Unionization in Indian Industries: Challenges and Opportunities in Workforce Transformation through Industry 4.0

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Abstract

The study focused on the dual effects of technologies associated with Industry 4.0 and trade union activity on labor relations and workforce transition in Indian industries. It examined how "automation, Artificial Intelligence (AI), the Internet of Things (IoT), and digital platforms" are changing the employment landscape, and what role unions play in protecting workers' rights and facilitating upskilling. The research design included a mixed-methods approach that included stratified random sampling of 200 participant workers, with the responses analyzed using SPSS regression procedures. The results suggested that the role of technology associated with Industry 4.0 had a weak positive and statistically significant impact on labor relations (R^2 = .030, p = .013) but with limited explanatory power. In contrast, union activity had a fair to moderate, significant influence on workforce transition (R^2 = .245, p = .000), signifying its role in managing technological displacement as an outcome of Industry 4.0 technologies. Generally, the results indicate that while Industry 4.0 technologies may Phillips et al. (2021) alter the traditional employment landscape and relations, an active union presence may stimulate an effective upskilling process and a more fair and resilient workforce transition.

Keywords: Unionization, Workforce dynamics, Automation, Reskilling, Gig economy, Indian industries

1. Introduction

The Industrial 4.0 revolution, or I4.0, is changing production and employment models worldwide, including in India. The term I4.0 encompasses automation, artificial intelligence, cyber-physical systems, robotics, and data-driven decision-making. To acknowledge a new era of I4.0 means to also recognize that technology—while central to the conversation—is not the only consideration; the very nature of work is changed, the workforce is changed, and organizations and policymakers are navigating new needs for labour relations (Eschmann et al., 2020). One of the implications for labour relations has to do with the effect of I4.0 on unionization and collective voices of worker action to negotiate workloads. In particular, India has a robust historical response to industrial labour voiced through unions, which remain influential in regards to fair wages, safe working conditions and avenues to pursue grievances. Unions hold a long tradition of being a legitimate and embedded feature of the industrial relations system, regularly representing their membership as part of a tri-partite dialogue, whenever forming labour policy (Pillai & Paul, 2023).

However, the advancement of the Fourth Industrial Revolution presents serious challenges to these conventional arrangements. Automated production processes and AI-enabled processes reduce demand for routine, manual labor and generate high-level, knowledge-based jobs. As a result, many permanent positions have been converted into short-term contracts, freelance jobs, or platform-based employment (Agarwal et al., 2022). The emergence of the gig economy, which typically revolves around digital platforms and lacks an identifiable employer, is further fractionating workforces and increasing the difficulty of engaging in collective bargaining (Bhat, 2020). These shifts are undermining and complicating the typical employer-employee relationship on which unions have historically relied to bring workers and employers to the bargaining table. Unions are dealing with an array of challenges such as recruiting union members, retaining a sense of commitment among members, and negotiating agreements with multiple employers. On the other hand, technology advances require more reskilling and upskilling of workers to adapt to changing jobs and future work. This generates a role for unions that is more proactive than ever to help their members with lifelong learning and career changes (Verma & Venkatesan 2023).

The consequences of these changes extend to numerous fields, including manufacturing, logistics, information technology, and services. Automation replaces routine work and creates new skills, which professionalizes the labour market with a split between high-skill, high-pay jobs and low-skill, low-pay or gig jobs (Miah et al., 2024). Gig workers—the drivers, delivery workers, and freelance coders—are often exempt from traditional labour and workplace laws, thus compounding their vulnerability to fluctuating income and/job risks (Hammer & Karmakar, 2021). Unions face difficult challenges existing in a post-labour context: loss of security in traditional employment, dispersal of workers across geography (i.e., gig workers), and loss of bargaining power. Employment law constructs for factory workers often fail to address the implications of algorithmic management by employers, the importance of privacy of workers' data, and workers' rights protection in platform work (Brahma et al., 2021).

At the same time, these disturbances continue to create possibilities for the reinvention of unionization. The same technologies that fragment employment can be employed to strengthen worker representation. Workers are better organized as unions employ a variety of digital communication, encrypted messaging applications, and social media platforms to organize physically dispersed workers, hold meetings, and deliver messages in a timely manner (Mishra & Maheshwari 2020). By negotiating structured reskilling and upskilling opportunities, unions can improve workers' employability and ability to share in productivity election initiated by the technologies. The only way to accomplish this is through negotiating policies that help make data transparent, agree to an ethical management of algorithmic review, and include gig and contract workers into social security and collective bargaining (Szabó-Szentgróti et. Al, 2021). E 4.0 provides unions with an opportunity to rethink their purpose from just exclusively a bargaining issue to negotiations around lifelong career employment, mediating the selection of technologies into the workplace, and coordinating social protections.

