

Women in India's IT Sector: Opportunities and Challenges in the Age of Industry 4.0

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Abstract—Indian IT has become a key source of employment and innovation and economic opportunities, as it presents significant opportunities to women in Industry 4.0. The combination of technological innovations, such as artificial intelligence (AI), automation, data science, and cloud computing, has transformed occupational organisation and opened new opportunities for women in high-skill, flexible, and leadership-driven jobs. Though this is encouraging, there is still a significant amount of gender inequality in wages, leadership, and technical training that do not allow women to participate and progress fully. This paper presents a secondary data analysis of NASSCOM, AISHE, and the World Economic Forum to investigate the two effects of Industry 4.0: its empowerment of women and its technological displacement dangers. The results show that, despite an increasing number of women entering STEM and IT fields, women are underrepresented in high-technology and decision-making roles. The article emphasises the importance of focusing on reskilling with precision, implementing an inclusive HR strategy, and adopting gender-sensitive digital practices to achieve equal participation. It is concluded that promoting diversity and technological literacy among women is essential to ensure the inclusive digital transformation and sustainable development of the IT industry in India.

Index Terms—Women in IT, Industry 4.0, Gender Equity, Digital Transformation, Reskilling, Economic Empowerment

I. INTRODUCTION

The Indian IT industry has been recognised as a global leader in the field, contributing to the growth of the national economy, creating jobs, and driving technological advancements. The IT industry in India is undergoing a transformative period, which is changing both the business model and workforce

dynamics with the advent of Industry 4.0, characterised by artificial intelligence (AI), automation, robotics, cloud computing, and big data. The female employees, who comprise a significant percentage of the IT workforce, are uniquely positioned to navigate this change. They have been increasingly active during the last twenty years, and now, the proportion of female talent in the IT sector has become almost 35-40 per cent in India.

However, despite these achievements, structural problems persist. Issues of gender inequality in leadership, remuneration, career mobility to work on high-profile assignments and career discontinuity due to caring continue to hinder the career of a woman. Industry 4.0 presents both opportunities and challenges: the automation process may result in a decrease in repetitive job positions traditionally occupied by women; however, the opportunities are more significant, including those in the fields of AI development, cybersecurity, and data analytics. The initiatives being embraced by some of the world's IT giants include flexible working models, reskilling, and diversity-based policies, in a move to enable the presence of women in this dynamic environment. The discussion of women's role in the Industry 4.0 revolution and their role in the IT industry is meaningful in the study of how India may leverage its population strength and, concurrently, create an inclusive and sustainable development. Women's empowerment in the technological sphere not only increases the diversity and productivity of women in their workplace but also makes India a competitive economy in the global technological environment, which is being propelled by innovation.

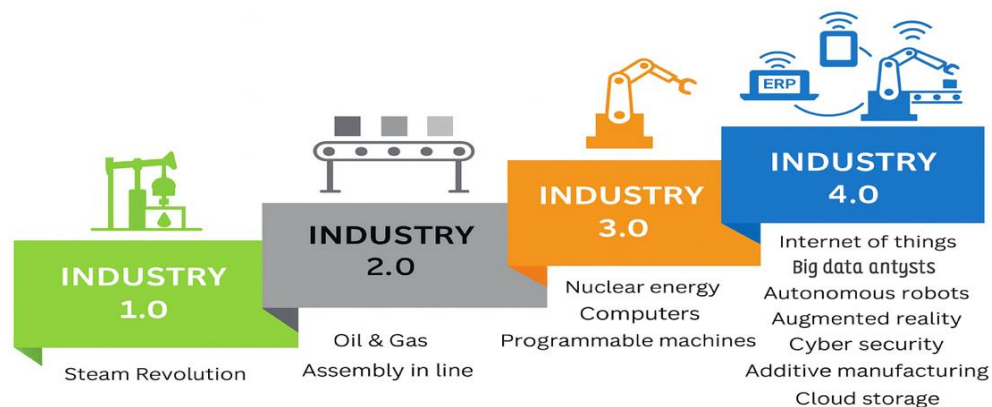
II. HISTORY AND BACKGROUND

The shift to Industry 4.0 is a continuation of the lengthy history of industrial revolutions that have changed manufacturing, technology, and human life. The Industrial Revolution (Industry 1.0), which occurred in the 18th century, employed steam power and coal as the means of mechanisation, bringing significant changes to industries, including textiles and transportation. Electricity, oil, and gas, as well as innovations such as the combustion engine, the telegraph, the telephone, and mass production systems, spurred the Second Industrial Revolution (Industry 2.0) of the late 19th century. The outcomes of such developments were the expansion of mass industries, improved communication and living standards. The Third Industrial Revolution (Industry 3.0) appeared at the end of the 20th century, associated with the emergence of digital technologies, electronics, automation, and computers, which heralded the age of information technology and

programmable systems and made biotechnology and space exploration possible.

