

Smart Technologies and Women Entrepreneurs: Building Human –Centric Businesses under Industry 5.0

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Abstract

Industry 5.0 emphasizes a human-centric, sustainable, and resilient approach to industrial development, creating new opportunities for women entrepreneurs to integrate smart technologies into business operations while preserving human values. This paper explores how technologies such as artificial intelligence (AI), the Internet of Things (IoT), cloud computing, big data analytics, blockchain, and digital platforms enable women-led enterprises to improve innovation, productivity, customer engagement, and decision-making. The study adopts a conceptual and analytical approach based on recent literature, policy reports, and industry evidence to examine the role of smart technologies in promoting inclusive entrepreneurship. The findings indicate that technology adoption enhances business resilience, operational efficiency, financial inclusion, and market competitiveness while supporting sustainability and social responsibility. The challenges including digital skill gaps, cybersecurity concerns, financial constraints, and unequal access to advanced technologies continue to limit widespread adoption. The paper concludes that supportive policies, digital capacity building, and innovation ecosystems are essential for empowering women entrepreneurs under the Industry 5.0 paradigm.

Keywords: *Industry 5.0, Women Entrepreneurs, Smart Technologies, Human-Centric Business, Artificial Intelligence (AI), Sustainable Entrepreneurship, Digital Innovation*

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1. Introduction

The emergence of Industry 5.0 represents a paradigm shift from technology-driven industrial transformation toward a human-centric, sustainable, and resilient model of economic development. Unlike Industry 4.0, which primarily emphasized automation and digitalization, Industry 5.0 advocates collaboration between intelligent technologies and human creativity to generate inclusive value for businesses and society (European Commission, 2024). Women entrepreneurs have become significant contributors to this transformation by establishing innovative enterprises that combine technological advancement with social responsibility. The rapid adoption of artificial intelligence (AI), Internet of Things (IoT), cloud computing, blockchain, big data analytics, and digital commerce platforms has enabled women-led businesses to improve operational efficiency, customer engagement, and strategic decision-making (Gaikwad, 2024). Smart technologies also facilitate greater access to markets, financial

services, and entrepreneurial networks, reducing many traditional barriers faced by women-owned enterprises. As governments and industries increasingly prioritize sustainable development and digital inclusion, women entrepreneurs are leveraging these technologies to create resilient business models capable of adapting to changing market environments. Consequently, understanding the intersection of smart technologies, women entrepreneurship, and Industry 5.0 has become an important area of contemporary research, policy formulation, and business innovation (European Commission, 2024). Artificial intelligence and other smart technologies have fundamentally transformed entrepreneurial ecosystems by enabling data-driven decision-making, predictive analytics, process automation, and personalized customer experiences. These technological capabilities allow women entrepreneurs to overcome resource limitations, improve productivity, and compete effectively in local and global markets. Digital platforms, fintech applications, cloud-based enterprise solutions, and intelligent supply chain systems have particularly enhanced business accessibility for women-owned micro, small, and medium enterprises (Bhanot & Gaikwad, 2025). Moreover, the Industry 5.0 framework recognizes that technological innovation should complement human intelligence rather than replace it, thereby encouraging creativity, empathy, ethical governance, and employee well-being within entrepreneurial organizations. Practical evidence from emerging economies indicates that women-led enterprises adopting digital technologies demonstrate higher innovation capacity, stronger customer relationships, and greater resilience during economic disruptions. The disparities in digital literacy, technological infrastructure, financial accessibility, and cybersecurity preparedness continue to restrict the full realization of these benefits. Human-centric entrepreneurship encourages businesses to balance profitability with environmental stewardship and social responsibility while creating long-term stakeholder value. AI-powered market intelligence, customer relationship management systems, digital marketing automation, and blockchain-enabled transparency support women entrepreneurs in enhancing business credibility and operational sustainability. Despite remarkable technological progress, women entrepreneurs continue to encounter numerous challenges associated with digital transformation, including limited access to advanced technologies, inadequate financial resources, algorithmic bias, cybersecurity threats, regulatory uncertainty, and insufficient technical competencies. These barriers may hinder technology adoption and reduce the ability of women-owned enterprises to realize the full potential of Industry 5.0. The ethical concerns relating to artificial intelligence, data privacy, responsible innovation, and digital governance require greater attention to ensure that technological advancement remains inclusive and equitable (Gaikwad & Bhattacharya, 2024). The businesses, policymakers, higher educational institutions, and technology providers must work collectively to strengthen entrepreneurial resilience through capacity building, digital infrastructure, innovation financing, and responsible technology governance.