1.1 Evolving Role of Trade Unions in India under Industry 4.0

Trade unions in India have historically played a pivotal role in protecting labour interests and ensuring social justice. Emerging in the early 20th century to counter exploitative colonial labour practices, Indian unions became a cornerstone of the organized industrial sector (Barua & Haukanes 2020). Trade unions played a major role in creating fair wages, oversight for occupational safety, grievance handling systems and social security. Since unions made collective decisions using the collective bargaining process and participated in tripartite forums, they gained statutory recognition and legitimacy to influence policy. However, over time, the process of economic liberalization, privatization, and globalization has changed industrial relations (Kulkarni & Datta, 2024). The emergence of contract labour, outsourcing, and flexible forms of employment has eroded traditional unions over time. In this context, Industry 4.0 introduces an unprecedented and revolutionary dimension to the challenge of unionization. Along the lines of smart manufacturing, digital supply chains, and platform-based service delivery, Industry 4.0 questions the standard employment–employer contracts that have formed the basis of all collective bargaining processes (Duncan 2022). The increase in digitally mediated work has meant that many employees work off-site digitally or multiple short-term projects for different employers, along with minimal employment contracts. The increased `fluidity' of employment has removed the stable base unions have relied on (Pillai & Paul 2023).

Industry 4.0 is not just an incremental technological change; it represents a complete transformation of employment interactions. Machines and artificial intelligence (AI) are taking over increasingly higher shares of the repetitive and routine tasks that once underpinned human work. Although this can raise productivity and efficiency it simultaneously displaces some jobs and generates new skill requirements (Agarwal et al., 2022). The stratification of the labour market is evident in all areas of manufacturing, logistics, and services. There is increasing demand for higher skilled jobs such as robotics maintenance engineer, data scientist, and cybersecurity, as well as stagnation and/or decline of low- and mid-skilled routine jobs (Szabó-Szentgróti 2021). For the Indian industries, with a substantial proportion of the workforce in semi-skilled jobs, this paradigm shift poses significant complications. Many individuals are at risk of being left behind if they do not routinely reskill and upskill to prepare themselves for an increasingly digitised workplace. In addition, the growth of the gig economy - when individuals are employed through digital platforms such as those for ride-hailing, food delivery, or freelance service workers - adds complexity to this already diverse workforce (Varshney 2021). Gig workers experience additional difficulties than standard employment such as no set salary, social security, or health insurance (Bongomin et al., 2020).

1.2 Changing Nature of Employment under Industry 4.0

The evolving nature of work in I4.0 represents not merely a form of technological shift but instead a major socio-economic transformation that reshapes the defining characteristics of labour relations in Indian industry. Employment models associated with conventional forms of work that relied on stable, long-term contracts and stable employer-employee relationships are being eroded as working arrangements

increasingly adopted flexible and project-oriented structures (Gajdzik 2021). In manufacturing, sophisticated robotics and automated production lines have reduced dependence on manual labour, while artificial intelligence and machine learning systems of data analytics in services are increasingly managing customer interfacing and logistics. The effects of these developments are two-fold: while some categories of jobs may decline or vanish, new jobs appear that involve increasing cognitive and digital skill attributes (Cimini et al., 2021).

The job market is increasingly characterized by instability and polarization: a few workers hold high-skill, high-wage jobs, while a much larger number of workers experience insecurity and persistent pressures to reskill. For unions and labor organizations that formed around workplaces with large numbers of workers and permanent employer–employee relationships, these new labor market dynamics present both structural and strategic issues (Puhovichova & Jankelova 2020). These issues are evident in the gig economy. Platform workers—delivery partners, app-based drivers or other freelance labor—often define themselves as independent contractors, rather than employees. They do not have a single employer and often have limited access to labor legislation or collective bargaining protections, making it difficult for unions to organize these workers and establish benefits such as social security, health benefits and job protections (Zizic et al., 2022). Additionally, algorithmic management and workplace data-driven surveillance in both manufacturing and service industries raises new concerns related to privacy, surveillance and fairness that must be addressed in terms of representation and advocacy (Sony & Naik 2020).

Similarly, while the same technologies transform conventional union practices, they also provide opportunities. Digital platforms for communication, encrypted messaging and chats, and data-based analytics are giving unions unprecedented ways to communicate with workers in distinct locations and employment categories (Sima et al., 2020). These modalities even allow for virtual member engagement drives, virtual consultations, and "real time" mobilization, assisting unions with connecting with a fragmented workforce. Moreover, the development of skills for Industry 4.0 to be resistant to automation provides a clear role for unions in negotiating curricula for training and ongoing education purposes (Malik et al., 2022). In conjunction with employers and other governmental supported programs like Skill India, unions may assist in designing the reskilling curriculum so it is directly tied to the emerging needs of each industry, in turn providing better opportunities for workers to be hired in industry and remain employable (Li 2024).

