Industry 5.0 Contribution Green Business Practices: Pathway Toward Sustainable Development

Dr Rakesh Kumar1
1 Post-Doctoral Lincoln University College, Petaling Jaya, Malasiya
aigrakeshkumar@gmail.com

Kittisak WONGMAHESAK 2
2 Faculty of Political Science, North Bangkok University, Thailand
2 Post-Doctoral Fellowship Research Collaboration Program, Lincoln University College, Malaysia
E-mail: pdfsv.kittisak@lincoln.edu.my

Abstract : Industry 5.0, the following stage in modern advancement, means to coordinate human-driven methods with trend-setting innovations for feasible turn of events. Industry 5.0's obligation to a human-driven labor force upgrades the productivity of modern cycles as well as contributes essentially to supportable improvement by tending to social, monetary, and individual prosperity viewpoints. By perceiving and esteeming the novel capacities of people coupled with innovative headways, Industry 5.0 makes ready for an additional practical and strong future. In the next industrial revolution, people are supposed to add high-esteem assignments to assembling strategies. This theoretical investigation examines the commitments of Industry 5.0 to supportable improvement by looking at its key standards, like human-machine cooperation, moral computer-based intelligence, and roundabout economy rehearsals.

Key Words: Industry 5.0, Green Business Practices, Sustainable Development, Smart Manufacturing, Circular Economy, Artificial Intelligence, Internet of Things (IoT), Resource Efficiency, Environmental Sustainability, Green Innovation

Introduction

The foundation of this industrial revolution is the concerted efforts of industry leaders, researchers, policymakers, and innovators. Their devotion to pushing the limits of innovation while staying aware of manageability objectives makes way for a future where monetary flourishing blends with natural and social obligation. The affirmation stretches out to the basic rule of human-driven coordinated effort implanted inside Industry 5.0. At its center, this standard perceives the characteristic worth of human abilities related to cutting edge innovations. The commitment to developing workplaces that prefer the well-being and progress of the workforce is an example of the values of Industry 5.0. Industry 5.0 is the upcoming innovation of the earlier era, indicated for qualified and amazing machines Co-working between humans and machines is one developing pattern for Industries 5.0[1]. Industry 5.0, though nascent, is being explored as a transformative advancement beyond Industry 4.0, addressing socio-environmental challenges like inequality and environmental degradation highlighted by recent crises. Industry 4.0 has provided some sustainability gains, but it ignores important issues like social exclusion and job upheaval. In response to these flaws, Industry 5.0 combines technology innovation with social and environmental ideals. However, given that Industry 4.0 is still developing and has not yet realized its full potential, particularly for smaller enterprises, it is criticized for its hasty introduction[2].

Appreciation is stretched out to the individuals who channel their assets into adventures that focus on monetary returns as well as certain cultural and ecological effects. Besides, the affirmation stretches out to the networks impacted by modern practices. Perceiving the significance of local area commitment, inclusivity, and strengthening is fundamental. Appreciation is imparted to those endeavors and affiliations that really incorporate area networks in powerful cycles, with respect to their social, social, and money related characteristics[3].

The developing ubiquity of computerized economy and uncountable number of down-to-earth applications have made areas of strength for a for improvement of Industry 4.0 innovations as of now and in the long haul can act as the platform for production of Society 5.0. This acknowledgement highlights the significance of ensuring that the advantages of Industry 5.0 have a positive impact on the communities in which industries operate beyond the realms of corporations. In the soul of inclusivity, the affirmation additionally perceives the job of assorted points of view in driving practical improvement inside Industry 5.0. Appreciation is communicated to people from different foundations, societies, and disciplines who contribute extraordinary bits of knowledge and approaches. The belief that diverse perspectives enrich the innovation ecosystem and foster technologically advanced, culturally sensitive, and socially inclusive solutions is included in the acknowledgement[4]. All in all, the affirmation of Industry 5.0's commitment to economic improvement is an extensive recognition for a tremendous organization of worldwide partners, policymakers, teachers, financial backers, networks, and different voices. An affirmation rises above boundaries, disciplines, and areas, perceiving the aggregate endeavors of a worldwide local area devoted to forming a modern future that focuses on manageability in the entirety of its aspects. This thorough insistence features the interconnected thought of Industry 5.0's impact and acclaims the various accomplices who add to an extra viable and fit world. Industry 5.0 is viewed as the response to the subject of a restored human focused/human driven modern worldview, beginning from the (primary, hierarchical, administrative, information-based, philosophical, and social) redesign of the creation cycles of industry[5]. The fifth version of Industry is considered to be an answer to the challenge of a reestablished human centered/human centric industrial paradigm, starting through the (structure, corporate, managerial, a knowledge-based philosophically and culture) reorganizing of the manufacturing procedures of industry[6]

