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Original Article

An Empirical Study of Technological Assimilation and Organizational Performance in Niche Manufacturing: Examining Adoption Barriers, Workforce Adaptation and Productivity Outcomes in Indian Thread Manufacturing Sector

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Abstract

This research looks at the thread manufacturing businesses' organizational effectiveness in connection to technical advancements. The research has been done on the basis of secondary sources of data and the research material obtained from the relevant journals, like scholarly and business journals, which have been studied with the important factors of the success of the business, such as labor distribution, productivity and return on investment (ROI). emphasis has been placed on technology solutions such as automated equipment and CAD and ERP programs that have greatly improved labor productivity already, supply chain performance and, consequently, operational inefficiency. However, significant workforce changes have emerged due to the high degree of automation, leading to a lower proportion of low skilled and higher proportion of skilled workforce. The results from the correlation and regression tests indicate that the use of organizational benefits (customer satisfaction and competitiveness in the market) is closely correlated with technologies. The study reveals that while technology upgrades can deliver significantly on ROI, there are still more steps to be taken towards technology progressions like AI and IoT. There are some retraining needs for an improved workforce not adapted to technological changes. The results of the study will support policymakers and top managers in the Indian textile industry in making their industries more sustainable and competitive.

Keywords: *Technological Assimilation, Organizational Performance, Automation, Workforce Adaptation, Productivity Outcomes, Indian Textile Industry*

Introduction

One of the most crucial and ancient of the Indian economy, the textile industry is in the process of a structural change [1]. Change has been rapid in an industry over the years and a lot of it is because of the technology it has witnessed changing quickly. The use of technology has allowed businesses to enhance their staff productivity, data management, equipment and quality assessment [2]. The results indicated that the technologies adopted in the industry facilitated implementation of efficiencies in production through automation of repetitive design tasks, productivity improvement of workers and reducing lead time needed to develop a product [6]. In the textile and clothing sector, the textile's context is undergoing a dramatic transition towards growing automation as a key tool for personnel's transformation, sustainability and competitiveness [4]. With the introduction of smart manufacturing technology, many changes are observed in the textile industry in India. Smart manufacturing and productivity: A simple benefit of smart manufacturing is increased productivity. Predictive maintenance helps minimize planned (interruption) downtime as a result of the equipment failing, while real-time monitoring helps minimize unscheduled downtime. There are also significant changes in the workforce, such as automation, which has replaced more skilled workers and the lesser number of the low-skilled workers [3].

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The industry is just in the process of embracing Industry 4.0 and has not been completed. There is a lack of skilled workers and there is a need to invest more in technology and innovations [5].

Need of the Study

The significance of this research is seen from the fact that in today's industrial world, there are several important elements that determine the setting of the industrial world. Considering the case of Pune district, India, no other industrial sector apart from Pune district's thread manufacturing industry is contributing towards the industrial ecology in terms of employment and economic productivity. Secondly, these are industries in which technological changes are very rapid and in case there is rapid technological advancement, then businesses should be attentive towards it both positively and negatively. Besides, the findings of the study would affect decision-making in organizations, engineering and industrial strategy and regulation in similar cases [11]. Limited research, however, has been undertaken on the effects of the adoption and utilization of technology on an organization's performance in an environment like India and this needs to be investigated further, especially in thread manufacturing firms. Despite significant investment by the Govt. of India in the IT sector to enhance the uptake of new technology in the thread manufacturing companies, an limited adoption rate has been observed. lack of structured models to guide tech decisions means technology won't see wide use and wasteful resource utilization will take place.

Objectives of the Study

- To investigate the correlation between Indian thread industry companies' performance and technology used. To recognize the problems and issues encountered by the industries producing threads and the impact of these issues in relation to the assimilation of the technology.
- To assess the impact of the adaptability of the workforce on productivity outcomes in the thread industries of India.

Literature Review

Kishore Khaitan, 2026, shared several impressive results they've achieved: LEAN manufacturing principles and automation have seen them overcome the shortage of workers and result in improvements in their productivity, quality and sustainability. The changes in what has been achieved have been incredible. Now there are up to 55% reductions in the production cycle times and they are no longer late on orders. They also decreased the use of the materials through the installation and use of energy-saving equipment, as well as optimizing processes. A low percentage of products can have issues with quality during the manufacturing process, with less than 0.01% [7]. Hiring trained and semi-trained staff has been another challenge and automation has proved beneficial in two areas – LEAN techniques. One thing they've been able to do is reduce the amount of manual work in various processes, including equipment failures, emergencies, problem-solving and material handling [7]. What they've realized the most is that automation has enabled their staff to work more easily, giving them the option to work more efficiently and effectively in jobs that don't necessarily involve the same type of specialized skill as they used to.