Industry 4.0 (Fourth Industrial Revolution) or the smart manufacturing era is an extension of digital innovation to intelligent automation, real-time decision-making, and the cyber-physical intersection. It utilises technologies such as the Internet of Things (IoT), cloud computing, artificial intelligence (AI), big data analytics, and robotics to create interconnected systems that are communicative, analytical, and autonomous. Industry 4.0 is centred on cyber-physical systems (CPS), which connect the virtual and physical worlds through the use of sensors and data models, enabling more efficient and flexible production. It is also sustainable in development through the use of renewable energy sources, such as solar and wind energy, and presents new concepts like augmented reality and additive manufacturing (3D printing). These developments are indicative of a radical shift in perspective from conventional automation to intelligent, secure, and interconnected industrial ecosystems.

INDUSTRY EVOLUTION



III. CONCEPTUAL FRAMEWORK

Information Technology (IT): Information Technology can be defined as the use of computers, software, networks, and other digital tools for the processing, storage, and handling of information. Simply put, technology helps organisations and

individuals manage data and work more efficiently with the aid of digital tools.

Industry 4.0 technologies: The technologies of Industry 4.0 are part of the fourth industrial revolution, which involves the integration of digital, physical, and biological systems. These are Artificial Intelligence (AI), Internet of Things (IoT), cloud computing, big data analytics, robotics, and automation. The

technologies render the industries smarter, more efficient, and connected.

Women's Empowerment: Women's empowerment refers to the capacity to enable women with the power, confidence, and resources to make decisions and take charge of their lives. It involves social, economic, political, and educational empowerment, where women can engage fully in decision-making, earn a separate income, and gain equal opportunities in society and the workplace.

Theoretical Framework

These views have been integrated into the theoretical framework to explain the dynamics of women in India's IT sector. It connects human capital and skill set development with the use of technology, taking into account social and organisational impediments that might hinder career advancement among women. This framework can be applied to identify both opportunities (reskilling, flexible work, new technology-driven positions) and challenges (gender bias, work-life balance, job insecurity) in the age of Industry 4.0.

Human Capital Theory (Becker, 1964): This theory posits that an individual's skills, education, and training have a direct relationship to their productivity and economic outcomes. Women with high digital capabilities and a willingness to learn constantly have more opportunities for good jobs, professional growth, and higher pay in the context of IT and Industry 4.0.

Glass Ceiling Theory (Morrison et al., 1987): This theory highlights the unseen barriers that women face in achieving leadership positions. Industry 4.0 presents an opportunity in the fast-moving IT industry, and the organisational prejudice, lack of mentoring, and shortage of high-tech employment may become barriers to female empowerment.

IV. REVIEWS OF LITERATURE

Poonam Chaubey (2023) explored the patterns of women's involvement in STEM and the impacts of policy interventions in Industry 4.0. The study, which analysed the participation rate of women in STEM as one of the key variables, concluded that the participation rate increased steadily to 43.2% (2016-2021), with enrolment in science rather than engineering being higher. It finds that female empowerment in the STEM field relies on long-term policy reinforcement, digital literacy, and institutional

change. Bhattacharya (2021) examined the effects of automation and AI on the employability and adaptability of women in the IT industry. The analysis using some of the variables, such as technological uptake and skills upgradation, identified both opportunities and job displacement. It finds that achieving gender equity in digital settings entails implementing inclusive HR policies, providing lifelong reskilling opportunities, and adopting mentorship practices. D.K. Parmar & Prof. V.K. Modi (2016) examined the development of women in higher and technical education using the literacy and enrolment data. With some of the variables being the female literacy rate and government schemes, the research established that the number of women in higher education enrolled went to 43.8% in 2014, with Kerala at the forefront. It also concludes that education empowers women and recommends the need to increase scholarships, access rural areas, and policies that support women. Rekha Sethi (2019) examined gender differences in STEM, assessed women representation and analysed gender disparities in education, research and employment. Based on the data collected by DST, UGC, and CSIR, it identified the constant underrepresentation of research and leadership positions. The analysis of the paper concludes that inclusion growth in science and technology has to be supported by stronger and gender-sensitive policies as well as effective mentoring. Kumar, S. & Devi, P. (2022), studied gender inclusion challenges during the change in technology. Some of these variables were organisational culture and work-life balance, which influence the career development and happiness of women. The research found out that there is still discrimination and excessive work hours but highlighted that HR adaptation and leadership training can be used to enhance gender equity in the IT industry. Nair, A. (2023) understood how training in digital skills is linked to job security among women. It was discovered that women who were talented in high-technology incomes and acquainted with AI received higher incomes and experienced greater security using such variables as AI exposure and income level. The research suggests that gender-sensitive digital training and lifelong learning systems should be used to make sure women are guaranteed sustainable participation in Industry 4.0.

