender equality in the welding industry is not merely a matter of social equity but a strategic imperative for economic development, skills sustainability, and industrial competitiveness. A concerted effort involving policymakers, training institutions, industry stakeholders, and communities is essential to dismantle structural barriers, create inclusive workplaces, and fully harness the potential of women as skilled contributors to the welding workforce.

6. Strategies in Promoting Gender Equality in the Welding Industry

The welding industry has long been perceived as a male-dominated sector due to traditional gender roles, limited exposure among women, and workplace cultures that historically favoured male participation. However, the increasing demand for skilled welders, coupled with global commitments to inclusivity and sustainable workforce development, calls for deliberate strategies to enhance gender equality. Several key approaches can help reshape the welding profession and create a more balanced and diverse talent pipeline.

One of the most significant strategies is strengthening recruitment and outreach (Lwamba et al., 2022). Many young women are unaware that welding offers stable employment, attractive salaries, and opportunities for career progression. TVET institutions, industry associations, and employers should actively promote welding as a viable career for women by organising school outreach programmes, career fairs, and industry talks (Alias & Hasan, 2013). Using gender-neutral promotional materials and showcasing successful female welders can also help challenge stereotypes and encourage more women to consider the field.

Creating inclusive training and work environments is equally essential (Singh & Seal, 2025). Many women experience barriers during training due to inadequate facilities, such as oversized personal protective equipment (PPE), a lack of female-friendly changing areas, or teaching practices that unintentionally exclude them. Ensuring training centres provide appropriate equipment, safe learning spaces, and gender-sensitive pedagogy can significantly improve participation and retention. At the workplace, companies must enforce strict policies against gender discrimination and harassment while fostering mixed-gender teams to normalise women's presence in welding roles.

Targeted support and incentives also play a crucial role (Fertifa, 2024). Scholarships, bursaries, and industry sponsorships can reduce financial barriers for women pursuing welding education. Mentorship programmes, particularly those connecting female trainees with experienced welders, provide moral support, confidence-building, and clearer pathways towards career success (IWD2025, 2025). Similarly, bridging programmes for women returning to the workforce or transitioning from other sectors can further widen participation.

Improving workplace policies and culture is a long-term investment that benefits both employees and employers (Verma, 2024). Transparent hiring criteria, equal promotion opportunities, and regular pay equity audits are necessary to ensure women receive fair treatment. Flexible working arrangements, where operationally possible, can support workers with caregiving responsibilities—an issue that disproportionately affects women (Fertifa, 2024). Continuous gender equality training for supervisors and staff helps reinforce respectful and inclusive workplace behaviour.

Beyond entry-level participation, it is critical to ensure that women have access to career advancement and leadership opportunities (Ameen & Rizwan, 2023). Providing equal access to upskilling programmes, including advanced welding techniques or inspection certifications, enables women to strengthen their technical capabilities (IWD2025, 2025). Encouraging female welders to pursue supervisory or training roles also helps break the cycle of male-dominated leadership within the industry.

Finally, promoting gender equality requires industry-wide collaboration (Burkhard, 2022). Supporting women-in-welding networks, setting diversity targets, and participating in advocacy campaigns can help accelerate progress. In addition, collecting gender-disaggregated data on enrolment, employment, and career progression also provides valuable insights for policy improvement and targeted interventions. This will help mitigate the severity of problems related to gender equality.

Overall, promoting gender equality in the welding industry requires a holistic approach involving education, policy reform, workplace culture, and sustained collaboration. By implementing these strategies, the welding sector can become more inclusive, diverse, and resilient in meeting future workforce demands.

7. Conclusion

In conclusion, this paper emphasises that gender equality in the welding industry is not merely an aspiration but a necessity for sustainable national development. Despite notable progress in promoting gender equity across Malaysia's education and labour sectors, the representation of women in welding remains disproportionately low. This imbalance persists largely due to longstanding cultural norms, societal stereotypes, and institutional structures that continue to frame welding as a male-dominated profession. Such barriers not only restrict women's entry into welding programmes but also create psychological, emotional, and practical constraints that hinder their success and continuity in the field.

The challenges faced by women, such as limited access to hands-on training, unequal opportunities for career advancement, and subtle forms of discrimination, highlight the need for systemic transformation rather than isolated interventions. Gender microaggressions, low peer acceptance, and the absence of female mentors further weaken women's confidence and motivation. To address these issues, institutions must adopt inclusive pedagogical approaches, reinforce zero-tolerance policies against discrimination, and create learning environments that support diversity and promote equal opportunities. Providing female-friendly facilities, ensuring equitable training experiences, and actively encouraging female participation in technical activities can significantly reduce structural disadvantages.

