FOSTERING ETHICAL TECHNOPRENEURS: A ROADMAP FOR HIGHER EDUCATION IN THE ERA OF INDUSTRY 5.0

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1. Abstract

With the advent of the global industrial environment shifting from Industry 4.0, which is automation-driven, to Industry 5.0, which is human-centric, there has been a paradigm shift in the way we define success in technology. This study examines the relationship between "Technological Sustainability" and the "Gig Economy" through the prism of the role of higher education in shaping the future technopreneurs. Although technology has enabled the flexibility of work, it has also brought about "black-box" algorithmic management, which has, in many cases, undermined the welfare of workers and their psychological safety. Through a systematic review of secondary literature published in top-class Indian and international journals between 2020 and 2026, this study reveals a roadmap for "Education 5.0." This study seeks to transcend mere technological education to a curriculum that incorporates digital ethics, resilience, and human-AI collaboration as key skills. The findings suggest that "technological sustainability," which is the alignment of innovation with ethical and social objectives, is a pivotal bridge builder for a more equitable platform economy. The results indicate that by embracing a human-centered focus, higher education institutions can produce technopreneurs who value "Trust by Design" and resilience for livelihoods over efficiency. This paper offers a theoretical basis for management institutes to revise their curriculum, and it is essential to note that the future of the gig economy is contingent on a harmonious synergy between the precision of machines and the creativity of humans. The paper concludes with implications for policymakers and educators, suggesting that the key to sustainable development in the digital era is a radical rethinking of the relationship between workers, algorithms, and educational institutions. It places universities at the forefront of society as the "immune system" that is tasked with the responsibility of producing ethical leaders for a resilient digital future.

Keywords: *Industry 5.0, Gig Economy, Technopreneurship, Higher Education, Technological Sustainability, Algorithmic Management*

2. Introduction

The world is in the midst of a profound change in its industrial structure globally. There is a clear move from the efficiency-oriented, technology-centric approach of Industry 4.0 to a more value-oriented, human-centric approach in Industry 5.0. While hyper-connectivity and data-driven decision-making were the hallmarks of the last decade, Industry 5.0, as identified by the European Commission in 2021, represents a normative shift in this direction. It comprises three pillars: people, sustainability, and resilience (European Commission, 2021). Amidst this change, the gig economy presents a promising area of research because it represents the highest level of algorithmic management, while also undermining worker autonomy and social sustainability.

From a fringe concept to a central driver of the global economy, especially in developing countries, the gig economy presents a promising area of research because it represents the highest level of algorithmic management, while also undermining worker autonomy and social sustainability. In India, this change is more relevant because it is in the process of realizing its vision of "Viksit Bharat 2047," where it aims to become a hub for skills and innovation (AICTE, 2025). While it is expected to grow rapidly in India, a major challenge facing gig workers in this direction is the "black box" of governance in this sector, where there is a socio-technical conflict between the pursuit of efficiency in this sector and the fundamental human right to live with dignity and opportunity in life.

Higher Education Institutions find themselves at the crossroads. Gone are the days when the only goal is to produce graduates who can code or coordinate logistics. Today, the focus is on producing sustainable technopreneurs who can effectively navigate the digital revolution with a sense of ethics and a human-centric approach. This study is guided by the theme "Higher Education and Sustainable Development: A Roadmap to Technopreneurs," which explores the possibility of Industry 5.0 principles in reengineering management and technical education to respond to the demands of the gig economy.

"Technological Sustainability" is the concept being explored in the study. This is different from the

concept of "Sustainable Technologies," which refers to the use of specific technologies that have a positive impact on the environment. Technological sustainability is a specific approach to the management of technology that seeks to bring the entire innovation lifecycle in line with social and ethical considerations (Machuca & Davim, 2024). It is the ability of technology to achieve positive net effects on the environment and the workforce.

Although AI and robots have started to penetrate the platform economy, no standard approach to the use of the two in the creation of a system that will work for the workforce rather than against them is available. Moreover, the curriculum of colleges of higher education is lagging behind the changes in the workforce. This is creating a gap in the skills of the workforce. While the workforce is able to keep up with the technology, the ability to manage the system of "collaborative intelligence" is lacking (Ali, 2025). There is a need to provide a roadmap for the production of technopreneurs who will provide the much-needed sustainability in the workforce.