Figure 1: An Introduction to The Industry 4.0 In Industries

The importance of the study goes beyond labor relations. As India seeks to become a global center for manufacturing and technology, sustainable and fair employment is essential for social cohesion and economic fragility. If appropriately transformed to meet the needs of the 21 century, trade unions can play a major role in ensuring that a technology-based transformation does not exacerbate inequality and/or erode labor rights. Bridging the skills gap, facilitating transitional pathways to automation, and promoting socially conscientious innovation are only a few of the ways unions can assist. All in all, Industry 4.0 brings an extraordinary challenge and unique opportunity for unionization in India.

2. Literature Review

The ever-growing speed of “I4.0 technologies” had changed the world of industry and work. It was influenced on employment relations, skills requirement and the role played by the institutions in controlling and sustaining these changes. According to Pillai and Paul (2023), there were four important drivers of employment relations in the Indian IT sector. The authors paid attention to labor legislature, compensation and HR policies, trade unions and health and safety of the working place. Authors argued that the current labor regulations and the non-homogenous HR practices had to be transformed in reaction to the needs of knowledge economy. In a similar vein, Mishra and Dwivedi (2024) claimed that the new Indian labor codes replicated the trend of “reforms by stealth” by continuing the dilution of union power and making conditions for workers more precarious. These issues were also valid in the European context. Teixeira and Tavares-Lehmann (2022) noted that EU member states were experiencing different levels of adoption of Industry 4.0, due in part to existing asymmetrical conditions as well as asymmetrical responses from the market. Haipeter (2020) showed in Germany that unions can play an important role in shaping some aspects of digitalization, specifically through “Work 2020,” which promoted participation by workers and workplace agreements. By and large, these studies made an important point that technological change cannot and should not be thought of independently of the reform of labor law, adaptation of institutions, and union strategies.

Then again, the conversation regarding Industry 4.0 stressed the possibilities for future-changing technological interventions, particularly with digitalization or advanced or smart systems, to improve the state's industrial structure. Varshney et al. (2021) listed ways smart sensors and IoT-infrastructure were crucial in the industrial advanced systems discussion, and referenced links about some of the connections to the mission India mission of Digital India and AtmaNirbhar Bharat. Mourtzis, Angelopoulos, and Panopoulos (2022) provided similar observations regarding Industry 4.0 as largely machine-oriented leading to the idea that industry 5.0 would primarily have been about human-centered and sustainable technology and development. Zafer and Vardarlier (2021) further noted that the complications of Industry 4.0 existed beyond production, into employment, class construct, and geographic environments, branding a new workforce. In a statement about work labor, Grodek-Szostak et al. (2020) noted how automation and robotization could compel or complement efficiency in the workplace, but also necessitated technologically integrated human-intelligent labor. Collectively these produced a sense that Industry 4.0 was not just a technological advancement but a socio-economic reshuffle requiring the right set of policies to meet eventualities.

A common thread across the literature was the primacy of workforce development, reskilling and upskilling as part of traversing transitions to Industry 4.0. Li (2024) stated that nearly 50% of employees would have needed to reskill, and that many current job requirements would no longer have existed by 2025; thus, developing strategies for lifelong learning had to occur for employees on an individual basis, and for organizations as a collective. Karpenko, Zasorina and Karpenko (2020) voiced worries that there was a skill gulf between the skills that Ukrainian employers wanted and those who graduates possessed, and called for stronger ties between business and education to better close this gap. Ozkan-Ozen and Kazancoglu (2022) shared that there were 13 workforce challenges, one of the “most pressing being the lack of IT/digital skills,” and that this lack of skill had a cascading effect on other areas. Bhat (2020), writing about India, described the country's advancement of digitalization, but noted that the penetration was unbalanced across sectors, and therefore collaboration with multiple stakeholders was essential to develop training and skills-building opportunities. Together, these studies reiterated that without a systematic focus on workforce development, promises of Industry 4.0 would have created or simply worsened inequities, rather than fostered inclusive growth.

Unions and collective representation also represented an important piece of navigating the Industry 4.0 transformations. Oberkrome (2024) considered both the historical and contemporary role of Indian unions in the development of labor law, and how unions were attempting to figure out how to maintain a lasting influence in the face of technological information and economic liberalization. Sobirjonov (2025) also noted that unions were adopting digital advocacy platforms - social media, virtual organizing, and online petitions - to "update" their activism and connect with new generations of workers. On a similar note, Achour (2025) documented how unions in the gig economy were creating new approaches to representation and were experimenting with partnering with social movements, even when labor relations were disintegrating. Saving the best for last, Haipeter (2020) made the German case of unions creating activities for the challenges of digitalization and acted more proactively than unions in countries such as Australia or Canada. All these texts reasonably converged on the conclusion that while traditional unions faced existential threats in the digital era, innovation and adaptation could have provided the opportunity for unions to once again be positioned as a central force in shaping the future of work.

