

**Productivity Challenges in Colonial India:
Entrepreneurial Insights from the Cotton Textile Industry
(1890-1940)**

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Abstract: *Despite persistent low productivity in India's colonial textile industry, little is known about whether entrepreneurs themselves recognised these challenges and proposed solutions. Through a thematic analysis of the Indian Textile journal's Golden Jubilee Edition, the paper reveals systemic barriers, such as outdated machinery, organisational inefficiencies, and underinvestment in R&D, that hindered modernisation despite entrepreneurial awareness. While indigenous adaptations and localised innovations emerged, structural constraints and colonial-industrial dynamics limited productivity gains. The case of Ahmedabad highlights successful technological adoption, contrasting with broader industry stagnation. Findings underscore the tension between entrepreneurial vision and institutional limitations in colonial industrial development.*

Keywords: *Colonial Industrialisation, Industrial modernisation, Indian textile etc.*

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Introduction

The “Indian Textile Journal”, first published in 1890, serves as an invaluable historical primary source for understanding how industry stakeholders perceived and addressed productivity challenges in the Indian textile industry. Its longevity and consistent publication since the late 19th century make it a unique repository of entrepreneurial awareness, technological solutions, and productivity-focused discourse within the industry. Our study aims to analyse how major Indian cotton textile entrepreneurs, engineers, and experts

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identified productivity challenges, particularly those related to technology, and communicated technological solutions in *The Indian Textile Journal* (ITJ) between 1890 and 1940. Parsing through the articles of the ITJ's Golden Jubilee Souvenir Edition (1941), our study seeks to uncover how prominent industrialists diagnosed operational bottlenecks, their awareness of efficiency issues, the proposed remedies and their strategic approaches to industry modernisation.

Established by and for the stakeholders of the Indian textile sector, the ITJ provided a dedicated platform for mill owners, managing agents, engineers, technologists, and policymakers to articulate their understanding of operational issues and advocate productivity-enhancing strategies. The use of the Golden Jubilee Souvenir Edition (1941) as the primary source offers a uniquely comprehensive lens on entrepreneurial consciousness regarding productivity and modernisation from 1890 to 1940. This commemorative volume transcends the limitations of individual annual issues by curating retrospective analyses from early industrialists and juxtaposing them with contemporary expert assessments. It offers first-hand accounts of how pioneers in the industry identified productivity bottlenecks and implemented technological interventions, while also including reflective essays by leaders who had the benefit of hindsight to evaluate the efficacy of those interventions. Because of its retrospective and synthesised format, the souvenir provides a distilled and holistic representation of key debates, decisions, and strategic solutions related to productivity, which might otherwise be scattered across decades of individual issues.

The research question addressed here is, how did prominent Indian cotton textile entrepreneurs, engineers, and experts articulate and address technology-related productivity challenges through their communications in *The Indian Textile Journal* Souvenir edition (1890 and 1940)?

As a technologically driven industry facing persistent productivity challenges, the Indian textile sector demanded continual innovation and efficiency improvements. Our study traces the evolution of solution-oriented thinking among Indian textile entrepreneurs, shedding light on how they recognised and actively addressed technological and organisational barriers to productivity.

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Literature review

The literature highlights persistent productivity challenges in Indian textile mills. Studies note that Indian mills lagged despite using technologies similar to Britain, the U.S., and Japan (Clark, 1987; Clingingsmith and Williamson, 2004, 2008). Clark (1987) attributed this gap to cultural factors, while Wolcott and Clark (1999) cited inefficient work norms and overmanning in Bombay mills. Wolcott (1994) argued that unionised resistance to labour displacement slowed technological progress, unlike Japan where labour dynamics encouraged adoption. Breman (1999) identified low labour productivity during the colonial period as a major constraint. Conversely, Gupta (2011) challenged the negative labour-productivity link, finding that unionisation in Bombay and Gujarat raised both wages and productivity.