V. RESEARCH GAP

Although women have been more engaged in the IT industry in India, the literature on the specific impact of Industry 4.0 technologies on the professional opportunities and issues faced by women is insufficient. Most of the available literature focuses on general trends in employment, rather than gender-specific impacts. There is also a lack of empirical evidence on the effectiveness of diversity policies and reskilling initiatives in addressing gender inequalities. Thus, the primary focus of this work is on enhancing diversity in the IT workforce by embracing AI, Data science, and automation (Industry 4.0).

VI. OBJECTIVES

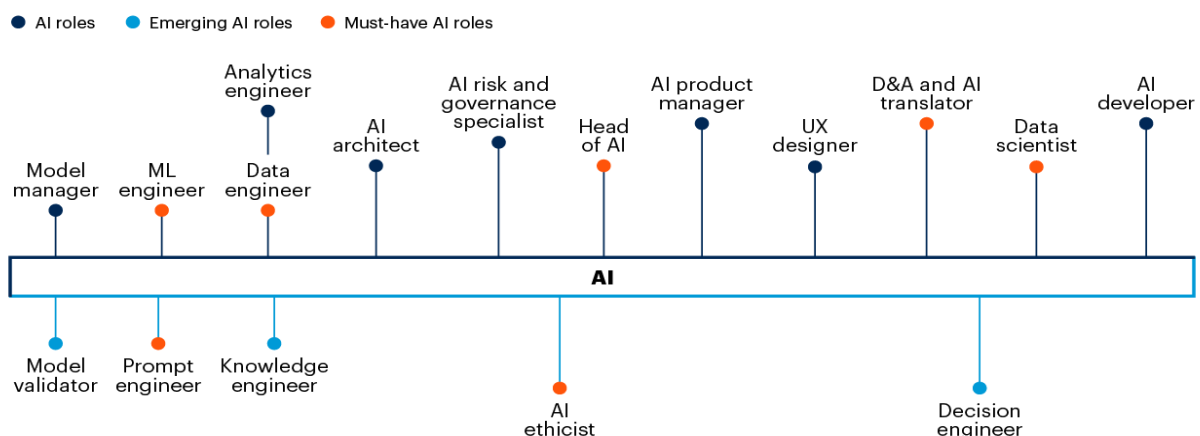
1. To examine the opportunities created by emerging technologies such as AI, data science, and automation (Industry 4.0) for women in the Indian IT sector.
2. To analyse the trends and patterns of women's participation and workforce engagement in the IT industry under the influence of technological transformation
3. To identify and evaluate the key challenges faced by women in the IT sector and assess the effectiveness of government and corporate

initiatives in promoting gender equity and empowerment.

Emerging Technologies Such as AI, Data Science, and Automation (Industry 4.0)

The most recent digital transformation is a wave of technology, known as Industry 4.0, which includes Artificial Intelligence (AI), data science, and automation, bringing about significant changes in the future of the secondary sector. Artificial intelligence enables machines to behave in a manner similar to human intelligence, resulting in more efficient and faster processes. Data science helps organisations analyse large datasets to gain actionable insights, thereby enhancing decision-making. Repetitive processes are simplified, mistakes are minimised, and productivity is improved in several areas, such as IT, industry, healthcare, and finance. These technologies are vital in the present context to ensure that the world remains competitive, innovative, and the world economy continues to grow. They also generate new workplaces, improve operational efficiency, and increase sustainability through the efficient utilisation of resources, which minimises human reliance on hazardous or monotonous work. This has made it imperative to comprehend and assimilate these technologies, as businesses and governments grow increasingly reliant on them as a key to organisational success and national development.