The recent academic discussions placed Industry 4.0 within a larger context of changes for the global economy and society that brought both opportunities and risks, and a growing emphasis on human

outcomes. Grodek-Szostak and colleagues (2020) demonstrated that technological change was creating different levels of job opportunities and promoting new business models and cost structures in a recursive way. Mourtzis et al. (2022) asserted that Society 5.0 required a counterbalance to the machine-centered orientation of Industry 4.0 with respect to resilience, sustainability, and human well-being. Zafer and Vardarlier (2021) pointed out that the societal impact of Industry 4.0 was shaping community issues and employment relations, creating a context for fair and inclusive practices. Li (2024) argued that lifelong learning needed attention in the workforce to ensure people could participate and benefit from ongoing technological change. From these studies it seemed that Industry 4.0 was more than an engine of innovation, it also posed a challenge for inclusive and equitable employment with principled policies, institutional reform, and robust social dialogue required.

Although studies show how Industry 4.0 affects employment relations, workforce initiatives, and union strategies, a major research gap remains: these perspectives have not been integrated into a single framework that addresses both technological and socio-institutional aspects. Some of the studies and literature on Industry 4.0 is based on the technological nature of adoption and skills (Li, 2024; Varshney et al., 2021), or labor law and union adjustment (Pillai and Paul, 2023; Oberkrome, 2024; Sobirjonov, 2023), although few of them bridge how these forces interact to shape the employment relations of the future. Furthermore, while some studies have explored reskilling, digitization advocacy, policy asymmetries, etc., little study appears to explore some comparative, cross-sectoral, and longitudinal studies in emerging economies, like India. Thus, future studies should look to bridge the gap of exploring interconnections of each of the technology, labor institutions, and workforce readiness in regard to Industry 4.0 situation.

3. Research Gaps

While the existing body of literature acknowledges that Industry 4.0 technologies are swiftly transforming production systems, labor demand, and skill structures in India, there are still considerable knowledge gaps regarding the effective intervention of trade unions in this transition. Current studies emphasize that the transformations in global value chains and the emergence of new human rights governance frameworks are changing the traditional roles of unions; however, systematic evidence from the Indian context remains scarce. At the national level, policy initiatives that advocate advanced manufacturing and cutting-edge technologies suggest a robust drive towards digital transformation, yet the consequences for labor relations and collective bargaining are still insufficiently explored.

Firstly, there is a notable absence of sector-specific empirical research that documents how unions in manufacturing, IT services, logistics, and construction are adapting to automation, robotics, AI-driven scheduling, and data-driven management systems. The existing literature addresses the overarching challenges posed by Industry 4.0; however, there is a significant lack of micro-level evidence regarding union strategies—such as negotiating for digital upskilling, securing automation safeguards, or forming worker-management technology committees.

Secondly, a critical gap exists concerning the relationship between India's recent labor code reforms, state-led skill development initiatives, and the involvement of unions in workforce transformation. Government programs—like ITI modernization and digital skill labs—are designed to enhance employability, yet academic research seldom examines whether these reforms enable unions to assume a significant role in securing training entitlements or in safeguarding workers displaced by automation.

Lastly, there is no standardized framework available for assessing Industry 4.0 skill gaps or the readiness of unions. Although international studies have sought to delineate Industry 4.0 competencies, the methodological tools applicable to Indian labor markets are still inadequately developed. This deficiency hampers the capacity of unions, businesses, and policymakers to effectively address the challenges posed by these technological advancements.

Fourth, the research concerning informal, gig, and migrant workers—who represent an increasing portion of the workforce impacted by automation—is inadequate. Studies indicate that unions encounter challenges in organizing platform-based and informal labor; however, there is a lack of empirical research exploring new organizing models (such as digital unions, hybrid cooperatives, or platform bargaining) that could provide representation for these workers in an economy undergoing technological changes.

Fifth, the gendered effects of automation are still not thoroughly examined. Evidence from industries like construction shows that female workers are disproportionately affected by job displacement and face obstacles in reskilling, yet research seldom links these findings to union strategies aimed at fostering inclusive workforce transitions.

Lastly, the existing literature is deficient in longitudinal analyses that evaluate whether Industry 4.0 results in sustainable enhancements in job quality—such as wages, job security, and working conditions—and how the presence of unions influences these outcomes. Current research tends to provide snapshots rather than long-term tracking of worker trajectories in workplaces that are undergoing technological transformation.

In summary, these deficiencies highlight the necessity for more rigorous, sector-specific, and methodologically varied research to comprehend how Indian unions can facilitate a fair and equitable transition to Industry 4.0.

