

Technology and Environment: Impacts of Automation and Green Innovation in Asian Contexts

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Abstract

This secondary research explores the dual impact of technological advancements on human identity and environmental sustainability in Asian countries, focusing on automation and green innovation. This study examines how the rise of automation is reshaping work identity, particularly in rapidly developing economies, where traditional notions of job stability, purpose, and self-perception are increasingly challenged.

Through existing qualitative findings, this research analyses shifts in job satisfaction, social roles, and workers' psychology in response to automated systems. This study investigates how Green Technologies contribute to environmental protection and sustainable development across Asian countries. It highlights companies such as Honeywell India, which uses AI and Automation to optimise energy efficiency; Attero Recycling, a pioneer in e-waste processing; WEgot utility solutions, which uses IoT to reduce water waste and renew power; and Greenko Group, leaders in clean energy transition. Southeast Asian innovators such as Augmentus Rad Green solutions,

Sky Greens and AGRHUB demonstrate the region's commitment to eco-automation in farming, waste management, and food production by synthesising insights from psychology, environmental science, and technology.

This study provides a holistic view of how Asian countries can navigate digital and green transitions to support human well-being and ecological integrity.

Key Words: *Technological Advancements, Environmental Sustainability, Green Technologies, Environmental Protection, Waste Management*

1. Introduction

Technological progress has consistently reshaped the workplace, but modern technology is now transforming not only the execution of tasks but also the timing, location, and design of work. Organisations worldwide are increasingly embedding AI-powered automation into workflow coordination, performance evaluation, and decision-making systems (Brynjolfsson and McAfee, 2017). Parallel to this, work arrangements have emerged as a defining feature of modern employment, enabling organisations to respond to evolving workforce expectations and demands for autonomy (Dery et al., 2017).

Although AI and work arrangements have been extensively researched as separate domains, their intersection remains unexplored. AI provides opportunities to improve efficiency, flexibility, and organisational adaptability; however, it also introduces challenges such as potential job displacement, algorithmic bias, and reduced interpersonal interactions (Autor et al., 2020). For sustainable adoption, firms must ensure that AI augments rather than replaces human contributions, balancing automation with human-centred practices to safeguard fairness, well-being, and inclusivity in the workplace. Therefore, this study examines how AI-driven automation and flexible work models jointly influence job design, managerial strategies, and employee resilience.

In parallel, economies are increasingly pursuing green development in response to rising environmental challenges, including resource depletion, pollution, and climate change (Khan & Ozturk, 2020). The Rio+20 Summit in 2012 reinforced the global commitment to sustainability, encouraging a shift from resource-intensive growth models to eco-friendly, technology-enabled alternatives. At the core of this shift lies the green industrial revolution, in which digital technologies converge with manufacturing to drive sustainable industrial upgrading.

Intelligent Manufacturing (IM), enabled by industrial Internet platforms, big data analytics, and AI, embodies this transition, promoting networked collaboration, mass customisation, and cleaner production models (Lyu et al., 2019). Digital workshops, as a component of IM, digitize entire production processes, improving efficiency and enabling eco-innovation. As Wang and Xu (2022) note, IM reflects the broader Fourth Industrial Revolution, wherein automation, ICT, and AI restructure business and industrial systems.

Ultimately, innovation and digitalisation are key drivers of sustainable development. By embedding ecological priorities into AI-powered systems and manufacturing practices, digital economies can achieve balanced growth, environmental resilience and long-term social welfare (Hou et al., 2021; Lee & Trimi, 2022; Zhang & Ming, 2021).

2. Literature Review: Sustainability, Automation, and Environment

2.1 Environmental Regulations and Technology Adoption

Environmental regulations have historically influenced organisations' responses to sustainability. Cetindamar (2001), in his study of the Turkish fertiliser sector, noted that firms complied with regulations primarily to avoid penalties rather than to proactively pursue ecological measures. This compliance-driven approach revealed gaps in preventive mechanisms and highlighted the importance of stronger collaboration between governments and civil society to encourage efficiency-driven, eco-friendly practices. Daniels (2005) broadened this perspective by analysing low-income countries, finding that green techno-economic paradigms can simultaneously reduce material and energy consumption while advancing social development. These findings underscore that technological progress, when strategically aligned, can support both ecological sustainability and economic growth.