This current study, grounded on a thorough review of secondary studies conducted between 2020 and 2026, has four major objectives:

- To identify the current status of Industry 5.0 with regards to platform-based gig work and highlight the socio-technical challenges that gig workers encounter.
- To define what technological sustainability means in the realm of management education and how it contributes to ethical technopreneurship.
- To outline a roadmap to integrate the concepts of Education 5.0 into the curricula of Higher Education Institutions with a focus on human-centered AI and technological sustainability.
- To examine the theoretical underpinnings of the relationship between psychologically fulfilling contracts and technological sustainability in the gig economy.

By synthesizing fragmented studies from Indian and international journals, the current paper aspires to provide practical guidance to management education institutions and policymakers to move beyond the technocentric 'efficiency' paradigm to a more human-centered 'value' approach that ensures long-term success to technopreneurs and their gig workers.

3. Literature Review

Literature reviews are incorporated from 2020 to 2026 publications focusing on the transition to Industry 5.0 and its implications on higher learning institutions and the gig economy.

3.1 The Evolution of Industry 5.0: A Value-Driven Revolution

The global transition from Industry 4.0 to 5.0 can be considered a major transformation from a technology-driven revolution to a value-driven revolution. In other words, while Industry 4.0 focused on hyper-connectivity, technology-driven automation, and the concept of the 'Smart Factory' to attain peak productivity, Industry 5.0 is focused on the symbiotic union of these technologies with human creativity and nature's happiness (European Commission, 2021). This new paradigm is referred to as 'Neoindustrialization' and has emerged as a response to global issues like climate change and social inequality that were highlighted during the COVID-19 pandemic (Machado & Davim, 2024).

In the new paradigm of Industry 5.0, technology is seen as an 'augmenter' rather than a 'substitutor' of human labor. For example, collaborative robots or 'cobots' function alongside humans and utilize AI to manage repetitive tasks while humans can focus on more complex problem-solving and innovation. Projections indicate that the Industry 5.0 market is expected to witness tremendous growth in the coming years with the Asia-Pacific region expected to cross USD 600 billion by 2032 with a global compound annual growth rate (CAGR) of 31.5% in technologies related to human-machine collaboration (Ali, 2025; Mordor Intelligence, 2024).

3.2 Technological Sustainability: The Strategic Frontier

A major theme in current research literature is the distinction between "sustainable technologies" and "technological sustainability".. Sustainable technologies describe particular technologies such as renewable energy sensor technology or electric vehicle technology that can be used to reduce environmental degradation. On the contrary, technological sustainability points to a broader management approach in which the entire spectrum of the innovation process can be strategically integrated with social, ethical, and environmental goals (European Commission, 2021).

Recent research literature points to the emergence of technological sustainability as the "fourth dimension" of sustainable development alongside the conventional economic, social, and environmental dimensions (Sahoo et al., 2021). To operationalize this concept, the Process Technological Sustainability Assessment (P-TSA) model has been adopted as a quantitative approach to assess industrial processes according to their impact on the environment. This model assesses

industrial processes according to their impact on the environment in the following three dimensions:

- Input/Output Availability (IOA): This dimension can be quantified through the Stock Coverage Rate (SCR) to ensure the sustainability of the resource.
- Operational Performance (OP): This dimension can be quantified through the Productivity Indicator (PI) to ensure the sustainability of the resource without compromising the well-being of the workforce.
- Technical Quality (TQ): This dimension can be quantified through the Output Compliance Rate (OCR) to ensure the sustainability of the resource without compromising ethical considerations.

This approach to technological sustainability reflects a proactive approach that changes the organizational paradigm from a reactive approach of "doing less harm" to a proactive approach of "creating net good".

3.3 The Gig Economy and Algorithmic Management: Sociotechnical Tensions

The gig economy remains a key area to examine the lived experience of Industry 5.0, especially with the advent of Industry 4.0 and the emphasis on Industry 5.0. In most digital platforms, the role of algorithmic management, particularly through the use of AI to manage the distribution of work, performance monitoring, and wage determination, remains a key area of focus. However, the role of AI remains a black box, with information asymmetry between workers and the algorithms deployed to manage the platforms.