4. Statement of the problem

Industry 4.0 has brought remarkable changes to production systems, workforce needs, and employment relations but remains unclear about its significance for labor institutions, skill development, or inclusive workforce integration. Technological advancements, such as automating, the Internet of Things (IoT), and digitalization, drive productivity and innovation, but also complicate the discussion around job loss, precarious employment, labour market legislation, and the erosion of employee representation. The scholarship in these areas is still scattered, often studying skills gaps, union coordination, or policy asymmetries, and not providing a holistic view of how these concepts relate to one another - particularly in developing economies, such as India, where capacity of institutions and workforce readiness varies considerably across regions and sectors. The lack of integrated treatment raises questions about how to reconcile the need for innovation within industry with decent work, adequate safety nets, and sustainable employment relations in an era of Industry 4.0.

5. Research Methodology

This study employs a “mixed-methods approach” that combines both “qualitative and quantitative methods” to achieve a holistic understanding of the research problem. The research design is “exploratory in nature and descriptive in approach”. The study adopts a broad geographical approach across India, adding to the relevance of the findings. The population includes employees working in industry, leaders of trade unions, and representatives of management, involved in executing or impacted by Industry 4.0 technologies and trade union initiatives.

➢ Sampling, Data Collection, and Instruments

A “stratified random sampling” approach was employed to make sure that the various groups of respondents were adequately represented, in order to gather differing perspectives within the industrial sector. A total of 200 participants were included in the study sample , which is appropriate for statistically rigorous analysis and useful interpretability. Data was obtained from both “primary and secondary sources”. “Primary data was collected, using a structured questionnaire” measuring the perceptions of respondents. Secondary data consisted of academic and career research report literature, policy documents, industry manuals, and government documents serving to supplement and validate the findings of the PD.

The study defines the independent variables as the “adoption of Industry 4 technologies and collective bargaining union initiatives”, while the dependent variables comprise the outcomes of labor relations and employment patterns and workforce transformation. The study used MS Excel and SPSS version 27 for data analysis. The methods applied include mean, standard deviation, and regression analysis.

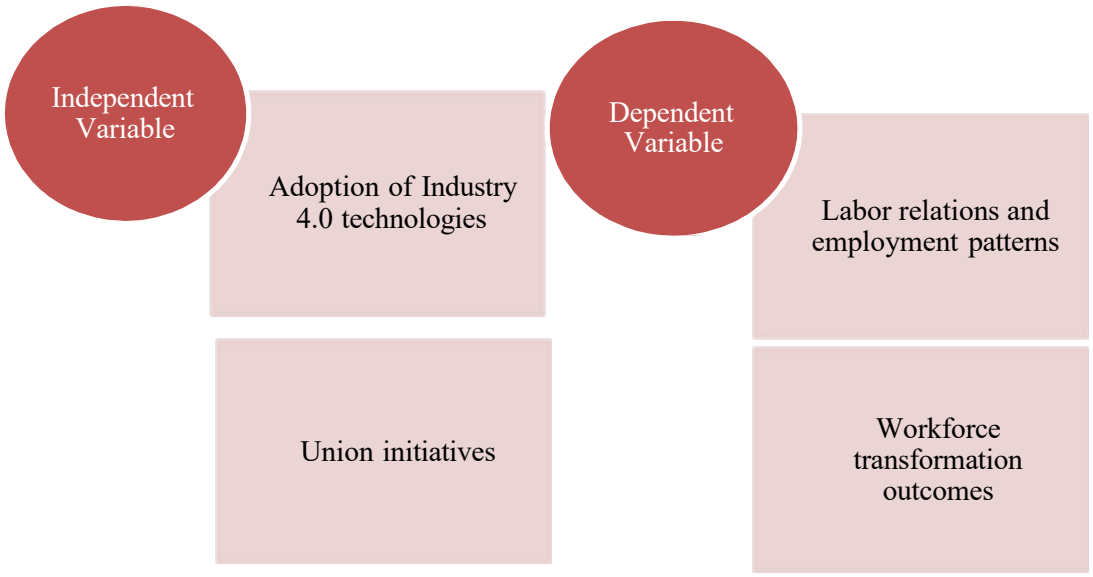

Figure 1: Conceptual framework

6. Analysis and Interpretation

Table 1: Demographic Characteristics

S.NO.	Demographic Characteristics		N	%
1	Gender	Female	89	44.50%
		Male	111	55.50%
2	Age Group	Below 25 years	35	18%
		25–34 years	44	22.00%
		35–44 years	41	20.50%
		45–54 years	42	21%
		55 years and above	38	19%
3	Educational Qualification	Graduate	34	17%
		Post-Graduate	38	19%
		Diploma / ITI	43	21.50%
		Doctorate	42	21%
4	Work Experience in Industry	Less than 1 year	42	21%
		1–3 years	49	24.50%
		4–6 years	42	21%
		7–10 years	36	18%
		More than 10 years	31	15.50%
5	Membership Status in Union	Member of a Trade Union	60	30%
		Not a Member	62	31%
		Management Representative	78	39%