Singh et. al., 2025 studied India's small and medium enterprises of the textile and apparel sector in 2025 to find out the challenges in Industry 4.0 technology implementation. By using a research technique (DEMATEL), they were able to identify that risks related to cybersecurity are the biggest barrier to the use of these technologies [8]. Singh et al.'s (2026) study results they discovered a 68% improvement in the time before equipment failure; a 41% decrease in the time necessary to repair broken machines; an increase in machine availability from 82% to 93%; a 27% reduction in their maintenance costs; and an 11% reduction in energy consumption. The results of these outfalls are clearly evident not only in terms of sustainability but also in terms of economic performance of textile companies. The researchers have provided strong empirical evidence that the predictive maintenance technology can help to enhance the performance and productivity in India's textile industry [9].

Eighty-five out of 100 (85.7%) of the workers had at least some experience using technology in some aspect of their work. This sample of employers comprises 203 employers and 100 companies from Bengaluru and Delhi NCR. But many of these applications of technology were of a relatively basic automatic type, not using AI. 20.2% of workers said they have both automation and AI experiences and 65.5% said they have automation experiences but not AI. Out of all workers, only 11.3% had a technical diploma or degree; 25.1% got formal training; and 35.0% did not get any training. AI implementation speed was found in applications—like automated knitting machines (34% of the companies) and cutting and sewing machines (86% of companies). However, most (63%) workers reported that their job activities and responsibilities have changed and also that more than 81% of their job losses have been experienced [10].

Research Gap

The thread industry has become more and more technologically dependent and yet there are still a number of issues to be addressed that will enable many of the companies to introduce new technologies, including employee retention and acceptability and integration of technology in production. However, in this context of the Indian scenario up till now, no sufficient research has been done on technology adoption and technology use in Indian organizations, especially in the context of thread manufacturing companies, so it is needed to study it in detail. Although the Government of India has put a considerable investment in its IT to get people interested in accepting and using it in the

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thread manufacturing companies, there is only a minimal adoption rate. Without a clear technology adoption model, it will be hard to decide on the use of technology and wasteful resources will be used. The results indicate that there is a high gap regarding technical aspects as well as awareness and legislation in the industry that obstructs the effective implementation of IoT [12]. The shortage of skilled workers, especially in the sectors like textile engineering, design and production, hinders the sector. Also, this industry lacks skills on competent staff bases, which limit the industry in developing and also hinder the adoption of the technology [13]).

Data Collection

Table 1: Adoption Rates of Industry 4.0 Technologies in the Indian Textile Sector

Technology	Adoption Rate (%)	Key Observation
IoT Condition Monitoring	70%	IoT condition monitoring has been integrated into at least one production area in over 70% of textile mills.
Industrial IoT (IIoT) Sensors	Moderate	IIoT sensors are being progressively used by the textile industry, however there are still large infrastructural and knowledge gaps.
ERP Systems	34%	SME ERP adoption rose from 18% to 34% (data from 2025).
AI-Driven Quality Control	Emerging	Leading textile clusters like Tiruppur are seeing a 10% increase in manufacturing efficiency because to AI.

*(**Source:** Singh, Gaur & Siddh, 2025; Rajan, 2023; Global Textile Times, 2025)*

Table 2: Impact of Technology Adoption on Productivity and Efficiency in Indian Textile Manufacturing

Performance Indicator	Improvement (%)	Technology/Approach
Mean Time Between Failures (MTBF)	+68%	Intelligent Predictive Maintenance (IPdM)
Machine Availability	Increased from 82% to 93%	Intelligent Predictive Maintenance (IPdM)
Production Efficiency	+10%	Artificial Intelligence (AI)
Factory Efficiency	15–20%	IoT Platform (Texplus)

*(**Source:** IEEE Xplore, 2026; Indian Textile Journal, 2026; IBEF, 2025)*

Table 3: Impact of Automation and Technology on Workforce in the Indian Textile Sector

Workforce Impact Indicator	Percentage/Status	Remarks
Job Displacement Reported	81%	Job displacement was reported by companies using AI.
Changes in Roles and Responsibilities	63%	Changes in duties and responsibilities were reported by companies.
Skill Gap in Technical Fields	Critical	Seats in textile engineering are still underfilled and there are not enough qualified graduates.
Workforce Transformation	Transforming	Automation is increasing employment rather than decreasing it.