Roles for AI



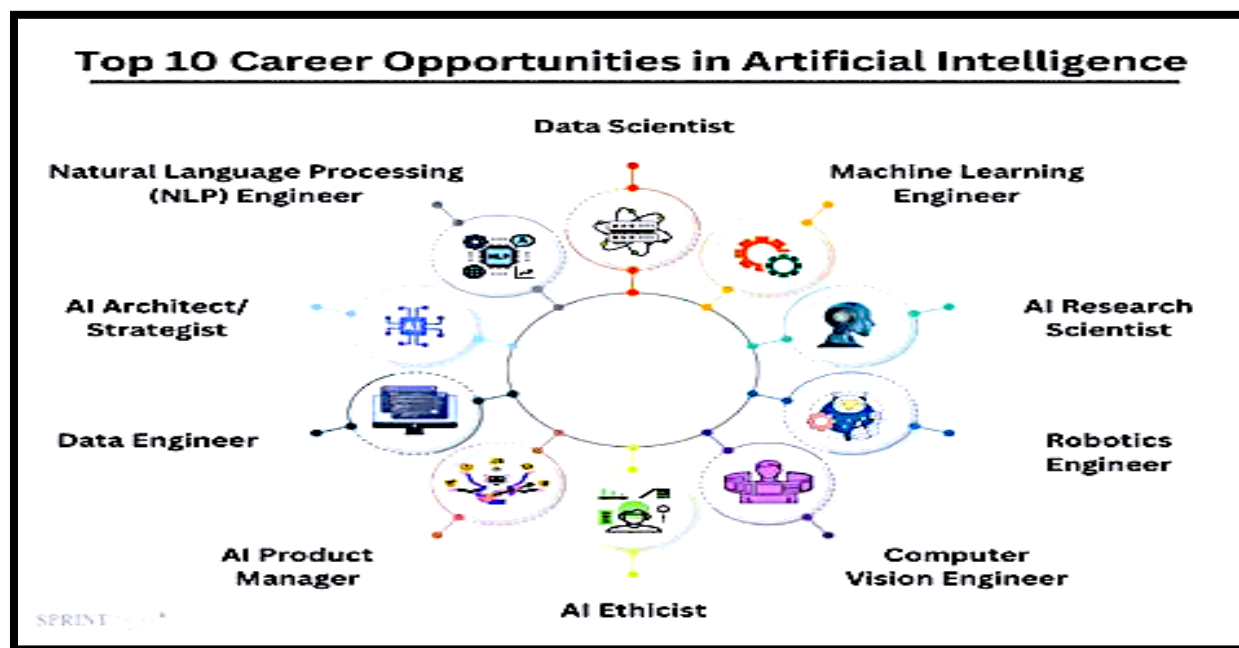
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Opportunities for Women in India's IT Sector through Industry 4.0

The Indian IT segment has long been an important source of female employment, particularly in software development/testing, customer support, business process management and so on. Due to the advent of Industry 4.0 technologies, such as Artificial

Intelligence (AI), data science, automation, cloud computing, and robotics, the scope and nature of the IT jobs undergo changes. The technologies are establishing new, skilled positions that used to be so few, and it opens up opportunities to allow women to enter analytics, cybersecurity, AI development, machine learning, and leadership roles.



Trends of Women's Participation in Technical Education

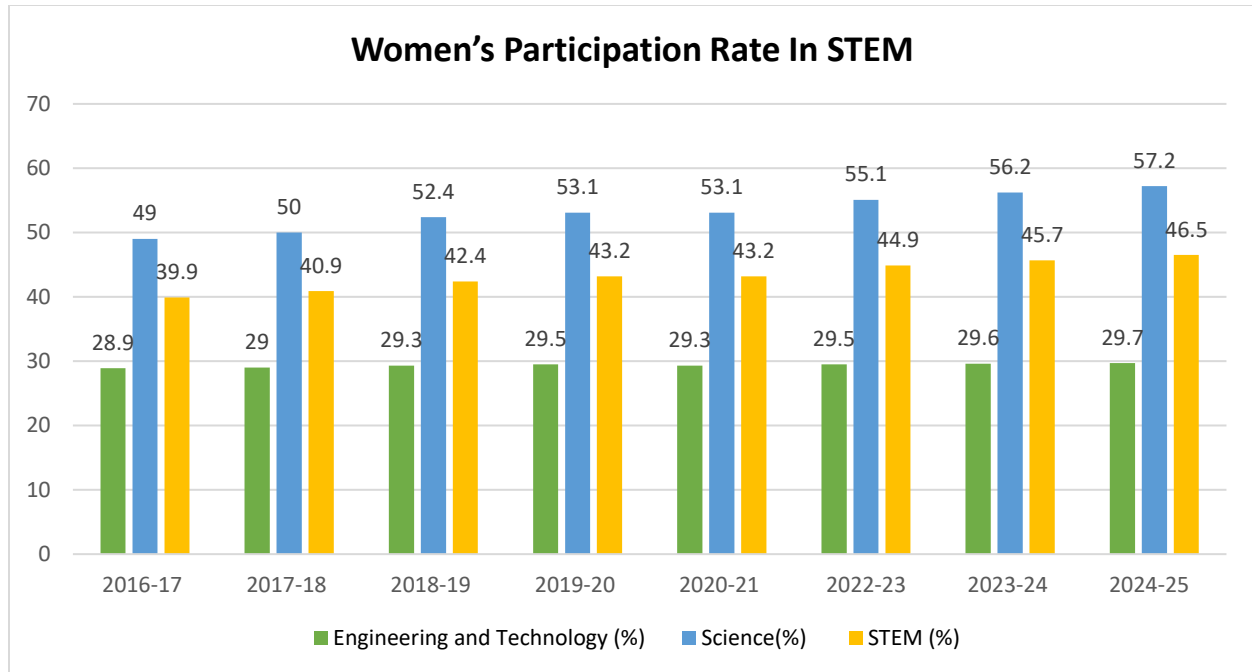
Technical education is a type of formal learning that focuses on engineering, technology, applied sciences, and related fields. Over the past few decades, there has been a steady increase in the number of women