Human-Centric Workforce

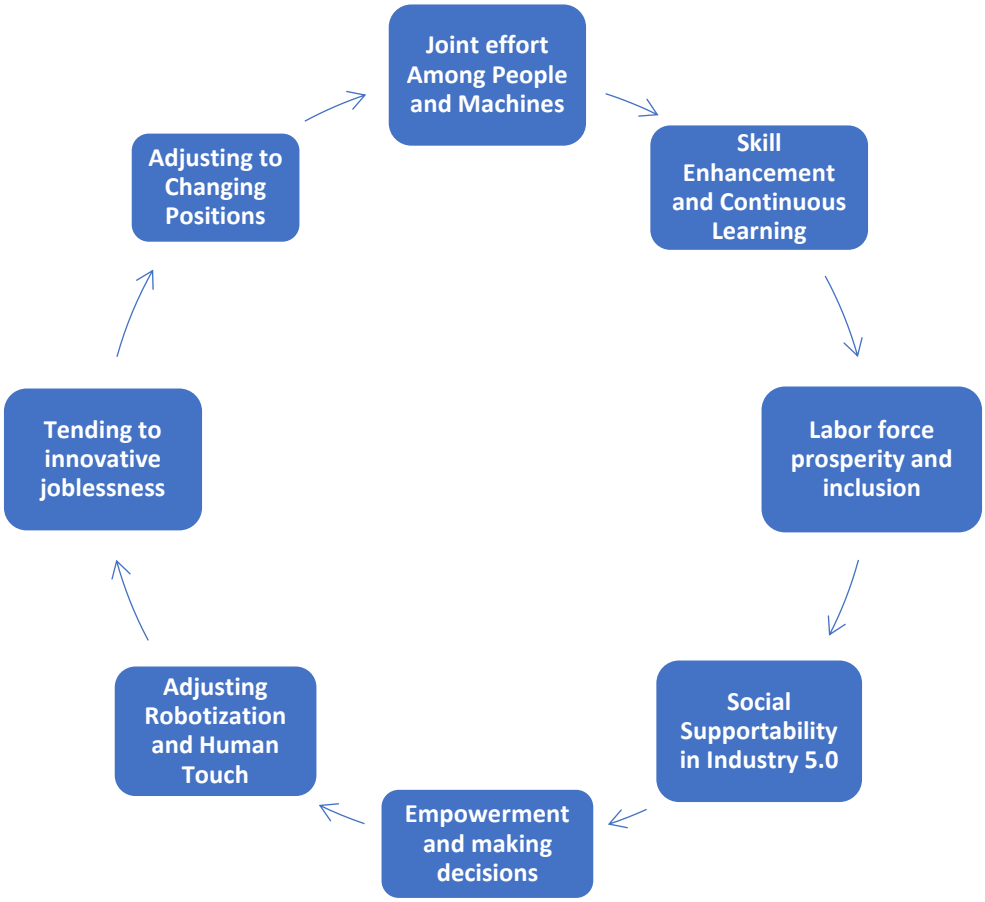

Figure 1: Human-Centric Workforce

In agreement with the standards of sustainable development, this emphasis on a workforce that is centered on people results in numerous advantages that span the economic, social, and environmental spheres. The human-driven vision additionally includes reevaluating how laborers and machines work together. Generally, static assembling cycles can be refreshed with advanced twins, and new cooperative mechanical technology with line laborers engaged to practice more prominent adaptability is underway[7]. A sound and heavenly labor force with opportunities for imaginative individual and expert headway is probably going to make an enduring incentive for the business.

1. Joint effort Among People and Machines:
    - Industry 5.0 encourages a cooperative climate where people work close by machines, each utilizing their novel assets. This joint effort upgrades effectiveness and efficiency by consolidating the accuracy of machines with the innovativeness, critical abilities to think, and versatility of people[8].
2. Skill Enhancement and Continuous Learning:
    - The joining of Industry 5.0 requires a talented labor force equipped for exploring trend-setting innovations. This prompts persistent learning and open doors, guaranteeing that representatives stay versatile and outfitted with the abilities required for developing jobs.

Nonstop ability improvement adds to individual development, work fulfillment, and by-and-large labor force versatility

3. Adjusting to Changing Positions:
    - The powerful idea of Industry 5.0 implies that work jobs are liable to change. A human-driven labor force is better prepared to adjust to these changes, cultivating a culture of constant pick-up, upskilling, and reskilling. This versatility is fundamental for people and enterprises to stay cutthroat and practical in the long haul.