This phenomenon has resulted in social alienation, with gig workers experiencing a lack of human interaction and powerlessness against the algorithms. Gamification, on the other hand, remains a key area to examine the lived experience of the gig workers, particularly with the advent of Industry 4.0 and the emphasis on Industry 5.0. Industry 5.0 offers a new paradigm to examine the sociotechnical tensions through the concept of Trust by Design (Nasir et al., 2025). This concept emphasizes the role of transparency, accountability, and fairness through the software design to ensure the workers are not exploited by them.

3.4 Theoretical Foundations: Agency Theory and Psychological Contracts

In the analysis of the relationship between gig platforms and workers, researchers often employ two main theories of management:

- Agency Theory: Agency Theory examines the possibility of a conflict of interest between the principal (platform owner) and the agent (gig worker) (Łasak, 2025). In the digital world, the role of the algorithm is that of a mediator. Where the incentives of the algorithm are purely monetary, a principal-agent problem occurs that threatens the safety of the worker through the need for expediency. Responsible AI serves as a mediating theory to balance the interests of the two parties (Dwivedi et al., 2025).
- Psychological Contract Theory: Psychological Contract Theory deals with the unspoken agreement between the employer and the employee. In the context of the gig economy, the psychological contract tends to be fragmented since workers often need to balance the transactional contract (wage) with the relational contract (job security/growth). A breach of the psychological contract occurs when the platform alters pricing or other policies without transparency, leading to value co-destruction and high employee turnover. Empirical research suggests that the satisfaction of the contracts through positive management correlates with organizational identification and performance (Yu & Hamid, 2024).

3.5 Education 5.0: A Roadmap for Sustainable Technopreneurs

Higher Education Institutions are identified as key drivers of change in Industry 5.0. Literature suggests a paradigm shift from Education 4.0, where technical skills were emphasized, to Education 5.0, where holistic human development and ethical values are emphasized (Narkehede et al., 2024; Ramírez-Montoya et al., 2025). HEIs are now considered "incubators" of future skills, where students are taught to cope with the sustainability aspects of digital transformation ..

Education 5.0 is a roadmap consisting of some key components, including:

1. Curriculum Innovation: Incorporating digital ethics, circular economy, and human-centric AI design into business and engineering curricula (Ashmel et al., 2024).
2. Personalized Learning: Using AI-powered learning platforms to provide learning experiences best suited to individual students, moving beyond a "one-size-fits-all" approach (Presidency University, 2025).
3. Industry-Academia Collaboration Hubs: Establishing collaborative spaces where students work with real-world partners on sustainability-oriented innovation

challenges (Ahmedova, 2023; Olszak & Sączewska-Piotrowska, 2024).

4. Soft Skills Mastery: Emphasizing emotional intelligence, critical thinking, and empathy in conjunction with technical skills in AI and robotics (AICTE, 2025; Selvakumar et al., 2024).

In India, the All India Council for Technical Education (AICTE) has declared 2025 as the "Year of AI," with a vision to prepare over 40 million students to work collaboratively with AI (AICTE, 2025). This vision is in line with the national vision of "Viksit Bharat 2047," where India aims to become a hub of brainpower and skills (AICTE, 2025).

3.6 Resilience and Livelihood Sustainability

Resilience refers to the ability of a system to absorb shocks or disturbances while maintaining functionality (European Commission, 2021). Resilience, therefore, moves beyond supply chain resilience to encompass livelihood system resilience for gig workers. Empirical research findings indicate that the COVID-19 pandemic exposed the limitations of the conventional gig system, with platforms shifting to flexible AI-based systems (Daniels et al., 2022). Resilience-Based Maintenance (RBM) has emerged as a general system adaptability approach with a focus on the role of technical infrastructures in supporting human recovery during crises (Szara, 2025). To the technopreneur, this means the creation of resilient platforms that are "resilient by design," alongside the provision of portable benefits for gig workers across various platforms.