pursuing technical education in India, driven by growing access, supportive policies, and heightened awareness of STEM careers. The following table indicates the rate of women's participation in tech-based education.

Table :1: Women's Participation Rate in STEM in Percentage

Year	Engineering and Technology in Percentage (%)	Science Percentage (%)	STEM Percentage (%)
2016-17	28.9	49.0	39.9
2017-18	29.0	50.0	40.9
2018-19	29.3	52.4	42.4
2019-20	29.5	53.1	43.2
2020-21	29.3	53.1	43.2
2022-23	29.5	55.1	44.9
2023-24	29.6	56.2	45.7
2024-25	29.7	57.2	46.5

Source : AISHE, 2016-2025



The chart indicates that the number of women joining the fields of STEM has been increasing consistently since 2016-17 to 2024-25. In the fields of engineering and technology, the enrolment of women rose gradually from 28.9 to 29.7, indicating slow progress in a male-dominated field. By comparison, the figure for women's participation in science has been steadily rising, from 49% in 2016-17 to 57.2% in 2024-25, implying that women find science more accessible and attractive. On the whole, the representation of women

in STEM increased from 39.9 to 46.5 per cent during this time, indicating an increase in gender inclusiveness in technical education. The positive trend underscores the fact that although the proportion of women joining STEM is on the increase, special interventions and facilitative policies are necessary to boost female representation in engineering and technology to achieve technical balance in all his/her technical fields.

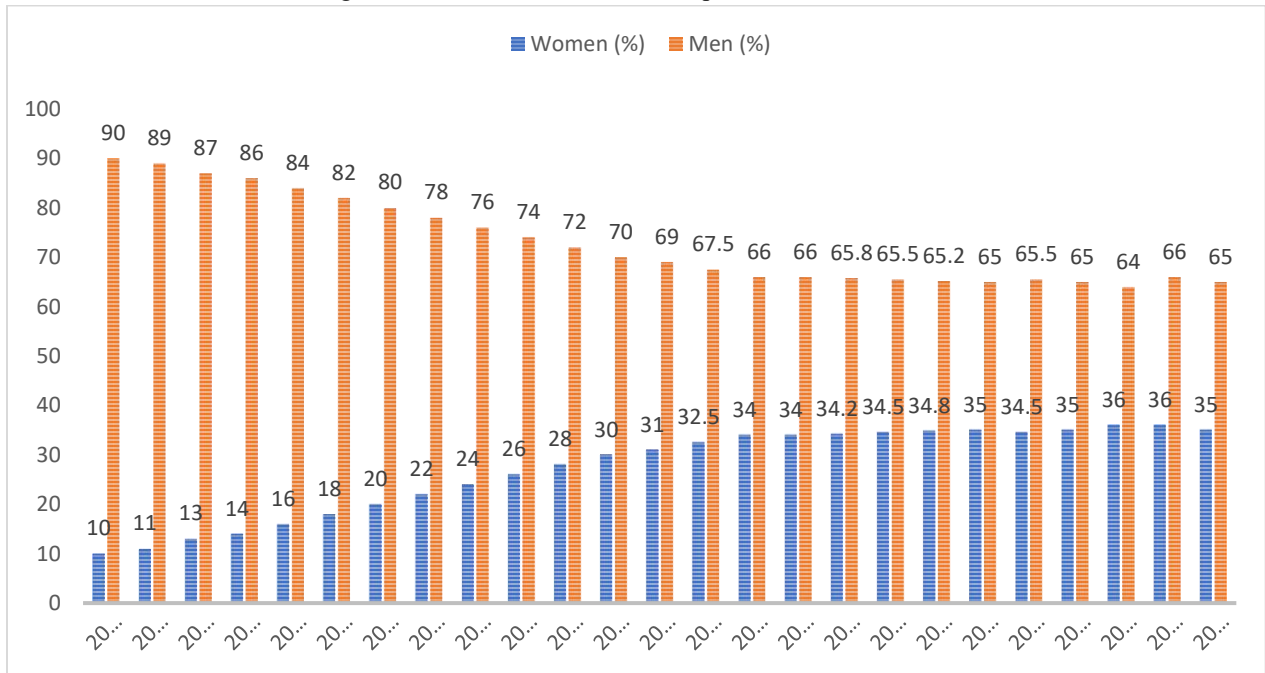
Table: 2 Women's Workforce Participation in the IT Sector (In percentage %)