Three perspectives dominate industrialisation studies, yet entrepreneurial awareness of productivity issues remains underexplored. The colonial exploitation thesis (Bagchi, 1972) emphasised British constraints on industry, while institutional accounts (Morris, 1983; Gadgil, 1971) quantified growth patterns. Labour historians (Sen, 1999; Chandavarkar, 1994) shifted focus to workers but overlooked entrepreneurial problem-solving. Business historians (Tripathi, 2004) analysed entrepreneurship through corporate archives, while technological studies examined outcomes rather than decision-making. Kiyokawa (1995) is a rare exception, using the Indian Textile Journal (ITJ) to explore cotton spinning debates (Saxonhouse and Wright, 1984; Kiyokawa, 1983). Our study addresses these gaps by analysing ITJ to uncover how industry leaders recognised productivity constraints and proposed technological solutions.

Backdrop

The period from 1890 to 1940 represents a transformative era for both the Indian textile industry and its premier publication, the Indian Textile Journal. The story of ITJ begins in October 1890 when Mr. S. M. Rutnagur established the Indian Textile Journal in Bombay, creating what would become the industry's most important chronicle. Under the editorial

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guidance of Mr. H. Morse, the journal initially served as a modest 8-page publication but quickly evolved to meet the growing needs of India's burgeoning textile sector.

On the industry front, the mid and late 19th century India was characterised by sporadic industrialisation. While the American Civil War (1861-65) initially boosted cotton exports, subsequent financial instability and the 1893 silver demonetisation forced a shift toward domestic cloth production. The 1905 Swadeshi Movement marked a turning point, as nationalist sentiment spurred demand for Indian-made textiles. This period saw crucial technological advances, including Bombay's first fully electrified mill (Finlay Mills, 1907). The ITJ mirrored these developments, expanding its technical coverage and establishing international presence through U.S. agents (1903).

The 1910s and 1920s witnessed both regulatory reforms and industry consolidation. The 1911 Factory Act represented early labour reform by limiting work hours to 12 per day, while the selected shift to Tata Hydro-Electric power marked sporadic modernisation. The 1930s proved pivotal for both the industry and publication. The Great Depression necessitated protective measures, leading to the 1930 Cotton Textile Industry (Protection) Act which imposed tariffs against Japanese imports. The decade saw intense labour unrest, culminating in the 1928 Bombay Mill Strike led by the Girni Kamgar Sangh (India's first textile union), which lasted 18 months and reflected growing worker consciousness. The 1934 Indo-Japanese Trade Agreement attempted to balance trade relations by linking raw cotton exports to cloth import quotas, while the 1935 Mody-Lees Pact favoured British textile imports in exchange for raw cotton purchases. During WWII (1939-45), despite material shortages, the conflict unexpectedly revived demand for Indian textiles as global supply chains faltered.

By its 50th anniversary in 1940, the ITJ had chronicled India's textile industry's journey from colonial dependency to industrial maturity. Its pages captured not just technological progress - from steam power to electrification, handlooms to mechanised production - but also the social and political forces shaping this transformation. More than a trade publication, it became a living archive of India's industrial awakening, reflecting the aspirations and challenges of a nation in transition.

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Discussion

In this main section we discuss the various articles written by the industry pioneers and key figures to understand how leading Indian cotton textile entrepreneurs, engineers and experts perceived and communicated regarding the low productivity and role of technology. We will present the articles in thematic sub-sections, adopting a narrative style that focuses on specific aspects of technological change. Each section will highlight key insights, and the concluding discussion will synthesise the knowledge gained across all sections to draw comprehensive inferences. *The details of the articles are presented in the Appendix section.*

Indigenous innovations (1890-1910)

The low productivity of India's cotton textile industry during its formative decades (1890-1910) stemmed significantly from technological limitations and systemic inefficiencies in machinery adaptation and use. Though the sector developed within a colonial framework that facilitated the inflow of imported equipment, these technologies were often ill-suited to Indian conditions. The industry's dependence on imported British machinery, such as Hick Hargreaves engines, meant that mills frequently started with outdated or suboptimal equipment, which hampered operational efficiency and restricted potential productivity gains. The mismatch between imported designs and local requirements, especially in terms of climate, raw material variability, and labour skills, resulted in frequent breakdowns, maintenance delays, and high operational costs.