Normalization and authorization will assist with forestalling any difficult issues between innovation, society, and organizations [9]. Industry 5.0 tries to reestablish a human-driven way to deal with business that some would agree was missing with Industry 4.0 methodology. The advantageous interaction of people and machines is vital for making more positions, utilizing efficiency and proficiency, and drawing in and holding ability[10]

Role of Industry 5.0 in Sustainable business practices

The combination of the Web of Things, or IoT for simple terms, in Industry 5.0 assumes a significant part in adding to manageable improvement across different aspects. Industry 5.0 uses IoT advancements to improve effectiveness, enhance asset usage, and decrease ecological effects. Industry 5.0 is more centered on consolidating human mental ability and imagination, remembering supportability, and the ability to use both hands. It is expressed that the IoT transformation is energizing the rise of Industry 5.0, and these ideas will be entwined soon. To add further another advancement is the executives' system that thinks about IoT, man-made consciousness, large information, and human/client centeredness and is expected to receive the most extreme potential rewards from Industry 5.0. [11]

The following are multiple manners by which IoT in Industry 5.0 adds to an economical turn of events:

1. Ongoing observation and control:
    - Real-time monitoring of industrial processes, equipment, and energy consumption is made possible by IoT devices. This continuous perceivability considers the brief ID of failures, diminishing energy wastage, and streamlining asset usage. Thus, Industry 5.0 works with a more reasonable and harmless approach to the ecosystem, producing rehearses.
2. Waste reduction and resource efficiency:
    - IoT sensors implanted in assembling hardware and cycles empower exact checking of asset use, like natural substances and energy. This information can be broken down to recognize potential open doors for effectiveness upgrades, prompting diminished squander and limited natural effect.
3. Prescient upkeep for manageable activities:
    - IoT-empowered, prescient upkeep is a critical part of Industry 5.0. By ceaselessly observing hardware conditions and execution, prescient support calculations can expect possible disappointments. This limits personal time as well as adds to the reasonable utilization of assets by staying away from pointless substitutions and fixes.
4. Energy Utilization Enhancement:
    - In Industry 5.0, IoT devices aid in energy efficiency optimization. Shrewd sensors and actuators can change energy use in view of continuous interest, guaranteeing that energy is utilized proficiently and diminishing the general carbon impression of modern tasks.

5. Inventory network perceivability and supportability:
    - IoT innovation improves perceivability and discernibility all through the production network. This straightforwardness permits organizations to settle on informed conclusions about obtaining materials capably, diminishing the ecological effect related with asset extraction and transportation. It likewise upholds moral and maintainable obtaining rehearses.
6. Reduced Environmental Impact from Smart Logistics:
    - In Industry 5.0, IoT is applied to planned operations and transportation processes. Shrewd coordinated operations frameworks use IoT gadgets to improve courses, screen vehicle conditions, and oversee stock. This works on by and large proficiency as well as decreases fuel utilization and ozone depleting substance emanations, adding to earth-favorable transportation.
7. Upgraded Item Lifecycle The board:
    - IoT gadgets work with the following and the executives of items all through their lifecycle: This incorporates checking the utilization of items by end-clients, following their presentation, and overseeing reusing or removal. This all-encompassing strategy contributes to sustainable consumption and production and supports a circular economy.
8. Information Driven Decision-Production for Manageability:
    - The information gathered by IoT gadgets in Industry 5.0 fills in as the establishment for information driven navigation. Associations can examine this information to distinguish regions for development in manageability, set execution benchmarks, and track progress towards ecological objectives.
9. Smart Grids and Energy Productivity:
    - The Internet of Things (IoT) is used to build smart grids that make it easier to manage and distribute energy. By improving energy appropriation and lessening energy misfortunes, Industry 5.0 adds to the improvement of more reasonable and strong energy frameworks.
10. Remote observation and the executives:
    - IoT considers remote checking and the executives of modern cycles, diminishing the requirement for actual presence. This upgrades security as well as adds to supportability by limiting travel-related fossil fuel byproducts.