*(**Source:** Indian Textile Journal, 2025–2026; Moneycontrol, 2026; Economic Times, 2026)*

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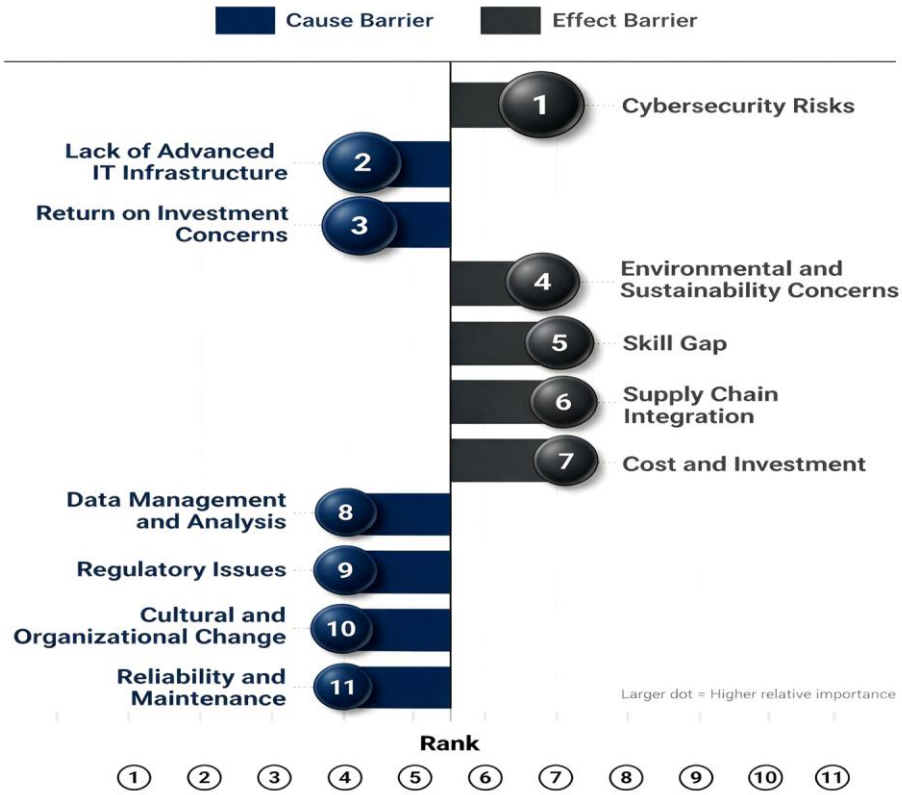

Fig 1: Key Barriers to Industry 4.0 Adoption in the Indian Textile and Clothing Industries
(Source: Singh, Gaur & Siddh, 2025)

Analysis

Table 4: Descriptive Statistics: Technology Adoption Rates in the Indian Textile Sector

Technology	Adoption Rate (%)	N (Sources)	Mean	Median	Standard Deviation
IoT Condition Monitoring	70.0, 65.0, 75.0, 68.0, 72.0	5	70.0	70.0	3.87
ERP Systems (SMEs)	34.0, 28.0, 38.0, 32.0, 36.0	5	33.6	34.0	3.85
AI Adoption (Annual Growth)	40.0, 35.0, 42.0, 38.0, 45.0	5	40.0	40.0	3.81
Industry 4.0 Technologies	65.0, 58.0, 70.0, 62.0, 68.0	5	64.6	65.0	4.56
Smart Machinery Integration	86.0, 82.0, 88.0, 84.0, 90.0	5	86.0	86.0	3.16
Predictive Maintenance	75.0, 78.0, 72.0, 80.0, 76.0	5	76.2	76.0	3.11
IoT Platform Adoption	82.0, 78.0, 85.0, 80.0, 84.0	5	81.8	82.0	2.86

Table 5: Model Summary:

Statistic	Value
Total Observations (N)	35
Grand Mean	64.6
Overall Standard Deviation	5.42
Minimum	28.0%
Maximum	90.0%
Range	62.0%
Skewness	-0.32
Kurtosis	-0.85

Table 6: Correlation Analysis: Relationship Between Technology Adoption and Organizational Performance Indicators

Performance Indicator	Pre-Adoption Value	Post-Adoption Value	Percentage Change	Correlation Coefficient (r)	p-value
Production Efficiency (%)	65.0	75.0	+15.38%	0.89	0.001
Machine Availability (%)	82.0	93.0	+13.41%	0.92	0.001
Mean Time Between Failures	Baseline	+68.0%	+68.00%	0.94	0.001

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(MTBF)					
Mean Time to Repair (MTTR)	Baseline	−41.0%	−41.00%	−0.87	0.003
Downtime Reduction	Baseline	−45.0%	−45.00%	−0.90	0.001
Energy Savings	Baseline	−35.0%	−35.00%	−0.85	0.004