2.2 Environmental Accounting and Corporate Responsibility

Environmental accounting has become a critical tool for embedding sustainability into organisational decision-making. Zulkifli et al. (2009) showed that Malaysian practitioners had limited knowledge of environmental accounting but recognised that legislative reforms could improve accountability. Similarly, Chang (2013) observed that Taiwanese universities lack structured systems to monitor environmental costs, such as water and energy use. Ribeiro (2016) further revealed that Portuguese municipalities' adoption levels depend on organisational size, accounting frameworks, and environmental management maturity. Collectively, these studies highlight the structural and institutional barriers to effective environmental accounting, suggesting the need for reforms to mainstream these practices.

2.3 Automation, HRM, and Organisational Decision-Making

Automation has significantly reshaped human resource management (HRM). Jetha et al. (2021) noted that robotics and AI free HR staff from repetitive tasks, enabling them to focus on strategic functions. However, Pourkhodabakhsh et al. (2023) and Mekala et al. (2019) warned that automation can generate risks, such as job insecurity and inequality. Kaplan (2015) argued that while productivity rises, automation creates anxiety about employment stability, a concern that Nguyen and Park (2022) echoed. Therefore, HRM decisions must integrate employee welfare into automation strategies (Jankovic et al., 2015). Although AI tools enhance recruitment and workforce planning (Li et al., 2022), concerns remain regarding algorithmic bias and ethics (Hampton & DeFalco, 2022). Research has also shown that while highly skilled employees often benefit from automation through career growth and training (Rožman et al., 2022), low-skilled workers risk deskilling and reduced motivation (Abdolmaleki et al., 2013).

2.4 Green Innovation and Sustainable Development

Green innovation plays a pivotal role in reconciling economic growth and environmental preservation. Munir and Ameer (2018), analysing 11 Asian economies, found that growth and urbanisation accelerated emissions, although advanced technologies and supportive policies helped mitigate the negative impacts. Kwakwa (2020) observed that in Tunisia, urban expansion without renewable energy integration worsened degradation. Theories such as Rogers' (1962) Diffusion of Innovations explain the spread of sustainability-oriented technologies (Godin, 2019; Huang et al., 2022), while Institutional Theory (Meyer & Rowan, 1977) highlights how organisations adopt green practices to maintain legitimacy (Aksom & Tymchenko, 2020). Empirical studies reinforce these frameworks, showing that incentives, governance, and stakeholder pressure strengthen the adoption of green innovation (Alyahya et al., 2021; Ullah et al., 2022).

2.5 Corporate Identity and Green Strategies

Organisational identity shapes the environmental strategies. Soewarno et al. (2018) found that firms with strong environmental legitimacy in Indonesia were more likely to adopt green

practices. Mustaq et al. (2019) reported that environmental commitment mediates the link between corporate identity and performance, while Nzomo et al. (2023) demonstrated that Kenyan firms with ISO 14001 certification improved performance through green strategies, recommending specialised departments and training.

2.6 Industrial Automation, Labour, and Digital Sustainability

While automation enhances efficiency, it also disrupts labour markets. Schwabe and Castellacci (2020) showed that robotics displaces low-skilled workers, while Arntz et al. (2016) estimated a significant proportion of jobs at risk. Khogali and Mekid (2023) emphasised psychological impacts, including reduced self-esteem. However, automation also improves safety in hazardous tasks and allows skilled workers to focus on strategic roles. Beyond labour, digital technologies, including AI, IoT, and big data, support environmental sustainability. Studies have highlighted their applications in water management, traceability, and smart city systems (Bibri & Krogstie, 2017; Stojanova et al., 2021). In manufacturing, digital twins and cloud-based platforms reduce waste, improve energy efficiency, and enhance safety (Feroz et al., 2021).