Demographic information shows that respondents have diversity related to gender, age, educational qualifications, work experience, and union membership. More respondents were male (55.5%) than female (44.5%). More of the age distribution was somewhat proportionate for younger (i.e., 25-34 years (22%)) and mid-career (i.e., 45-54 years (21%)), having both groups represented well in the sample. In terms of educational level, there were differences among the respondents but there were a considerable number of respondents with either a Diploma/ITI (21.5%) or a Doctorate degree (21%) compared to postgraduates (19%) and at least one undergraduate degree (17%). For work experience, the bulk of respondents were in the range of 1-3 years (24.5%), with just under 1 year and 4-6 years experience also equally represented and around 21%, which signifies that there were at least, a few responses from inexperienced employees at the early stages of their career and some experienced employees who were still relatively early in their careers. Eighteen percent and 15.5% fall senior category with 7-10 years and 10+ years of work experience, respectively. In terms of union membership, management representatives made up the largest representation (39%), and while members (30%) and non-members (31%) were nearly an equal contingent, each provided a perspective from an employee or management perspective. Overall, the sample is broad enough to gather a representation of workplace experiences and experiences.

Objective 1: To examine the impact of Industry 4.0 technologies (automation, AI, IoT, robotics, digital platforms) on labor relations and employment patterns in Indian industries.

H1: Industry 4.0 technologies significantly influence labor relations and employment patterns in Indian industries.

Table 2: Model Summary

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.175[a]	.030	.026	2.94382

a. Predictors: (Constant), Adoption of Industry 4.0 technologies

According to the findings, the independent variable, "Adoption of Industry 4.0 technologies" accounts for approximately 3% (R Square = .030) of the variance in the DV. The Adjusted R Square value (.026), which corrects for SS and number of predictors, linearly shows there is still very little explanatory power and suggests that Industry 4.0 adoption alone is insufficient for determining the outcome variable. Alternatively, the CC (R = .175) demonstrates a weak positive association between the predictor and DV. The standard error of the estimation (2.94382) indicates there is an average distance from the observed value, and it is possible be significant. This generally means, while there is a positive association with the predictor, there was a large amount of variance unexplained by the model. Thus, it would suggest that other variables other than Industry 4.0 adoption are having more explanatory power and should be included in further revisions.

Table 3: ANOVA[a]

ANOVA[a]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	53.911	1	53.911	6.221	.013[b]
	Residual	1715.884	198	8.666		
	Total	1769.795	199			
a. Dependent Variable: Labor relations and employment patterns						
b. Predictors: (Constant), Adoption of Industry 4.0 technologies						

The "ANOVA table indicates that the overall regression model is statistically significant (F = 6.221, Sig. = .013)". This indicates the predictor, "Adoption of Industry 4.0 technologies", is having a significant impact on the DV, Labor relations and employment patterns. The regression "sum of squares" (53.911) compared to the residual "sum of squares" (1715.884) shows that while the "Adoption of Industry 4.0 technologies" does explain some of the variation in labor relations and employment patterns (about 3%), 97% of the total variation is still unexplained by the single predictor. With 198 degrees of freedom in the residual, the model is capturing a real, but small effect. This statistically significant result again affirms that the "Adoption of Industry 4.0 technologies" is significantly influencing changes in labor relations and employment patterns, however, there remains variance occurring because of combinations of other factors.

Table 4: Coefficients[a]

Coefficients[a]						
		Unstandardized Coefficients		Standardized Coefficients		
Model		B	Std. Error	Beta	t	Sig.
1	(Constant)	7.162	.904		7.927	.000
	Adoption of Industry 4.0 technologies	.202	.081	.175	2.494	.013
a. Dependent Variable: Labor relations and employment patterns						

The coefficients table establishes the influence of the "Adoption of Industry 4.0 technologies" (explanatory variable) on Labor relations and employment patterns (dependent variable). When the explanatory variable is not being considered (constant), the constant value in the model shows that labor relations and employment patterns would be quite high (B = 7.162, p = .000). The unstandardized coefficient provides the information that one unit of increase in Adoption of Industry 4.0 technologies is associated with an increase of 0.202 units in Labor relations and employment patterns (B = .202, p = .013). The Beta or the standardized coefficient implies that Adoption of Industry 4.0 technologies has a weak but positive positive effect on Labor relations and employment patterns (Beta = .175). Furthermore, - since the results reached significance at $p < .05$ - it can be concluded that the adoption of I 4.0 technologies indeed has value to note as it relates to Labor relations and employment patterns. That said, it is important to point out that the overall effect would be modest and, in all likelihood, other variables explain the dependent variable with greater power.

Objective 2: To analyze the evolving role of trade unions in addressing workforce transformation challenges

arising from technological disruptions.

H2: The role of trade unions significantly influences how workforce transformation challenges are managed in the context of technological disruptions.