2. Background of Study

The emergence of Industry 5.0 represents a fundamental transformation in industrial development by shifting the focus from technology-driven production to human-centric, sustainable, and resilient innovation (United Nations Trade and Development [UNCTAD], 2025). Unlike Industry 4.0, which primarily emphasized automation and cyber-physical systems, Industry 5.0 promotes collaboration between intelligent technologies and human capabilities to generate economic, environmental, and social value. Smart technologies, including artificial intelligence (AI), Internet of Things (IoT), cloud computing, blockchain, robotics, and big data analytics, have become strategic enablers of this transformation by improving operational efficiency, decision-making, innovation, and customer engagement (UNCTAD, 2025). Women entrepreneurship has become an important contributor to economic growth, employment generation, innovation, and financial inclusion worldwide. The rapid

diffusion of digital technologies has reduced many traditional barriers that historically limited women's participation in entrepreneurial activities, including restricted market access, limited financial resources, and geographical constraints. According to the United Nations Development Programme (UNDP, 2024), digital technologies enable women entrepreneurs to improve productivity through AI-powered business intelligence, digital marketing automation, fintech solutions, cloud-based enterprise systems, and data-driven customer relationship management. These technological capabilities strengthen business competitiveness while facilitating participation in national and international value chains. The women entrepreneurs continue to encounter challenges such as inadequate digital skills, unequal access to advanced technologies, cybersecurity risks, financing constraints, and persistent gender disparities in innovation ecosystems (UNDP, 2024). Addressing these challenges is essential for ensuring equitable participation in the Industry 5.0 economy.

India has witnessed remarkable progress in promoting technology-enabled entrepreneurship through initiatives such as Digital India, Startup India, Stand-Up India, and several MSME digital transformation programmes. These initiatives have significantly enhanced digital infrastructure, financial inclusion, innovation support, and entrepreneurial opportunities for women-led enterprises across manufacturing, agriculture, healthcare, education, retail, and service sectors. The Global Entrepreneurship Monitor (GEM, 2025) reports that women entrepreneurs are increasingly adopting AI applications, digital payment systems, e-commerce platforms, cloud computing, and social commerce technologies to enhance operational efficiency and market expansion. The Industry 5.0 philosophy encourages entrepreneurs to balance technological advancement with employee well-being, customer satisfaction, ethical leadership, and environmental sustainability. Such integration enables women-owned enterprises to create resilient organizations capable of generating long-term economic and social value while contributing to sustainable development goals (GEM, 2025). Limited digital literacy, insufficient access to investment capital, weak technological infrastructure, concerns regarding artificial intelligence governance, cybersecurity vulnerabilities, and unequal participation in innovation networks restrict the ability of many women-led enterprises to fully benefit from Industry 5.0. The Organisation for Economic Co-operation and Development (OECD, 2024) emphasizes that strengthening digital competencies, improving access to technology financing, promoting responsible AI practices, and establishing collaborative innovation ecosystems are essential for fostering inclusive entrepreneurial growth.

3. Rationale of Study

The transition from Industry 4.0 to Industry 5.0 has shifted the focus of business transformation from technology-centric automation to human-centric innovation, sustainability, and resilience. While existing research has extensively examined the technological dimensions of digital transformation, comparatively limited attention has been paid to how smart technologies empower women entrepreneurs to build businesses that balance economic performance with social responsibility and human well-being. The growing adoption of artificial intelligence (AI), Internet of Things (IoT), cloud computing, blockchain, and data analytics presents significant opportunities for women-owned enterprises to enhance innovation, improve operational efficiency, and strengthen customer engagement (Choudhury, et al., 2024). The empirical and conceptual evidence integrating women entrepreneurship with the principles of Industry 5.0 remains fragmented, thereby creating a need for comprehensive academic investigation (United Nations Industrial Development Organization [UNIDO], 2024). The World Bank (2024) highlights that closing the gender gap in technology access and entrepreneurship is essential for accelerating inclusive economic growth, innovation, and employment generation. The examining how

smart technologies can address these structural barriers under the Industry 5.0 framework is both timely and relevant for developing evidence-based strategies that promote inclusive entrepreneurial development (World Bank, 2024). Achieving the United Nations Sustainable Development Goals (SDGs) particularly SDG 5 (Gender Equality), SDG 8 (Decent Work and Economic Growth), SDG 9 (Industry, Innovation and Infrastructure), and SDG 10 (Reduced Inequalities) requires greater participation of women in technology-enabled entrepreneurship. Human-centric businesses are expected to integrate technological innovation with ethical governance, employee well-being, environmental sustainability, and stakeholder value creation.