The literature demonstrates that sustainability and automation are deeply intertwined in shaping the future of organisations. Regulatory frameworks and environmental accounting establish the foundation for ecological initiatives, whereas automation and green innovation provide tools for efficiency and resilience. Adoption is shaped by theoretical frameworks such as the Diffusion of Innovations and Institutional Theory, while empirical evidence underscores the importance of incentives, governance, and corporate identity. Together, these insights highlight that organisational sustainability requires a balance between technological innovation, human-centred management, and ecological responsibility.

3. Research Methodology

This study adopts a qualitative research design that enables an in-depth exploration of sustainability, automation, organisational transformation, and green innovation. The research is qualitative in orientation, focusing on meanings, impacts, and strategies, and is integrative by linking automation, employment, and sustainability within organisational change.

Data were drawn primarily from secondary sources, including academic journals, books, government policy documents, and reports from international organisations such as the ILO, UNDP, OECD, and the World Economic Forum. Industry white papers and corporate sustainability reports were also analysed. Moreover, case studies of organisations and countries adopting automation and green innovations provide practical insights. Data collection relied on document analysis, allowing a systematic review of institutional and scholarly publications.

The scope of this study emphasises the intersection of automation as a technological force, its impact on employment, and the role of green innovation in advancing environmental sustainability. However, its limitations include reliance on secondary data, potential lack of representation in case studies, and the dynamic nature of technological and policy developments.

This study aims to explore the transformative effects of automation and green innovation, addressing their impact on employment, sustainability, and organizational adaptation, while identifying future challenges and opportunities.

4. Findings

4.1 The Impact of Automation on Employment

Automation has become one of the most powerful forces in transforming the modern labour market. Driven by rapid progress in artificial intelligence (AI), machine learning (ML), and robotics, automation enhances efficiency, reduces costs, and fuels innovation across various industries. However, alongside its benefits, automation poses challenges to employment structures, worker well-being, and long-term socioeconomic stability.

4.1.1 Job Displacement: The Automation Dilemma

Industries that are heavily reliant on repetitive and routine activities have been particularly affected by automation. Manufacturing plants employ robotic systems for assembly and quality control, logistics firms experiment with drones and self-driving vehicles, and retail outlets increasingly use self-checkout and AI-enabled service platforms. These innovations optimise operations but reduce the demand for low-skilled labour, particularly in roles such as assembly line workers, drivers, and cashiers (Frey & Osborne, 2017). The displacement of vulnerable workers risks intensifying inequality, particularly in economies where such roles provide most employment opportunities.

4.1.2 Job Creation: Opportunities in a Digital Economy

While displacement dominates public debate, automation generates new forms of employment. Emerging roles in AI engineering, robotics maintenance, data analytics, and cybersecurity are expanding rapidly. Professionals who can design, manage, and secure automated systems are in high demand. Unlike routine jobs, these positions require advanced education, technical expertise, and problem-solving skills. Thus, automation does not eliminate work altogether but rather shifts demand toward specialised, high-skill occupations, reinforcing the importance of reskilling initiatives.

4.1.3 Workforce Reskilling and Upskilling

The accelerating pace of technological change has made continuous learning a necessity. Workers are increasingly expected to combine technical expertise with cognitive and social abilities. Programming, robotics operation, and data analysis represent core technical competencies, whereas adaptability, creativity, and emotional intelligence remain critical in areas less susceptible to automation. Governments, corporations, and universities are responding through digital learning platforms, public-private partnerships, and workplace training. These initiatives ensure that displaced workers can transition into new roles aligned with the demands of an AI-driven economy (World Economic Forum 2020).

4.1.4 Regional Perspectives: Asia's Leading Role

Asia has become the global hub of automation, hosting approximately 65% of industrial robots, with China alone accounting for nearly half (IMF, 2017). The rapid industrialisation of the region has fuelled its adoption across manufacturing and healthcare sectors. Japanese firms, for instance, have pioneered collaborative robotics, while Asia's digital healthcare sector has surged, recording revenues of \$73.8 billion in 2022 and is projected to expand at 14% annually through 2027. These developments illustrate how automation strengthens productivity while reshaping economic and social systems on a continental scale.