While prominent figures such as H.L.T. Aspden (pg. 323) and Sir Cusrow Nowrosjee Wadia (pg. 41) acknowledged the importance of machinery imports, they also documented the critical challenges associated with adapting this technology. Early mechanisation efforts, as seen in Tata and Petit mills, were thus marked by technological discontinuity, where the imported machinery was neither easily maintained nor efficiently integrated into Indian mill environments. These constraints led to a strong reliance on *makeshift and workaround solutions*, rather than systemic technological upgrading.

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The loom stabilisation technique developed in 1904, where Brazilian vibration control methods were modified using tar-resin-felt pads, highlights this reality. Rural and up-country mills faced even greater technological hurdles. In many cases, mills were built in areas lacking infrastructure, and labour housings were erected using machinery cases due to resource scarcity. Essential tools were forged from non-industrial materials, such as bullock cart tyres converted into spanners.

Although such innovations reveal the ingenuity of Indian engineers, they were fundamentally reactive measures to address machinery misfits rather than proactive steps toward sustained productivity enhancement. The broader technological ecosystem suffered from limited access to precision tools, standardised parts, and specialist technical knowledge, further slowing down production efficiency. Such improvisations, while creative, underscored a lack of systemic technological support and hampered consistent productivity. These trials were often based on trial-and-error and localised knowledge, which, while valuable, lacked the rigor and repeatability necessary for large-scale efficiency improvements.

Furthermore, while informal knowledge-sharing networks flourished- like the technical evening discussions in Tardeo and Parel between the labourers- the absence of institutional mechanisms for technological dissemination limited the scalability of innovations. Over time, these grassroots knowledge cultures declined as technical education was formalised through institutions like the Victoria Jubilee Technical Institute. However, the shift to formal training did not immediately address the deeper structural constraints that had historically limited productivity: a fragmented technological base, dependency on foreign machinery, insufficient domestic manufacturing capabilities, and minimal state support for industrial R&D. Together, these factors entrenched low productivity in the Indian textile industry during its critical early decades.

Technological vision and modernisation strategies

Despite the ambitions of Indian industrialists, the Indian textile industry in the early 20th century continued to suffer from low productivity, largely due to fundamental technological deficits and systemic barriers to modernisation. The writings of Sir H.P. Mody (pg. 15) and Sir Ness Wadia (pg. 16) in the *Indian Textile Journal's* Golden Jubilee edition reflect not only

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their awareness of these productivity issues but also the technological and institutional challenges that impeded effective responses.

Mody explicitly identified the paradox that, although Indian labour was inexpensive in absolute terms, the lack of technological efficiency rendered production costlier per unit than in technologically advanced countries like Japan. The mismatch between labour input and output highlighted the urgency of mechanisation, but Indian mills lagged due to reliance on outdated or ill-maintained machinery, inefficient workflows, and minimal investment in process optimisation. Modern equipment was often unaffordable, difficult to import, or mismatched to local conditions, resulting in continued reliance on suboptimal machines and manual operations.

Wadia's discussion of post-war reform initiatives, such as double-shift operations and machinery standardisation, points to earlier failures in organisation and technology alignment. Indian mills had not systematically adopted such practices, leading to underutilised capacity, machine downtime, and labour underemployment. His analysis revealed that prior approaches to technological change were often fragmented, lacking the systemic overhaul required for meaningful productivity improvement.

A key contributor to low productivity was the absence of structured research and institutional technical training. Both Mody and Wadia called for a shift from experiential, informal knowledge networks to structured technical education. However, the transition was slow, and the lack of dedicated research institution. Wadia's suggestion to empower the University of Bombay's Department of Chemical Technology was a forward-thinking proposal, but it underscored the vacuum that had long existed in the Indian innovation landscape.

Furthermore, the Indian textile sector faced a strategic disadvantage in global competition due to its technological backwardness. Mody's plea for protective tariffs was rooted in India's inability to match Japan's productivity levels, which stemmed from their superior machinery and technical training. Wadia's critique of the failed Bombay Mill Merger Scheme similarly exposed how the lack of coherent technological integration and strategic planning had stifled the ability of Indian firms to scale efficiently or compete globally.