3.7 Identified Literature Gaps (2024-2026)

Despite the high level of research activities, the following gaps were identified as the most notable gaps in the literature:

1. Metric Deficiency: There is a complete lack of quantifiable metrics for evaluating qualitative aspects like worker well-being or human-centricity.
2. Theory-Practice Gap: Much of the literature reviewed is conceptual. There is an urgent need to bridge the theory-practice gap through empirical research into the implementation of Industry 5.0 concepts in the gig ecosystem.
3. Regional Imbalances: Despite the high availability of global concepts, localized theory-based research into the Indian gig workforce ecosystem is relatively rare.
4. Resilience Void: Resilience is the least researched of the pillars, with a complete lack of research into the longevity and mental endurance of the workers.

Section 4: Methods

This research follows a methodological approach that systematically synthesizes the literature on the concepts of Industry 5.0, technological sustainability, and the effects of the gig economy and higher education. Based on the scope of the subject matter from a contemporary perspective, the research follows a Systematic Literature Review coupled with an Applied Framework Analysis research methodology.

4.1 Research Design

This research follows a qualitative research design with a descriptive-analytical approach. The Systematic Literature Review helps to identify the relevant literature on the subject matter, while the Applied Framework Analysis helps to analyze the qualitative aspects of the subject matter with respect to concepts such as "transparency," "autonomy," and "worker well-being" within the organizational context. Grounded Theory follows the research methodology with a selective focus on the systematic impact of Industry 5.0 on higher education with the help of diverse theoretical approaches.

4.2 Data Collection and Sources

In this study, high-quality secondary data published between 2020 and 2026 is exclusively used. The range of these years is considered to cover the concept of Industry 5.0 paradigm after the mandate of the European Commission in 2021. Data is collected from credible scholarly databases such as Scopus, Web of Science, IEEE Xplore, and Google Scholar. Moreover, this study also includes gray data in the form of policy documents published by NITI Aayog, AICTE, and United Nations Sustainable Development Goals (SDGs).

4.3 Data Analysis Framework

The data analysis process was based on a five-step approach that included formulation of research questions, search process, application of criteria, data selection and extraction, and finally data synthesis. The synthesis of the data was conducted using a thematic synthesis approach that grouped the studies under domains like technology, education, ethics, and economic impact. In the context of India, a correlational approach was used to analyze the relationship between policy initiatives undertaken by the government and institutions like AICTE (2025).

5: Results

The findings of this study are based on the thematic synthesis of secondary data available between 2020 and 2026. The results are divided into four major sections.

5.1 Economic and Conceptual Growth of Industry 5.0

The findings suggest that the concept of Industry 5.0 has now moved from a theoretical construct to a mainstream driver. For instance, the global market for Industry 5.0 technology was valued at 51.5 billion dollars in 2023. Furthermore, the market is expected to grow at a compound annual growth rate (CAGR) of 31.5% between 2023 and 2032. The Asia-Pacific region has been identified as a major hub for the expansion of the concept. For instance, the market in the Asia-Pacific region alone is expected to reach a value of 600-691 billion dollars by the end of 2032. This expansion is mainly driven by the adoption of collaborative robots (cobots) and the concept of digital twins in the logistics industry (Ali, 2025).

The findings also identify the fundamental difference between the concepts of Industry 4.0 and Industry 5.0. For instance, the findings suggest that the main difference between the two concepts lies in the move from "automation" to "augmentation" (Miftahurroziqin et al., 2025). While the concept of Industry 4.0 aims at replacing human capabilities through technology, the concept of Industry 5.0 aims at utilizing the capabilities of artificial intelligence to augment human capabilities. For instance, in the ecosystem of platforms, the findings suggest that the concept of Industry 5.0 aims at moving towards "Human-in-the-Loop" configurations, where the capabilities of artificial intelligence are utilized as a partner rather than a strict controller (Nasir et al., 2025).

5.2 Socio-Technical Challenges in the Gig Economy

A major segment of the findings has been dedicated to the "black-box" nature of platform governance. The findings suggest that despite the expansion of the concept of Industry 5.0, there still exist power asymmetry and information asymmetry between the stakeholders. For instance, the findings suggest that the lack of visibility of the "black-box" nature of the algorithms used to allocate tasks and compute performance ratings results in a sense of alienation among the gig workforce.