Table 5: Model Summary

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.495[a]	.245	.241	2.10353
a. Predictors: (Constant), Union initiatives				

The information from the model summary suggests that union initiatives demonstrate more predictive strength than Industry 4.0 adoption identified in the previous model. CC (R = .495) indicates there exists a moderate positive relationship with the DV. The R Square of .245 indicates that union initiatives estimates account for 24.5% of the variance to the outcome variable, which is notable for social science research. The Adjusted R Square (.241) - which is adjusted for the sample size and the number of predictors - communicates the model overall remains a strong relationship with minimal reduction in predictive power overall. Relative to the previous model, the "standard error of the estimate (2.10353)", is lower, indicating predictions are closer to the observed values. In sum, it can be interpreted that union initiatives are significantly more powerful than Industry 4.0 adoption, as it relates to labor relations, and employment patterns.

Table 6: ANOVA[a]

ANOVA[a]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	283.859	1	283.859	64.151	.000[b]
	Residual	876.121	198	4.425		
	Total	1159.980	199			
a. Dependent Variable: Workforce transformation outcomes						
b. Predictors: (Constant), Union initiatives						

The ANOVA results indicate that the regression model is significant (F = 64.151, Sig. = .000), which suggests that Union initiatives exert a strong and statistically significant influence on Workforce transformation outcomes. The regression sum of squares (283.859) versus the residual sum of squares (876.121) shows that union initiatives explain a substantial share of the total variance in workforce transformation. Given that the R^2 value from the model summary is R^2 = .245 means nearly a quarter of the variance is accounted for – this suggests that union action and initiatives such as negotiations, policy changes, and training support for workers, determine how the workforce transitions to changing industrial needs. The large F-value corroborates the strength of this relationship, indicating union initiatives are an important part of workforce transformation - more important at explaining workforce transformation than technology alone.

Table 7: Coefficients[a]

Coefficients[a]						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	4.632	.625		7.416	.000
	Union initiatives	.477	.060	.495	8.009	.000
a. Dependent Variable: Workforce transformation outcomes						

Tables of Coefficients indicate that Union Initiatives significantly predict Workforce transformation outcomes. The constant (B=4.632, p=.000) indicates that even with no union initiatives, there is expected to be a level of workforce transformation. The UC (B=.477, p=.000) “indicates that for every one unit increase” in union initiatives, workforce transformation outcomes are expected to increase by .477 units. The SC (Beta=.495) indicates that union initiatives have a moderate, positive, to strong positive influence,

which suggests that union initiatives are one of the most important predictors in determining how the workforce will be transformed. The t-value (8.009) was once again high, with a finding of high statistical significance ($p<.001$), indicating that the relationship is robust and reliable. This generally means that activation of union actions that are proactive, such as advocacy, worker training, negotiations for fair treatment, and to adjust to the inevitable changes to the changing labor relations climate, are important enabler factors for workforce transformation in changing labor relations.

Objective 3: To identify best practices and strategies for strengthening union effectiveness in ensuring fair labor practices, upskilling, and workforce well-being in the digital age.

H3: Adoption of best practices and innovative strategies significantly enhances union effectiveness in ensuring fair labor practices, upskilling, and workforce well-being.

The international case studies point to the fact that unions that involve best practice and innovative practices, including collaborative bargaining; member participation actively; and digitalization practices overall, are in the majority gaining much in their capacity to support fair labor practices and worker welfare (Rouka 2025). Member communication, advocacy, and training through digital devices embrace transparency; support outreach; and allow the members to communicate in real-time irrespective of their location disparity and geographic distribution (Yakymchuk et al., 2025). The unions have a leverage to overcome new challenges in the digital workplace with such strategies as the bargaining that implies data-based decision-making, the use of AI to resolve grievances, and the management-partner programs with skill-development orientation (Orujov and Ismayilova 2025).

Moreover, unions also increase the flexibility of workers in the digital era organization change vertical through instantiating an ongoing upskilling/reskilling workshops, mentoring and learning programs with industry partners (Crespo et al., 2025). Unions focused on lifelong learning can support development of not only technical skills, but interpersonal skills, too, that help members manage modified roles in response to increasing technologies and job displacement. Moreover, by involving employees in decision making, promoting their advocacy with the help of social media, and building relationships with other stakeholders, the institutions enhance their bargaining power and expand their reach (Sfetcu, 2024). The more effective they will be is how best practices that match the principles of transparency, inclusiveness, use of technology, will not only guarantee equitable working conditions, human rights and employee well-being, it will enable unions to remain relevant, powerful and influential in problematic and contentious working environments (Zervas and Stiakakis, 2025).