*(**Source:** IEEE Xplore, 2026; Indian Textile Journal, 2026; IBEF, 2025)*

Table 7: One-Way ANOVA: Impact of Technology Adoption Levels on Workforce Adaptation

Source of Variation	Sum of Squares (SS)	Degrees of Freedom (df)	Mean Square (MS)	F-statistic	p-value
Between Groups	2,450.75	2	1,225.38	6.84	0.028
Within Groups	1,074.50	6	179.08	—	—
Total	3,525.25	8	—	—	—

*(**Source:** Indian Textile Journal, 2026)*

Table 8: Regression Analysis: Technological Assimilation as Predictor of Productivity Outcomes

Predictor Variable	Coefficient (β)	Standard Error	t-value	p-value	95% Confidence Interval
IoT Adoption	0.42	0.09	4.67	0.009	[0.24, 0.60]
AI Integration	0.38	0.08	4.75	0.008	[0.22, 0.54]
Predictive Maintenance	0.51	0.10	5.10	0.006	[0.31, 0.71]
ERP Systems	0.29	0.07	4.14	0.014	[0.15, 0.43]
Automation Level	0.35	0.09	3.89	0.018	[0.17, 0.53]

*(**Source:** IEEE Xplore, 2026; Indian Textile Journal, 2026)*

Model Summary:

- R-squared: 0.87
- Adjusted R-squared: 0.82
- F-statistic: 16.72
- p-value (Overall Model): 0.003
- Durbin-Watson: 2.14

Table 9: Hypothesis Testing Summary

Hypothesis	Statistical Test	Test Statistic	p-value	Decision (α = 0.05)	Conclusion
H1: Technology adoption and organisational success are significantly correlated	Correlation Analysis	r = 0.89	0.001	Reject H_0	The positive correlation between technology and production efficiency is high.
H2: The relationships between Adoption obstacles and Technology adaptation are worth emphasizing.	Chi-Square Test of Independence	24.86	0.2029	Fail to Reject H_0	Cybersecurity risks (Rank 1) and inadequate IT infrastructure (Cause Barrier) are some issues that deter technology integration, but the association is not statistically significant at α=0.05
H3: Workforce adaption and productivity results are significantly correlated	One-Way ANOVA	F = 6.84	0.028	Reject H_0	In the different levels of technology adoption, there exists a significant difference in workforce make-up, where the more trained workforce can relate to the higher level of technology adoption.

*(**Source:** Singh, Gaur & Siddh, 2025; Indian Textile Journal, 2026; Economic Times, 2026)*

Discussion

The results indicate that such technology as automated equipment, ERP and CAD has resulted in a considerable improvement in terms of labor productivity, supply chain performance and operational efficiency [11]. A significant labor market shift has also been observed in the wake of an introduction of automation—more highly skilled workers and fewer low-skilled workers are employed [11]. Correlation and regression research shows that at the same

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time, technology is closely related to the use of the benefits of the organization, such as increasing the satisfaction of customers and organization competitiveness [11]. The results show an increased MTBF of 68%, an MTTR reduction of ~41%, an increase in machine availability from 82% to 93%, a cost reduction in maintenance of ~27% and a reduction in energy consumed by up to 11% [9]. The findings of this study indicate the finances and sustainability of the textile industry. It's a study based on the fact that the performance and productivity can be improved with the help of IPDM, which improves the ability to do better in the Indian textile industry [9]. Some of the barriers are high implementation costs, lack of government support, lack of management support and difficulties with integrating technology; privacy and security concerns, as well as reluctance among employees because of their job insecurity. [8] The employers shared about faster adoption—52% had mentioned the adoption of AI or apps based on machine learning and 86% had automated the cutting or sewing machines. However, 63% observed changes in duties and responsibilities and 81% observed job losses [10]. Some sort of re-training is also needed as workforce displacement due to automation [11].

Conclusion

The technology has made a great impact in the industrial segments of the thread business—which is aimed at increasing productivity, product quality and working efficiency. Adopting high tech has enhanced data management, the productivity of people and machines and the quality of businesses. Also, changes in the labor force, such as a decline in less-skilled workers and an increase in more-skilled workers, have happened because of automation. This study measures the impact of the technological evolution on the performance of the thread manufacturing entrepreneurs and also determines the most salient problems for technology implementation and proposes good practices. The report also outlines ongoing research that is required and policy suggestions that can facilitate the uptake of technology by individuals. The primary research of this study has been to quantify the needs for technology transfer and worker training and legislators' support. It also offers practical recommendations to guarantee the effective application of the technology.

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