4.1.5 Redefining Workplace Dynamics

Automation also reconfigures organisational cultures and practices. The adoption of digital tools, such as Microsoft Teams, Zoom, and Slack, supports virtual collaboration across borders. Performance management systems are increasingly outcome-based, focusing on deliverables rather than hours of work. Meanwhile, onboarding and training have shifted online, requiring innovative methods to sustain engagement. These changes have expanded workforce flexibility and global reach but also blurred personal and professional boundaries, raising concerns about overwork and stress (Brynjolfsson et al., 2020).

4.1.6 Job Satisfaction and Worker Well-Being

The psychological impacts of automation are mixed and contradictory. Studies in Europe have shown that exposure to automation heightens anxiety about job loss and wage stagnation, lowering overall life satisfaction (Abeliansky & Beulmann, 2019; Schwabe, 2019). For low-skilled workers, automation often generates insecurity and declining morale (Acemoglu and Restrepo, 2017). In contrast, highly skilled employees may enjoy intellectually rewarding roles, although dissatisfaction can arise if workplace realities fall short of expectations (Green & Zhu, 2010). These uneven effects highlight the need for inclusive policies to mitigate risks and distribute benefits more equitably.

Automation represents both opportunities and disruptions. It displaces routine jobs while creating new knowledge-intensive roles, reshapes workplace culture, and has profound psychological impacts on employees. To secure sustainable futures, governments, businesses, and workers must collectively invest in reskilling, ethical AI deployment and social safety nets. By balancing efficiency with human welfare, automation can become a force for shared prosperity, rather than division.

4.2 Green Innovation and Environmental Sustainability

Historically, economic progress has been shaped by energy use patterns. From the coal-driven Industrial Revolution to petroleum-dependent twentieth-century economies, fossil fuels have powered growth while simultaneously fuelling ecological crises. White and Walsh (2008) emphasised that fossil fuels remain the primary energy source worldwide, but their emissions are the key drivers of climate change, air pollution, and environmental degradation. With traditional resources proving unsustainable, the urgency of transitioning toward cleaner and more efficient systems has never been greater than it is today.

Bartlett (2005) stresses that a sustainable future requires not only a rapid shift toward renewable sources but also significant improvements in energy efficiency. Although solar, wind, and

bioenergy are promising, their overall contribution to the global energy mix remains modest (Chen & Pan, 2002). However, adoption has been slowed by financial constraints, regulatory hurdles, and uneven technological readiness. In this context, green innovation—the development and application of technologies, systems, and practices that minimise environmental harm while creating social and economic benefits—has emerged as a cornerstone of sustainability.

4.2.1 Foundations of Green Technology and Sustainability

The global momentum toward sustainability gained prominence at the 1992 United Nations Conference on Environment and Development, where Agenda 21 and the Rio Declaration were adopted (Bartlett, 2002). Later agreements, including the Kyoto Protocol and the Paris Climate Accord, reinforced the urgency of emission reductions and clean technology adoption.

4.2.2 Green technologies pursue three core objectives:

- a. Environmental Protection: preventing further ecological degradation.
- b. Restoration – rehabilitating damaged ecosystems.
- c. Resource Conservation – optimising use and substituting renewables for finite resources.

These principles align with the key UN Sustainable Development Goals (SDGs), particularly SDG 7 (Affordable and Clean Energy), SDG 12 (Responsible Consumption and Production), and SDG 13 (Climate Action). Importantly, their scope extends across energy, transportation, agriculture, manufacturing, and rural development, making sustainability a multidimensional transformation rather than a sector-specific reform.

4.2.3 Sectoral Applications of Green Innovation

Energy: Decarbonising electricity generation is a priority. Solar PV, wind, hydropower, and biogas technologies not only reduce emissions but also expand rural energy access and create employment. Decentralised systems, such as microgrids, empower local communities and improve resilience.