Year	Women (%)	Men (%)	Total IT-BPM Workforce (millions)
2001	10	90	400
2002	11	89	410
2003	13	87	420
2004	14	86	430
2005	16	84	440
2006	18	82	450
2007	20	80	460
2008	22	78	470
2009	24	76	480
2010	26	74	490
2011	28	72	500
2012	30	70	510
2013	31	69	520
2014	32.5	67.5	530
2015	34	66	540
2016	34	66	550

2017	34.2	65.8	560
2018	34.5	65.5	570
2019	34.8	65.2	580
2020	35	66	590
2021	34.5	65.5	600
2022	35	65	610
2023	36	64	620
2024	36	66	607.7
2025	35	65	617.0

Source: NASSCOM 2001-2025 REPORT

Figure: Women's Workforce Participation in the IT Sector



Source : NASSCOM 2001-2025 REPORT

The graph indicates how the workforce participation trends of men and women in the IT industry in India are distributed between 2001 and 2025. It demonstrates that the rate of women's employment has been increasing, with a percentage increase of 10 to 35 in 2001 and 2025, respectively. However, the participation of men has been decreasing steadily, from 65 to 90 per cent, respectively. This indicates that the gender gap in the IT workforce has been significantly reduced. The period of the highest growth in women's involvement was between 2005 and 2015, when women had increased access to higher education, governmental programs encouraging women in technological fields, and the IT/ITES industries expanded in urban areas. Since 2015, the representation of women has been fairly stable,

ranging between 34% and 36%, indicating that gender inclusion activities are bearing steady fruit. The general tendency demonstrates the direction of India towards an increased gender equity on the IT field, yet, more efforts are required to reach the level of equality, in particular, in executive and highly technological fields.

Representation of Women in Emerging Technologies
Women's representation in new technologies, such as AI, data science, and cloud computing, is slowly increasing in India. These disciplines had been historically male-dominated, and women were barred from education, skills, and career advancements. Although there has been an increase in the enrollment of women in these fields in recent years, the

participation of women in these fields continues to grow, thanks to improved STEM enrollment, corporate diversity programs, and government-based reskilling initiatives. This notwithstanding, women continue to be underrepresented in the majority of

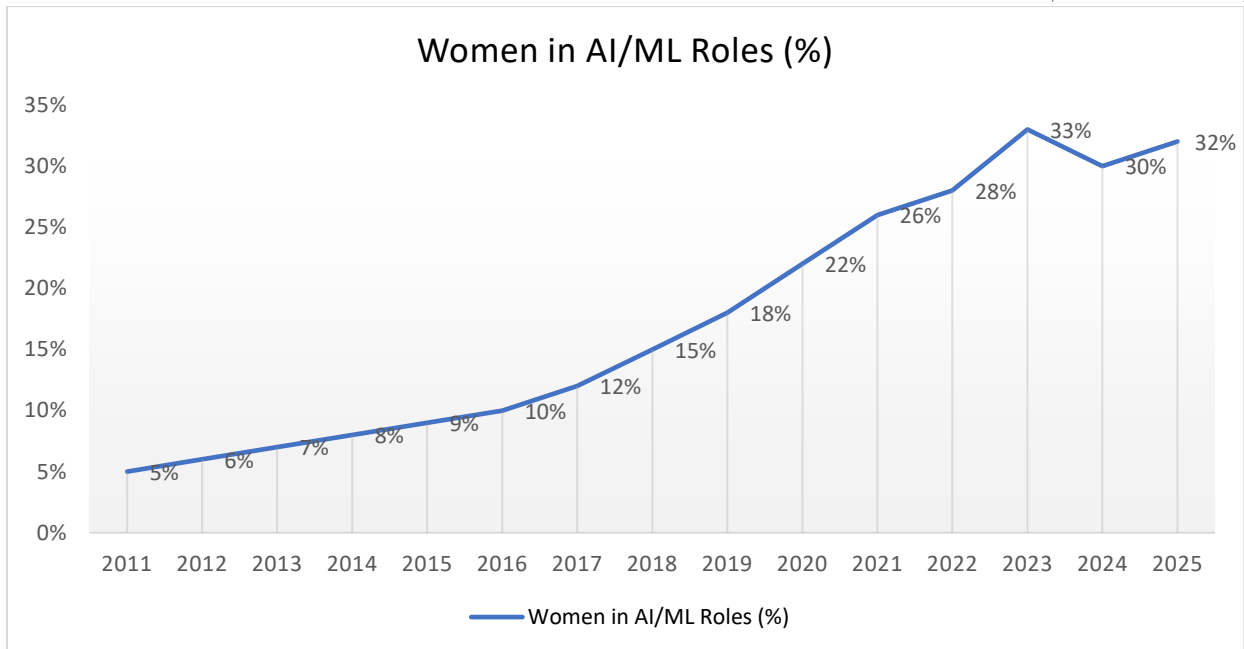
technical and leadership positions in the newer technologies. It is necessary to understand their trends of participation to be able to learn the opportunities, overcome difficulties, and advance gender equity in the technological labour market.