Moreover, the welding industry stands to benefit greatly from enhanced gender equality. Women bring diversity of thought, strong problem-solving skills, and high levels of precision attributes that are invaluable in technical work. Their participation expands the industry's talent pool, supports innovation, and strengthens workforce resilience. As Malaysia aims to increase female labour participation and boost its economic competitiveness, integrating more women into skilled technical sectors such as welding becomes increasingly important. Projections from global and regional studies illustrate that empowering women economically can significantly contribute to national productivity and GDP growth.

Achieving gender equality in welding also aligns with broader commitments to the Sustainable Development Goals (SDGs), particularly those related to quality education, decent work, reduced inequalities, and responsible industry development. Therefore, a holistic, multi-stakeholder approach is essential. Government agencies must continue to reinforce gender-sensitive policies; educational institutions should embed equity and inclusion in curriculum design and training delivery; industries must invest in safe, supportive, and inclusive workplaces; and communities should be engaged in reshaping perceptions surrounding women in technical fields.

All in all, strengthening gender equality in the welding sector requires sustained commitment, strategic reforms, and cultural transformation. Overcoming the historical and structural barriers that limit women's participation is critical for building a skilled, diverse, and future-ready workforce. By ensuring equitable access, addressing discriminatory practices, and promoting inclusive practices, Malaysia can unlock the full potential of its human capital and contribute to a more just, progressive, and competitive national landscape.

8. Contributions of Literature Review on Gender Equality in Welding Industry

This article makes several important contributions to the literature on gender equality, TVET, and technical industries, particularly within the context of the welding sector. First, it provides a comprehensive and integrated overview of gender equality issues in welding by linking educational pathways, workplace practices, policy frameworks, and socio-cultural factors. This holistic perspective helps bridge the gap between gender studies and technical workforce development research.

Second, the article contributes to the TVET discourse by highlighting welding as a critical yet underexplored technical field in gender equality research. While existing studies often focus on STEM broadly, this paper brings attention to skilled trades, thereby expanding understanding of gender inclusion beyond academic and professional STEM occupations.

Third, by situating the discussion within Malaysia's national development agenda and SDG commitments, the article offers policy-relevant insights that can inform decision-makers, training institutions, and industry stakeholders. The analysis underscores how gender equality in welding is not only a social justice issue but also a strategic imperative for economic growth, skills sustainability, and workforce resilience.

Fourth, the article contributes practically by proposing actionable strategies—including inclusive training environments, mentorship programmes, institutional reforms, and awareness initiatives—that can be adopted by TVET institutions and industry players. These recommendations provide a useful foundation for programme design, policy enhancement, and future empirical investigations.

Finally, this study lays a conceptual groundwork for future research, encouraging scholars to undertake empirical, longitudinal, and intervention-based studies on women's participation in welding and other male-dominated technical fields. By articulating key challenges and opportunities, the article advances scholarly and practical conversations on building a more inclusive and future-ready technical workforce.

9. Limitations

Despite its contributions, this article has several limitations that should be acknowledged. First, this literature analysis adopts a conceptual and narrative review approach, relying primarily on secondary sources, such as policy documents, institutional reports, and prior scholarly literature (journal and proceedings). As a result, the findings are not supported by primary empirical data such as surveys, interviews, or observational studies involving female welders, trainees, instructors, or employers. This limits the ability to capture lived experiences and nuanced workplace dynamics specific to women in the welding industry.

Second, the discussion is largely contextualised within the Malaysian setting, drawing heavily on national policies, reports, and socio-cultural conditions. While this contextual focus strengthens the relevance of the article for Malaysia, it may limit the generalisability of the findings to other countries with different cultural, economic, and industrial contexts. Comparative or cross-national perspectives could have provided broader insights into how gender equality in welding is addressed globally.

Third, although the article highlights multiple structural and cultural barriers faced by women, it does not quantitatively assess the magnitude or relative impact of these barriers. The absence of gender-disaggregated industry data—such as enrolment trends, employment rates, retention levels, and career progression within welding—restricts deeper statistical analysis and evidence-based evaluation of policy effectiveness.

Finally, while the article proposes several strategies for promoting gender equality in the welding industry, it does not empirically evaluate the implementation outcomes or long-term effectiveness of these strategies. Future research incorporating longitudinal data and intervention-based studies would be valuable in assessing which initiatives yield the most sustainable impact.

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Conflict of Interest

The authors declare that they have no conflict of interest regarding the publication of this paper.

Author Contribution

*The authors confirm contribution to the paper as follows: **study conception and design:** Syaidatul Nadia Hairuddin, Lai Chee Sern; **data collection:** Syaidatul Nadia Hairuddin; **analysis and interpretation of results:** Syaidatul Nadia Hairuddin, Lai Chee Sern; **draft manuscript preparation:** Lai Chee Sern, Syaidatul Nadia Hairuddin. All authors reviewed the results and approved the final version of the manuscript*

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