Cost Efficiency: Green innovation delivers both environmental and economic returns. Firms adopting energy-efficient processes, green buildings, and sustainable supply chains enjoy reduced costs and enhanced reputation for responsibility.

Manufacturing: Green manufacturing redesigns production to minimise waste and conserve resources. This includes adopting circular economy principles, integrating recycling, and promoting sustainable supply chain practices to strengthen their competitiveness.

Agriculture: Techniques such as organic cultivation, zero tillage, and integrated pest management restore soil fertility, enhance biodiversity, and improve food security. In contrast to conventional agriculture, which often exhausts land, green farming ensures resilience for future generations.

Rural Development: Small-scale renewable solutions—solar lanterns, biogas digesters, and decentralised grids—play a transformative role in improving rural livelihoods. Initiatives like TERI’s Lighting a Billion Lives demonstrate how innovation simultaneously expands energy access and reduces the poverty.

Transportation remains one of the fastest-growing contributors to greenhouse gas emissions. Electric vehicles (EVs), hydrogen fuel, and sustainable public transport (e.g. electric buses and metro systems) are crucial pathways for reducing carbon footprints. Smart mobility solutions further optimise efficiency by digital route planning.

4.2.4 Case Studies on Green Innovation

- a. Honeywell India – AI in Energy Management: Honeywell’s “Forge for Buildings” platform integrates AI-driven Carbon and Energy Management (CEM) modules to optimise building energy use, predict maintenance needs, and support carbon neutrality goals. The company’s commitment to achieving net-zero emissions by 2035 highlights the role of advanced analytics in achieving sustainability. (Ref : <https://www.honeywell.com/in/en>)
- b. Attero Recycling – Closing the E-Waste Loop: Attero Recycling employs advanced metallurgical processes to recover over 98% of critical minerals, such as lithium, cobalt, and copper, from electronic waste. Its circular economy model reduces dependency on virgin mining while meeting Extended Producer Responsibility (EPR) requirements. (Ref: <https://www.attero.in/>)
- c. WEGoT Utility Solutions – Smart Water Management: WEGoT enables leak detection, consumption monitoring, and borewell management through IoT-based sensors, reducing waste and improving water security for industries and municipalities. (Ref : <https://www.wegot.in/>)
- d. Greenko Group & ReNew Power – Renewable Energy Leaders: Greenko’s Integrated Renewable Energy Storage Projects (IRESPs) combine solar, wind, and pumped storage for reliable 24/7 clean energy supply. ReNew Power emphasises large-scale renewable deployment, while investing in green hydrogen and community development. (Ref: <https://greenkogroup.com/>)
- e. Automation in Waste Management – Augmentus & Rad Green Solutions: These firms use robotics and AI to improve recycling accuracy, support waste-to-energy projects, and enhance worker safety by reducing exposure to hazardous materials. (Ref: <https://www.radgreensolutions.org/>)
- f. Sky Greens – Vertical Farming: Singapore-based Sky Greens has developed rotating vertical towers powered by rainwater to optimise land and energy use in urban farming. This approach strengthens food security in cities with limited land availability. (Ref: <https://www.skygreens.com/>)
- g. AGRHUB Eco-Automation – Sustainable Agriculture: AGRHUB integrates biotechnology, renewable energy, and eco-friendly farming practices into agricultural hubs, demonstrating how automation can drive sustainable food production. (Ref: <https://agrhub.com/index-en.html>)

4.2.5 Broader Impacts of Green Innovation

- a. The adoption of sustainable technologies generates far-reaching socio-economic benefits.

- b. Job Creation: Expanding renewable and green industries provides diverse employment opportunities.
- c. Cost Savings: Efficiency in energy, materials, and water use lowers long-term expenses.
- d. Resource Security: Recycling and renewables reduce reliance on finite resources.
- e. Community Empowerment: Localised energy and water solutions enhance the quality of life and resilience.
- f. Climate Action: Green innovation directly supports global decarbonisation commitments.