4. Objectives of Study

- To examine the role of smart technologies in promoting women entrepreneurship under the Industry 5.0 framework
- To identify the major smart technologies adopted by women entrepreneurs for building human-centric businesses
- To analyse the impact of smart technologies on innovation, business performance, and sustainability among women-led enterprises
- To examine the challenges faced by women entrepreneurs in adopting smart technologies in the Industry 5.0 era
- To suggest suitable strategies and policy measures for strengthening technology-enabled, human-centric, and sustainable women entrepreneurship

5. Review of Literature

Artificial Intelligence (AI) has become a significant catalyst for entrepreneurial innovation by enabling predictive analytics, intelligent automation, personalized customer engagement, and data-driven decision-making. According to Dwivedi et al. (2024), AI enhances entrepreneurial competitiveness by improving operational efficiency, facilitating strategic planning, and supporting innovation across small and medium enterprises (SMEs). The authors further argue that AI adoption enables entrepreneurs to optimize resource utilization, reduce operational costs, and respond more effectively to dynamic market conditions. Within the Industry 5.0 framework, AI complements human intelligence rather than replacing it, thereby strengthening creativity, ethical decision-making and customer-centric business practices.

Digital transformation has significantly improved entrepreneurial opportunities for women by reducing barriers associated with finance, market access, and business scalability. United Nations Development Programme (UNDP, 2024) reported that digital technologies such as cloud computing, fintech platforms, AI-enabled applications, and e-commerce ecosystems have strengthened women's participation in entrepreneurial activities, particularly in developing economies. The report highlights that digital entrepreneurship enhances financial inclusion, business resilience, and innovation capacity while enabling women-owned enterprises to access broader domestic and international markets.

Nahavandi (2024) examined that Industry 5.0 encourages collaborative interaction between humans and intelligent technologies, where automation serves to augment human creativity rather than replace human capabilities. This human-centric industrial model supports entrepreneurs in developing ethical, sustainable, and socially responsible business models capable of addressing complex economic and environmental challenges. The study further emphasizes those women entrepreneurs are well positioned to benefit from Industry 5.0 due to their increasing adoption of smart technologies for customer engagement, innovation management, and sustainable value creation.

Recent global evidence further indicates that women entrepreneurs are increasingly adopting digital technologies to strengthen business resilience, innovation, and sustainable growth. According to the Global Entrepreneurship Monitor (GEM, 2025), women-owned enterprises are demonstrating higher rates of digital platform adoption, AI-assisted business management, digital marketing, and online customer engagement than in previous years. The report also identifies access to advanced technologies, entrepreneurial education, and digital finance, mentorship, and innovation ecosystems as critical factors influencing business success. Although digital transformation has created new entrepreneurial opportunities, disparities in technology access, digital confidence, and investment support remain major obstacles for women entrepreneurs.

6. Discussion and Analysis

Artificial Intelligence (AI), Internet of Things (IoT), cloud computing, blockchain, big data analytics, and digital platforms have significantly improved business intelligence, operational efficiency, customer relationship management, and strategic decision-making. Unlike Industry 4.0, which largely emphasized automation and productivity, Industry 5.0 advocates collaboration between intelligent technologies and human creativity to generate sustainable and socially responsible business outcomes. Women entrepreneurs are increasingly utilizing AI-driven market analytics, intelligent financial management systems, and digital marketing tools to personalize customer experiences and enhance competitiveness. This technological integration has enabled women-owned enterprises to become more resilient, innovative, and adaptable to rapidly changing market environments. The smart technologies are no longer viewed merely as operational tools but as strategic resources for creating human-centric and value-driven enterprises (European Commission, 2025).