Table:3: Number of Women in AI/ML Roles (2011–2025)

Using the provided percentages and applying them to the estimated total workforce for each year:

Year	Women in AI/ML Roles (%)	Estimated Total Workforce	Estimated Number of Women
2011	5%	50,000	2,500
2012	6%	55,000	3,300
2013	7%	60,000	4,200
2014	8%	65,000	5,200
2015	9%	70,000	6,300
2016	10%	75,000	7,500
2017	12%	80,000	9,600
2018	15%	85,000	12,750
2019	18%	90,000	16,200
2020	22%	100,000	22,000
2021	26%	150,000	39,000
2022	28%	200,000	56,000
2023	33%	329,400	108,300
2024	30%	500,000	150,000
2025	32%	1,000,000	320,000

Source: World Economic Forum 2001-2024 (NASSCOM-2025)



The graph illustrates the projected increase in the number of women in Artificial Intelligence (AI) and Machine Learning (ML) positions in India between 2011 and 2025. The statistics are on an upward trend,

and the number of women representing the country in 2025 is projected to rise to 32 per cent, compared to 5 per cent in 2011. The increase is slow from 2011 to 2016, and then increases more sharply from 2017

onwards, highlighting the positive aspects of digitally literate policies, reskilling, and firm-level policy diversity. The largest growth is expected to occur between 2018 and 2023, when the percentage is projected to be 33, indicating an increasing number of women entering areas of high skill and technology. Even though the participation margin declines slightly (to 30 per cent in 2024), the figure returns to 32 per cent in 2025, indicating the continuity of women's participation in AI/ML professions. On the whole, the trend demonstrates a positive movement towards gender exclusion in new technologies, encouraged by the support of the policy, access to education, and the transformation of working relations.

1. Artificial Intelligence and Machine Learning: They are changing IT operation through artificial intelligence (AI) and need expertise in algorithm design, data modelling and predictive analytics. The STEM women can use these opportunities to take up high-value technical jobs.
2. Data Science and Big Data Analytics: The data deluge in the IT and business industries has created the need of data analysts, data engineers, and business intelligence specialists. Women in IT can leverage on such opportunities to focus on data-driven decision-making, which makes them more visible and earn more in their careers.
3. Automation and Robotics: Although automation could eliminate certain routine IT occupations, it also generates processes design, robotic process automation (RPA) implementation, and AI supervision jobs. By learning about these technologies, women can be able to become leaders and managers.
4. Remote Work and Digital Inclusion Industry 4.0 technologies have made it possible to have flexible and remote work, which has brought on board more women, particularly those who have family responsibilities, and be able to work effectively in the IT careers.

Industry 4.0 is not only redefining IT roles but also creating inclusive opportunities for women in India. With adequate reskilling, mentorship, and organisational support, women can move into high-value, decision-making, and leadership roles, enhancing both their economic empowerment and the competitiveness of the IT sector.