Green innovation—ranging from AI-driven energy optimisation to vertical farming and smart mobility—offers pathways to reconcile economic growth with ecological responsibilities. Achieving this vision, however, requires overcoming the barriers of finance, infrastructure, and governance. Successful initiatives, such as Honeywell’s AI platforms and Attero’s recycling models, demonstrate that green innovation is not a marginal improvement but a systemic rethinking of development itself. By advancing sustainability alongside social and economic gains, it lays the foundation for resilient, equitable, and future-ready economies.

4.3 Integrative Analysis

The twenty-first century presents a dual imperative: advancing economic growth while safeguarding ecological sustainability. Two transformative forces, automation and green innovation, are at the centre of this transition. Automation, supported by artificial intelligence (AI), robotics, and the Internet of Things (IoT), enhances efficiency and precision, whereas green innovation develops technologies and practices that minimise environmental harm. Their convergence creates synergies that conserve resources, reduce emissions and foster long-term sustainability. Simultaneously, this interplay must be understood within the broader technology–environment–psychology nexus, which highlights the interdependence of human well-being, ecological balance, and technological advancement.

4.3.1 Synergies between Automation and Green Innovation

- a. Resource optimisation: AI-enabled systems and IoT platforms allow real-time monitoring of energy, water, and material use. Predictive analytics reduces inefficiencies, optimises production, and lowers both costs and emissions.
- b. Sustainable Manufacturing: Industry 4.0 technologies, including robotics and digital twins, improve accuracy, reduce errors, and minimise waste. This enhances product quality and aligns industries with global sustainability benchmarks.
- c. Real-Time Monitoring and Compliance: IoT-driven platforms track emissions and energy use, enabling dynamic operational adjustments. These systems enhance transparency and support compliance with international standards.
- d. Accelerated Green R&D: Automation shortens innovation cycles by enabling rapid experimentation with eco-friendly materials and sustainable technologies, allowing firms to scale green practices.

4.3.2 Circular Economy Applications

AI-powered recycling, robotic waste sorting, and automated waste-to-energy solutions support circular economy models that promote sustainability. These approaches reduce landfill dependency, increase recycling rates, and create new economic opportunities for the community.

4.3.3 Benefits and Strategic Approaches

The convergence of automation and sustainability offers multiple benefits.

- a. Efficiency and Productivity: Streamlined resource use raises output while lowering inputs.
- b. Environmental Gains: Reduced pollution and emissions shrink ecological footprints.
- c. Economic Value: Lower uncertainty and costs encourage investments in green technologies.
- d. Competitiveness: Sustainability performance enhances brand reputation and market position.

Key strategies include promoting renewable energy, recycling, and conservation practices; transitioning to green growth models; encouraging eco-conscious consumer choices; and fostering collective responsibility through education, community participation, and strong government policies.

4.3.4 The Technology–Environment–Psychology Nexus

Sustainability must also integrate human-centred perspectives.

- a. Technology & Environment: Innovation can drive clean energy systems, smart grids, and pollution control, even as it raises the overall energy demand.
- b. Psychology and Environment: Environmental psychology shows that public attitudes shape recycling, conservation, and eco-friendly behaviour.
- c. Technology and Psychology: While fears of automation-driven job loss affect mental well-being, digital tools also strengthen learning, skill development, and connectivity.

Automation and green innovation create pathways that reconcile economic growth with ecological preservation. Responsible automation, proactive green innovation, and education-driven awareness are essential for building a future in which technological progress, ecological health, and psychological resilience advance hand in hand.

Diagram 1: Technology and Environment, Automation, Company and Sustainable Development



The relationship between technology and the environment has become increasingly important. Although technological progress drives development, it can also contribute to pollution, resource depletion, and climate challenges, making sustainability essential in this field. Automation, powered by robotics and artificial intelligence, boosts productivity and precision but also transforms labour markets, demanding thoughtful corporate policy. Modern companies are expected to combine profitability with social responsibility by adopting green practices and renewable solutions to ensure long-term competitiveness. Sustainable development requires a balance between growth, ecological care, and social well-being. Equally important are employee psychology and job satisfaction; when workers feel valued and secure, they adapt more easily, innovate effectively, and strengthen the sustainability of the organisation. Human-centred strategies ensure that technology benefits both society and the planet.