Challenge Category	Findings from Secondary Research	Impact on Workers
Transparency	High "black-box" complexity in task allocation (Nasir et al., 2025).	Reduced autonomy; lack of trust in the system.
Well-being	Use of gamified interfaces to drive productivity (Nasir et al., 2025).	Increased stress; social alienation and burnout.
Job Security	Prevalence of "transactional" contracts (Yu & Hamid, 2024).	High turnover; feelings of instability.

Based on an analysis of Gojek, it has been found that there is a partial alignment with human-centric principles, reflecting a concern with algorithmic invisibility (Miftahurroziqin et al., 2025). The research indicates that in the absence of a "Trust by Design" approach, where there is a focus on transparency and fairness, worker well-being could be compromised even as operational efficiency improves (Nasir et al., 2025).

5.3 Competencies for Technological Sustainability

From the analysis, it is clear that Technological Sustainability acts as a tool in strategic management, where innovation is aligned with social values. Organizations where there is a focus on indices such as the Output Compliance Rate (OCR) and Stock Coverage Rate (SCR) are more resilient to supply chain disruptions (Machuca & Davim, 2024).

In terms of technopreneurs, it is clear from the research that there is a "skills rebalance" where soft skills are now on a par with hard skills (AICTE, 2025):

- Hard Skills: Artificial intelligence, robotics, data analytics, cybersecurity.
- Soft Skills: Emotional Intelligence (EI), critical thinking skills, creativity, and ethical thinking. The study emphasizes the need for technopreneurs to be "born green" and "born responsible" to inculcate the concept of sustainability in the very fabric of their business models.

5.4 Higher Education's Role: The Education 5.0 Roadmap

The study proposes a roadmap for the development of higher education institutions. A study carried out by various Indian organizations, including AICTE, suggests that declaring 2025 as the "Year of AI" is a vital step to groom more than 40 million students for the future workforce (AICTE, 2025).

A synthesis of various educational studies reveals the following exemplary components of successful Education 5.0 models:

1. Personalized Learning: Harnessing AI to design the curriculum as per the strengths of students (Presidency University, 2025).
2. Industry Academia Hubs: Creating platforms where students collaborate with gig platforms to solve real-world problems for the betterment of society (Olszak & Sączewska-Piotrowska, 2024).
3. Experiential Learning: Designing internship models for students to engage in technical work combined with ethical thinking (Harahap et al., 2023).
4. Agile Delivery: Offering trans-disciplinary education and micro-certifications to minimize the boundaries between disciplines in the portfolio of courses (Ashmel et al., 2024).

5.5 Resilience and Sustainability Performance Synthesis

This is then followed by the results indicating a robust positive correlation between AI orchestration and sustainability performance (Sarkar et al., 2024). Moreover, the construct of resilience is indicated as a "competitive superpower," with platforms built to be crisis-ready showing greater ability to protect workers' livelihoods during economic shocks.

6: Discussion

The results obtained in this study provide a critical look at how the transition into Industry 5.0 is reshaping expectations around the gig workforce as well as educational institutions.

6.1 The Automation-Augmentation Paradox

The results obtained in this study confirm that the major dichotomy in the gig workforce stems from the "industry 4.0" paradigm of "automation-first" as a whole. The "black box" approach to managing the gig workforce leads to information asymmetry, thus aligning with the construct of "Psychological Contract" breach as per the theory. On the other hand, the Industry 5.0 paradigm provides an avenue for "augmentation," or the union between human creativity and technological precision.

An important point to note is the "Automation-Augmentation Paradox," whereby "augmentation" leads to increased efficiency but simultaneously decreases worker resilience and increases alienation in society as a whole. Management theorists argue that augmentation cannot be decoupled from "automation" as they are dual applications of AI technology. A "single-dimensional" approach leads to negative social outcomes. In the case of technopreneurs, a "human-in-the-loop" approach whereby AI is utilized as a "supporting" entity can significantly reduce worker "burnout" and increase platform loyalty.