Parallel to Industry 4.0, the idea of Industry 5.0 (from 2016 forward, described by computerized shrewd society, the mix of virtual and actual spaces, IoT, robots, increased reality, development environment, cerebrum machine point of interaction, and human centrality of innovation) is likewise thriving. The primary differentiating factor between Industries 4.0 and the present stage of Industry 5.0 is the improved interaction between humans and machines, which empowers individuals to articulate their thoughts through customized products and services[12]. In order to ensure the seamless management of these Internet of Things and their continuous integration into the business cycle, an alternative development approach—the board system—is necessary. Furthermore, the exponential expansion of the World Wide Web of Things and advances in technology demand items that are feasible, financially feasible, focused on users, as well as capable of offering value to both prospective customers and company .Presently the

spotlight isn't simply on development, yet additionally on the execution of advancement .In conclusion, the integration of the Internet of Things (IoT) into Industry 5.0 opens up a plethora of opportunities to improve the sustainability of industrial and manufacturing processes[13]. By utilizing continuous information, prescient examination, and savvy advancements, Industry 5.0 adds to being more proficient, asset cognizant, and harmless to the ecosystem, lining up with the standards of practical turn of events. Additionally, they emphasized that IoT requires an innovation management framework that allows for a balance between business and consumer requirements and between the amount of openness and privacy. In reality, the widespread adoption and implementation of Internet gives rise to a new ecosystem, i.e., Industry 5.0.[14]

In the domain of Industries 5.0, where the merging of modern facilities invention and economic processes turn the main goal, the obligations to environmentally friendly development are notably shown by means of different situations. This condition recognizes that the feasible improvement effect of Industry 5.0 is a consequence of the joined impact of human-driven cooperation, moral man-made intelligence, round economy practices, and development environments. The variable T perceives that this effect is dynamic and develops over the long run as these standards are coordinated and refined in modern cycles.[15]

Discussion and Finding

Industry 5.0 delivers an extraordinary outline of human-driven coordinated effort. Envision a creation floor where cooperative robots, or robots, work flawlessly close to human laborers. These coots, outfitted with cutting edge sensors and computer-based intelligence, upgrade efficiency as well as guarantee a protected and intelligent climate. This outline emphasizes the agreeable coordination of innovation to expand human abilities, encouraging position creation, and essentially working on working circumstances.

The accentuation on human-machine coordinated effort in Industry 5.0 contributes not exclusively to monetary manageability yet in addition to the prosperity of the labor force. Take a journey into supply chain management to see how ethical AI is affecting Industry 5.0. There are different dreams for Industry 5.0. A few futurists contend that while Industry 4.0 is basically about interfacing gadgets together, Industry 5.0 is about joint effort among people and machines on the plant floors.

The outcome is a flourishing climate where advancement flourishes, adding to manageable improvement across monetary, social, and ecological aspects. Basically, these representations act as depictions of the extraordinary force of Industry 5.0. They feature how human-driven coordinated effort, moral simulation intelligence, round economy rehearsals, and cooperative development biological systems are hypothetical builds as well as unmistakable real factors molding a reasonable modern future. Industry 5.0, in its many-sided transaction of innovation and human qualities, offers a plan for a future where development and supportability remain closely connected, making a stronger and capable modern scene.

Limitation of the Study

This study finds various critical points that have an impact its results and how they are interpreted. As the study have only use secondary data, which could not accurately reflect recent developments in Industry 5.0 technologies. With this, broad generalizations are limited by the gap in Industry 5.0 adoption between industries and geographical areas. The implementation of sustainable technology has further complicated the issue of infrastructure and financial differences, specifically for small and medium-sized businesses (SMEs). In the absence of definitive evidence from businesses, the study main focus is the theoretical relation between Industry 5.0 and green business practices. Furthermore, the study's scope may be

increase by the rapid development of digital technologies like AI and IoT and also, the findings' practical usability may be affected by national variations in social and regulatory issues.

Conclusion and future scope

Industry 5.0, which integrates modern technology with sustainability and human-centric ideas and represents a significant turning point in industrial development. With The help of improved resource efficiency, waste reduction, and environmentally friendly production, it improves the green practices. It connects economic growth with social responsibility and sustainable development by increasing operational efficiency while also reducing environmental impact using AI, robotics, IoT, and smart production. To realize Industry 5.0's sustainable goals, partnership between stakeholders, enabling laws, and strategic investment are all necessary. In order to fulfill sustainable development goals, future research should focus on empirical study of how well it going to works across different sectors and long-term environmental benefit. And ways to overcome implementation challenges, and the interaction of policy frameworks with emerging technology.

References

[1] M. Ghobakhloo, M. Iranmanesh, M. E. Morales, M. Nilashi, and A. Amran, "Actions and approaches for enabling Industry 5.0-driven sustainable industrial transformation: A strategy roadmap," *Corp. Soc. Responsib. Environ. Manag.*, vol. 30, no. 3, pp. 1473–1494, May 2023, doi: https://doi.org/10.1002/csr.2431.