7. Discussion

The introduction of Industry 4.0 technologies provides a twofold impact upon work relations and employment practice in Indian industries. The regression analysis (Tables 2 - 4) documented a statistically significant effect (although weak) ($R^2 = 0.030$, $p = 0.013$), which shows that “Industry 4.0 technologies including automation, artificial intelligence, and digital platforms are changing the nature of work and employer-employee relationships”. This can be supported by the literature on Industry 4.0, which suggests that technologies are changing the traditional employment practices that involve routine types of manual labour into the alternative forms of work that are not involved in the traditional employment relationships, such as the work in the gig economy (Agarwal et al., 2022; Bhat, 2020). This new working environment has caused fragmentation of workers, geographical scattering and erosion of the traditional industrial relation between the employee and the employer. These developments are also leading to erosion of union power and to making collective bargaining more difficult (Pillai & Paul, 2023; Hammer and Karmakar, 2021). The same fragmentation of the labour market also polarizes the possibility of generating insecure working conditions to a large share of the working population forcing there to be a mechanism to protect the interests of the workers to the erosion of economic stability created by technology.

Conversely, the study demonstrates that clearly, trade unions have remained a relevant player in the management of the ever-evolving character of work. Results of the second objective (Tables 5-7) reflect a more robust and highly significant impact of union programming on transforming work ($R^2 = .245$, $p = .000$). This discovery provides reasons to believe that proactive unions can be crucial in surmounting the problems of Industry 4.0. According to the literature, trade unions are also redefining their efforts by adopting the same technology that is destabilizing work in the first place. They have adopted the usage of digital communication tools, encrypted messaging, and social media in order to coordinate remote workforce, handle virtual conferences, and organize easily (e.g., Mishra and Maheshwari, 2020; Sobirjonov, 2025). Moreover, their role is moving away from simply engaging in wage bargaining to promoting ongoing reskilling and upskilling through government-established programs such as Skill India - to enable workers to remain employable in a digitized economy (Li, 2024; Malik et al., 2022). By advancing ethical algorithmic management, data transparency, and coverage for gig and contract workers in social safety nets, unions are innovating their social purpose to protect worker rights and worker well-being from the negative consequences of technology (Szabó-Szentgróti et al., 2021; Achour, 2025). Therefore, while

Industry 4.0 presents existential challenges for traditional unionism, it also provides unions a chance to transform themselves into key actors in creating a more equitable, skilled, and resilient workforce.

8. Limitations and Directions for Future Research

- Limitations
  - The generalizability of the findings is limited since they were based on a modest sample size (N=200) and India's great regional and sectoral heterogeneity.
  - While the descriptive and exploratory design identifies relationships between the variables, it does not identify causal relationships.
  - A perception-based questionnaire rests on participants' perceptions, and is subject to response biases; the study lacked objective measures.
  - The study's focus on specific variables may have caused it to overlook additional relevant factors, such as corporate policies or economic conditions.
  - It is a cross-sectional study capturing a moment in time and does not include longitudinal or comparative cross-sectoral analysis.
- Directions for Future Research
  - Leading a comparative cross-sector analysis across the manufacturing, IT, logistics, and gig economy sectors, to understand and identify sector-specific challenges and union responses to imitation processes leading to International labour standards.
  - Developing and testing an integrated applied research framework linking technology adoption, policy reform, union strategies, and workforce outcomes.
  - Examining causal factors for the weak relationship between technology adoption and labour relations identified in this study with a focus on mediating and moderating factors.
  - Focusing on organizing models and representation frameworks for non-standard workers across the gig economy and platform work.
  - Examining union's role in the governance of workplace technology use, including ethical use of AI, data privacy, and algorithmic management.
  - Analyzing the implications for the implementation of new labour codes on collective bargaining and worker protection in the context of I4.0.

9. Conclusion

The study concludes that the advent of I4.0 presents an intensely dualistic scenario of unionization and labor relations in Indian industries, with both serious threats and radical opportunities. On the one hand, the data supports that "technologies, such as automation, artificial intelligence, and digital platforms", have statistically significant impact on altered employment trends, however, their explanatory power in the model is rather low. This technological transformation is essentially undermining the old models of employment by lessening the reliance upon routine manual labor, encouraging diffusion of non-standard work, including the gig economy, and making it easier to fragment the workforce and physically spread it out. The combination of these changes leads to a weakening of the employer-employee relationship under the basis of which, historically, a traditionally trade union productive relationship has been formed, which leads to a decrease in membership among the traditional relationships, a multilayered collective bargaining, a polarized labor market, and in which a large proportion of the workforce becomes vulnerable to an even greater extent of job precariousness and in need of further reskilling to remain able to work in a digital economy.

The disruptive era has also brought a revival and reinvention of the role of unions in India, the argument of the analysis goes. It demonstrates a positive, significant and positive association between positive union action and improved worker outcomes, which confirms the fact that unions are still of paramount importance. Rather than be passive consumers of technological change, adaptive unions are now employing the same disruptors, digital platforms, encrypted messages and social media, to coordinate dispersed workers, organize through virtual mobilization and accelerate the flow of information. The goals of these unions are increasingly non-traditional, like bargaining to organize reskilling/upskilling, frequently governmental and industrial cooperation; arguing in favour of ethical algorithmic management and data disclosure; and offering cover to gig and contract workers in these domains as well.

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