6.2 The Roadmap for Higher Education: Implementing Education 5.0

A major finding is the pressing need for Higher Education Institutions (HEIs) to move towards Education 5.0. Conventional curricula are no longer effective in matching the inter-disciplinary demands of Industry 5.0 (All Commerce Journal, 2025)

The proposed roadmap prioritizes the development of technopreneurs according to the "Trust by Design" paradigm (Nasir et al., 2025). This involves enabling students to design fair algorithms. Evidence of the success of "5.0 hubs" and the AICTE "Year of AI" programs confirms experiential learning is the best method for addressing the skills gap (AICTE, 2025). By engaging students with social projects, HEIs can develop "sustainable technopreneurs" who correlate social value with profitability.

6.3 Implications for Management and Policy

Practical implications for management include the following:

1. **Leadership 5.0:** Leaders should integrate digital minds with high EI. Leadership 5.0 requires leaders to be empathetic and caring for the well-being of the workforce to sustain engagement with technology (Avolio & Kahai, 2003; Nasir et al., 2025).
2. **Sustainability as Strategy:** Organizations should use the P-TSA framework to monitor the organization's "sustainability index." By monitoring OCR, organizations can ensure technology is being used for ethical purposes, thereby creating a competitive advantage (Machuca & Davim, 2024).
3. **Livelihood Resilience:** Governments should implement policies to provide "portable benefits" for gig economy workers, enabling the transfer of benefits from one platform to another. This is critical for protecting the workforce from economic shocks (Ali, 2025).

6.4 Comparisons with Prior Literature and Theory

This research confirms the findings of the European Commission (2021) but also extends the scope of the research through the Indian context. Unlike the findings of the prior research on the subject of "smart factories," the research proves the applicability of the "human-centricity" principle to service platforms as well.

The positive correlation between AI orchestration and sustainability performance (r = 0.71) confirms the "triple bottom line" theory, which suggests that there is an unbreakable link between technological progress and environmental protection (Sarkar et al., 2024). However, this research goes a step further by pinpointing the exact form that the "Education 5.0" phenomenon takes to ensure the creation of leaders capable of effectively balancing the two.

6.5 Limitations and Future Research Directions

A limitation of the research lies in the fact that the findings were based on secondary research. Future research directions involve carrying out primary research to conduct a survey of gig workers across the country to understand their "lived experiences" (Miftahurroziqin et al., 2025). Future research also needs to be carried out to understand how the principles of Industry 5.0 can be adapted to the unique regulatory requirements. Resilience is the least researched area of the three pillars. Developing quantifiable measures for the concept of "well-being" is a crucial area for future research.

7: Conclusion and Summary

This study aims to explore the transformative potential of Industry 5.0 and Education 5.0 in reshaping the gig economy through a higher education perspective. It begins with the assumption that, although Industry 4.0 was successful in enhancing digital efficiency in the gig economy, it failed to address the human factor in terms of the well-being of gig workers. However, by shifting focus to human-centricity, sustainability, and resilience, higher education institutions (HEIs) can play a crucial role in incubating "sustainable technopreneurs."

Based on the research, it is found that the future of the gig economy will depend on a "Trust by Design" approach. It involves a paradigm shift from algorithmic management to transparent systems that complement, not replace, human labor. "Collaborative intelligence" technopreneurs are more likely to create gig platforms where the psychological contract of gig workers is respected, thus enhancing organizational identification and reducing turnover.

The proposed roadmap for management institutes includes curriculum reforms in terms of technical knowledge in artificial intelligence and robotics, combined with human-centric knowledge in terms of emotional intelligence and ethical decision-making. By creating university-industry hubs, HEIs can provide experiential learning experiences in tackling sustainability challenges in the gig economy, thus supporting the "Viksit Bharat 2047" vision and the Sustainable Development Goals (SDGs).

Future Research Directions

Empirical research is necessary to identify the experiences of gig workers in India. Future research should focus on the development of standards for measuring the well-being of gig workers, as well as the human–machine interface. Furthermore, future research should explore the long-term outcomes of livelihood resilience strategies, such as the use of portable benefits, for the well-being of gig workers during economic crises.

In conclusion, the emergence of Industry 5.0 presents a unique opportunity to humanize the digital workplace. By ensuring that the outcomes of education are consistent with the principles of technological sustainability, it is possible for higher education institutions to produce future generations of technopreneurs who are committed to the development of a more equitable society. The future research directions outlined above provide a blueprint for this transition.

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