The World Economic Forum (2025) emphasizes that organizations combining advanced technologies with human skills achieve superior innovation performance, adaptability, and sustainable competitive advantage in the digital economy. A significant observation emerging from the literature is that human-centric innovation has become a defining characteristic of successful women entrepreneurship. Industry 5.0 emphasizes that technology should enhance rather than replace human capabilities by promoting creativity, collaboration, ethical leadership, and employee well-being. Women entrepreneurs are increasingly integrating digital technologies with customer-focused business models, inclusive workplace practices, and sustainable production systems. AI-powered customer relationship management, predictive analytics, intelligent inventory management, and digital collaboration platforms allow entrepreneurs to deliver personalized services while maintaining strong human interactions. Smart technologies have also strengthened the economic empowerment of women entrepreneurs by improving financial inclusion, market accessibility, and business scalability. Digital payment systems, fintech platforms, cloud-based accounting software, e-commerce ecosystems, and AI-assisted financial planning have enabled women-owned enterprises to expand beyond geographical limitations while reducing operational costs. Despite these positive developments, the adoption of advanced technologies remain uneven due to disparities in digital literacy, financial resources, technological infrastructure, and innovation readiness. The Global Entrepreneurship Monitor (2025) identifies digital capability, access to technology finance, entrepreneurial education, and innovation ecosystems as the most influential determinants of technology-driven business growth among women entrepreneurs.

Sustainable entrepreneurial growth therefore depends not only on technological investment but also on policy support, digital skill development, responsible AI implementation, and collaborative innovation ecosystems involving governments, educational institutions, industry partners, and financial

organizations. These findings suggest that Industry 5.0 offers significant opportunities for women entrepreneurs to build resilient and human-centric enterprises, provided that technological advancement is accompanied by inclusive policies, continuous capacity building, and ethical digital governance (United Nations Conference on Trade and Development [UNCTAD], 2025).

7. Findings of Study

- Smart technologies, particularly Artificial Intelligence (AI), Internet of Things (IoT), cloud computing, blockchain, big data analytics, and digital platforms, have emerged as key enablers of women-led entrepreneurial growth under the Industry 5.0 framework. It promotes a human-centric approach in which technology complements human creativity, emotional intelligence, ethical decision-making, and innovation
- AI-enabled business intelligence, predictive analytics, and digital marketing tools facilitate personalized customer engagement, demand forecasting, inventory optimization, and strategic planning, thereby enhancing organizational performance. Smart technologies strengthen financial inclusion by improving access to digital payment systems, fintech solutions, online lending platforms, and cloud-based financial management, reducing traditional barriers to entrepreneurship.
- Women entrepreneurs utilizing digital platforms and e-commerce ecosystems experience greater market expansion, business scalability, innovation capability, and global market accessibility, contributing to sustainable business growth. The study identifies several persistent challenges, including limited digital literacy, inadequate technological infrastructure, cybersecurity concerns, financial constraints, algorithmic bias, and unequal access to advanced technologies, which hinder widespread technology adoption among women entrepreneurs. Human-centric businesses under Industry 5.0 demonstrate stronger alignment with the United Nations Sustainable Development Goals (SDGs) by promoting gender equality, sustainable innovation, inclusive economic growth, responsible production, and social well-being.

8. Conclusion

The Industry 5.0 represents a significant evolution in entrepreneurial development by integrating advanced technologies with human values, sustainability, and resilience. This study demonstrates that smart technologies such as Artificial Intelligence (AI), Internet of Things (IoT), cloud computing, blockchain, big data analytics, and digital platforms have become strategic enablers for women entrepreneurs seeking to establish human-centric and sustainable businesses. Rather than replacing human capabilities, these technologies enhance creativity, innovation, collaboration, and informed decision-making, enabling women-led enterprises to improve operational efficiency, customer engagement, financial inclusion, and long-term competitiveness. The study also highlights that despite remarkable technological advancements, women entrepreneurs continue to encounter barriers including limited digital literacy, restricted access to finance, inadequate technological infrastructure, cybersecurity concerns, and unequal participation in innovation ecosystems. Governments, higher educational institutions, financial organizations, technology providers, and industry stakeholders must collaborate to create an inclusive innovation ecosystem that promotes digital empowerment and sustainable entrepreneurship. Future empirical research should further investigate technology adoption patterns, sector-specific applications, and the long-term socio-economic impact of smart technologies on women-led enterprises across different regions and industries.

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