[2] M. Madhavan, M. A. Sharafuddin, and S. Wangtueai, "Impact of Industry 5.0 Readiness on Sustainable Business Growth of Marine Food Processing SMEs in Thailand," 2024. doi: 10.3390/admsci14060110.

[3] A. Saini and V. Garg, Eds., "Prelims," Feb. 17, 2023, *Emerald Publishing Limited*. doi: 10.1108/978-1-80262-277-520231023.

[4] K. Luchkov, G. Chipriyanova, and M. Chipriyanov, "Industry 5.0 and Green Transition—Challenges and Opportunities for Business and Society BT - Sustainable Innovation for Engineering Management (SIEM)," M. El Khatib, H. M. Alzoubi, and Y. Angelova, Eds., Cham: Springer Nature Switzerland, 2025, pp. 3–11.

[5] K. S. Dhayal, A. K. Giri, A. Kumar, A. Samadhiya, S. Agrawal, and R. Agrawal, "Can green finance facilitate Industry 5.0 transition to achieve sustainability? A systematic review with future research directions," *Environ. Sci. Pollut. Res.*, vol. 30, no. 46, pp. 102158–102180, 2023, doi: 10.1007/s11356-023-29539-w.

[6] G. B. Narkhede, B. N. Pasi, N. Rajhans, and A. Kulkarni, "Industry 5.0 and sustainable manufacturing: a systematic literature review," *Benchmarking An Int. J.*, vol. 32, no. 2, pp. 608–635, Feb. 2024, doi: 10.1108/BIJ-03-2023-0196.

[7] M. M. Ali and N. Ali, "Green Entrepreneurship and Industry 5.0," 2025. doi: 10.1016/B978-0-443-13701-3.00587-9.

[8] L. Zhang *et al.*, "Artificial intelligence-driven internet of things-based green supply chain for carbon reduction in sustainable manufacturing," *J. Environ. Manage.*, vol. 389, p. 126170, 2025, doi: https://doi.org/10.1016/j.jenvman.2025.126170.

[9] B. Liu and M. Adil, "Digital Technologies and Sustainable Competitiveness: The Role of AI and Internet of Things in Driving Green Innovation and Firm Performance," *Corp. Soc. Responsib. Environ. Manag.*, vol. n/a, no. n/a, May 2026, doi: https://doi.org/10.1002/csr.70635.

[10] I. Rojek, P. Prokopowicz, M. Piechowiak, P. Kotlarz, N. Náprstková, and D. Mikołajewski, "The Impact of Data Analytics Based on Internet of Things, Edge Computing, and Artificial Intelligence

on Energy Efficiency in Smart Environment," 2026. doi: 10.3390/app16010225.
[11] O. O. OLUMIDE, "INTERNET OF THINGS AND ARTIFICIAL INTELLIGENCE: THE KEY TO SUSTAINABLE DEVELOPMENT IN DEVELOPING COUNTRIES," *Int. J. Humanit. Soc. Dev. Res.*, 2024.
[12] A. L. A. Guedes, B. S. Cezario, C. A. da Silva Carvalho, O. C. Longo, V. G. A. Carneiro, and L. F. C. Nascimento, "The Impact of Artificial Intelligence (AI) and the Internet of Things (IoT) on the Sustainability of Globalized Businesses BT - Economic Sustainability Potentiated by Artificial Intelligence," M. J. Sousa, J. R. dos Santos, M. Sousa, and S. K. Pani, Eds., Singapore: Springer Nature Singapore, 2025, pp. 87–106. doi: 10.1007/978-981-96-8089-4_6.
[13] A. K. Feroz and A. Stines, "Utilization of AI, big data, and internet of things (IoT) in sustainable innovation and their role in the emergence of novel business models.," *Issues Inf. Syst.*, vol. 25, no. 1, 2024.
[14] A. M. Al-Momani, "Artificial Intelligence and Industry 4.0: Catalysts for Sustainable Organizational Development BT - Current and Future Trends on AI Applications: Volume 1," M. A. Al-Sharafi, M. Al-Emran, M. A. Mahmoud, and I. Arpaci, Eds., Cham: Springer Nature Switzerland, 2025, pp. 231–245. doi: 10.1007/978-3-031-75091-5_13.
[15] H. Onyeaka *et al.*, "Using Artificial Intelligence to Tackle Food Waste and Enhance the Circular Economy: Maximising Resource Efficiency and Minimising Environmental Impact: A Review," 2023. doi: 10.3390/su151310482.