Challenges Faced by Women in India's IT Sector

Despite increasing participation in the IT sector, women in India continue to face multiple challenges that limit their career growth and professional advancement. These challenges include:

1. Gender Bias and Workplace Discrimination: Women usually face unspoken or overt prejudices during recruitment, promotions and project assignments. Women and their technical skills may be stereotyped, to which can restrict their participation in high-visibility projects and other leadership positions.
2. Pay Gaps: Women often receive lower pay than their male colleagues in the same positions, even when they have the same qualifications and experience. The wage disparity is steeper at the higher ranks, and it has a lasting impact on long-term economic empowerment.
3. Limited Access to Leadership Roles: The female gender is underrepresented in management and executive ranks. These barriers, including structural and cultural demands, as well as a lack of mentorship opportunities, limit their advancement to decision-making positions.
4. Job Risks due to Automation and Industry 4.0: As automation, AI, and robotics are adopted, there is a risk that routine IT positions traditionally held by women (e.g., testing, back-office processing) may be supplanted. Women can be insecure in their jobs without reskilling and upskilling.
5. Work-Life Balance and Career Breaks: Women often struggle to juggle their professional and family lives. Childcare or other household duties, such as career breaks, may decrease the opportunity to continue and advance in the career.

Support for Women in the IT Sector through Policies and Programs

1. Reskilling and Upskilling Programs
 - Emerging technologies, such as AI, data science, cloud computing, and cybersecurity, are among the training being offered by companies.
 - These programs are designed to help women stay current, upgrade their skills, and keep abreast of the evolving IT landscape, thereby securing high-value technical positions.
2. Diversity and Inclusion Initiatives

- Lots of IT companies have policies that promote gender diversity in hiring, promotions, and leadership.
- Mentoring, women's leader networks, and inclusive cultures promote career development and professionalism.
- 3. Flexible Work Arrangements
 - Flexible working hours, remote working, and hybrid working models enable women to juggle work, family, and personal life.
 - These arrangements enhance retention, decrease career breaks and increase involvement in high-impact projects.
- 4. Support for Leadership Development
 - Women can be empowered to assume senior roles through programs that concentrate on management and leadership training.
 - This involves workshops, coaching, and sponsorships for women who aspire to executive positions.
- 5. Government Schemes and Incentives
 - Efforts such as Skill India, digital literacy, and startup support programmes are aimed at encouraging women to take up tech jobs or start their own enterprises.
 - The programs also provide financial support, offer training, and networking opportunities to enhance women's involvement in the IT world.

VII. FINDINGS AND SUGGESTIONS

Findings

1. As per secondary data, participation of women in India's IT sector has increased steadily from about 10% in 2001 to around 35% in 2025, showing significant progress in gender inclusion.
2. Women's enrolment in STEM education has grown from 39.9% in 2016–17 to 46.5% in 2024–25, reflecting improved access to technical fields.
3. Industry 4.0 technologies, such as Artificial Intelligence (AI), Data Science, Automation, and Cloud Computing, have created new career opportunities for women in high-value and technical roles.
4. Flexible work arrangements and remote job options have enabled more women to maintain a better work–life balance and remain active in the IT workforce.

5. Gender bias, wage disparities, and limited leadership opportunities continue to restrict women's advancement in the IT industry.
6. A noticeable skills gap persists among women employees due to limited access to reskilling and upskilling programs in emerging technologies.
7. Routine and repetitive IT roles traditionally occupied by women are increasingly being replaced by automation, leading to job insecurity.
8. Government and corporate initiatives, such as Skill India, Digital Literacy Missions, and Diversity & Inclusion programs, have improved women's representation but require stronger implementation.

Suggestions

1. Strengthen reskilling and upskilling programs focusing on AI, Data Science, Automation, and Cybersecurity to enhance women's employability in advanced IT roles.
2. Implement strong diversity and inclusion policies to ensure equal pay, fair promotions, and unbiased recruitment processes.
3. Develop mentorship and leadership programs to support women's career growth and encourage their participation in managerial and decision-making positions.
4. Promote flexible and hybrid work models to help women balance professional responsibilities with family and personal commitments.
5. Enhance collaboration between government and industry to create gender-sensitive digital literacy and training programs.
6. Conduct regular pay and equity audits in organisations to identify and eliminate wage gaps and discriminatory practices.
7. Organise awareness and gender-sensitisation programs to promote inclusive and respectful workplace cultures.
8. Encourage women's entrepreneurship in the technology sector by providing financial incentives, incubation support, and startup training.

VIII. CONCLUSION

The Indian IT market is at the forefront of digital business, offering women unparalleled opportunities

as Industry 4.0 evolves. The combination of AI, automation, and data analytics has facilitated more women to be involved, flexible and innovative in the workplace. Nevertheless, the enduring gender inequality in wages, positions, and representation highlights the necessity of systematic changes. This requires a multi-stakeholder strategy, i.e., the combination of organisational changes, government intervention, and lifelong skill development, to achieve true gender equity. Inclusivity in digital transformation and empowerment of women through technology and education can not only improve the IT industry in India, but also the sustainable and equitable global digital economic development.

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