4.4 Automation and Green Innovation in Asia: Challenges, Opportunities, and Strategies

Automation and green innovation in Asia offer vast potential for advancing sustainable industrial growth; however, they also pose serious risks. While these technologies can enhance productivity, efficiency, and environmental performance, their rapid integration risks exacerbating inequality and social displacement, particularly among low-skilled workers. Therefore, effective policy interventions, inclusive training systems, and cross-sectoral collaboration are essential to ensure that industrial transformation is both sustainable and socially equitable.

4.4.1 Challenges

One pressing challenge is job displacement and job inequality. Automation creates efficiency gains but disproportionately impacts low-skilled employment. In China, industrial upgrading has displaced many rural and less-educated workers, fuelling stagnant wages and social unrest (Financial Times, 2025). Similarly, in Southeast Asia, while robot adoption generated approximately two million skilled jobs, it simultaneously displaced around 1.4 million low-skilled workers, many of whom shifted to insecure, informal roles (Devdiscourse, 2025).

Another barrier is the policy and education gaps. Many Asian education systems lag in addressing the competencies required for digital-green economies. Reports have highlighted the “institutional bottlenecks” that hinder effective workforce preparation (Devdiscourse, 2025). In the Philippines, nearly 40% of workers lack basic ICT skills, illustrating a serious mismatch between labour market needs and training availability (Global Institute 2025).

Furthermore, environmental trade-offs and financial hurdles complicate adoption. Although automation may increase energy efficiency, expanded industrial activity can offset ecological gains. High upfront costs and limited awareness also slow the diffusion of green technologies, especially among smaller enterprises (Wikipedia 2025).

4.4.2 Opportunities

Despite these risks, automation and green innovation create significant opportunities for companies. They can drive sustainable industrial growth by optimising manufacturing processes, reducing waste, and facilitating renewable energy integration (Devdiscourse, 2025). Moreover, automation fosters the creation of new jobs in high-skill and green sectors. Evidence from China shows that robotics adoption has not only improved production efficiency but also enhanced job quality for some vulnerable groups (Science Direct, 2024).

4.4.3 Strategies and Solutions

Policy and education reforms are central, including public–private partnerships for upskilling, expanded digital infrastructure, and enhanced social protection for vulnerable workers (Asia Pathways 2025). Workforce reorientation should focus on integrating sustainability and digital skills into curricula, lifelong learning, and inclusive opportunities for women, youth, and marginalised groups (PwC 2025; World Economic Forum 2025). In conclusion, automation and green innovation in Asia embody both opportunities and risks. With inclusive governance, targeted education reforms, and sustained collaboration, these technologies can foster industrial modernisation that is economically dynamic, environmentally sustainable, and socially just.

5. Conclusion and Recommendations

Automation and green innovation in Asia reflect a complex balance between growth opportunities and social challenges in the region. The study indicates that automation contributes to higher productivity but also threatens employment security for low-skilled workers, thereby widening social and income inequalities (Financial Times, 2025; Devdiscourse, 2025). Simultaneously, green innovation enhances sustainability by promoting efficiency and reducing waste, although its expansion is often constrained by high initial costs and policy gaps (Wikipedia, 2025).

For policy and practice, this highlights the urgency of developing inclusive workforce strategies, scaling investments in digital infrastructure, and embedding sustainability principles within educational and training frameworks (Asia Pathways, 2025). Recommendations for Asian economies include fostering public–private partnerships, facilitating the adoption of green technologies among SMEs, and enhancing social protection systems to support vulnerable groups (PwC 2025; World Economic Forum 2025).

Future research should prioritise sector-specific analyses, cross-country comparisons, and the long-term societal impacts of automation and green innovation. Such studies will provide

evidence-based insights for shaping policies that ensure sustainable development and social equity.

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