Even nationalist aspirations, such as calls for self-reliance in dyestuff and machinery production, stemmed from the deep-seated recognition of technological dependence on Europe and America that perpetuated industrial vulnerability. The inability to manufacture

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critical machinery and inputs domestically kept Indian mills technologically behind, further lowering productivity. The industrial visionaries of the time thus understood that without addressing the structural and systemic technological gaps, Indian textile production would remain inefficient and globally uncompetitive.

Problems of industry

S.H. Batlivala's analysis in "Problems of the Indian Mill Industry" (pg. 26) reveals complex technological challenges severely hampering global competitiveness. Batlivala, a Parsi entrepreneur managing mills like Empress mill and member of Nagpur mill association, identified the most glaring challenge as dramatic labour productivity disparity: Indian mills required 450,000 workers to process 3.5 million cotton bales annually, while Japanese mills achieved identical output with 180,000 workers; a 2.5:1 productivity advantage.

Japanese technological advantages included advanced high-speed spinning frames doubling processing capacity, automatic looms reducing manual intervention, rationalised workflows through scientific management, and integrated production systems minimising material handling. Indian limitations encompassed outdated spinning machinery, manual looms requiring constant attention, fragmented production processes, and absence of quality control.

Critical challenges included inability to maximise equipment utilisation through double-shift operations. While Japanese mills operated 16-20 hours daily, Indian mills typically ran single shifts due to aging machinery prone to breakdowns, maintenance deficits causing frequent shutdowns, unreliable electricity making continuous operation risky, and labour resistance to intensive schedules.

On the other hand, the power transition from coal to electricity presented both opportunities and challenges. Traditional coal-fired systems imposed high transportation costs, inconsistent quality affecting steam generation, environmental pollution, and inefficient and unsafe boiler technologies. Hydroelectric power offered advantages but faced obstacles including grid infrastructure limitations, high capital requirements, technical expertise gaps, and standardisation issues.

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Raw material challenges included limited research into high-yield cotton varieties, inadequate irrigation and mechanisation, poor post-harvest processing causing fibre degradation, and insufficient grading systems. Processing problems encompassed old carding machines unable to handle mixed grades, rudimentary combing technology, and underdeveloped blending techniques.

Batlivala, too, identified absence of structured R&D as core problem. Unlike Japan’s robust research institutes, India lacked dedicated facilities, minimal industry-academia collaboration, and zero pilot plants. Without standardised testing labs, Indian mills struggled with inconsistent quality, manual process control, and absence of feedback systems, leaving them unable to meet export market demands while competitors surged ahead.

Table 1: Japan Vs. India- Batlivala

Category	Japanese technological advantages	Indian technological limitations
Spinning technology	Advanced high-speed spinning frames that doubled processing capacity	Outdated spinning machinery operating at sub-optimal speeds
Weaving technology	Automatic looms that reduced manual intervention and human error	Manual looms requiring constant operator attention
Workflow efficiency	Rationalised workflows optimised through scientific management principles	Fragmented production processes with multiple handling stages
Production integration	Integrated production systems that minimised material handling time	Absence of quality control automation

Source: Authors conceptualisation from Batlivala

Organisation and technology

Between 1890 and 1940, the low productivity of Indian cotton textile mills was closely tied to structural organisational inefficiencies that obstructed effective technological adoption. While a few progressive mills experimented with decentralised systems, much of the industry

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remained constrained by outdated organisational models that hindered timely responses to technical challenges and slowed the integration of new technologies.

Fyyazuddin Ahmad's (pg. 114) writings highlight that only select mills successfully moved away from the traditional "big boss" model, where all decisions were centralised in the hands of a few, to more agile structures that empowered departmental heads. Such decentralisation was essential for addressing real-time operational needs, like machine calibration or automatic loom deployment. However, these changes were limited in scope and implementation, with many mills unable to overcome internal resistance. Short-term production targets often took precedence over long-term investments in capital-intensive modernisation, further entrenching inefficiencies.

Technological coordination across production lines was frequently fragmented. Though specialisation, via separate spinning, weaving, and dyeing departments, could have enabled expertise-building, the lack of integrated system-wide planning stymied gains. Technological upgrades in one section, such as installing high-speed spinning frames, often failed to deliver productivity improvements when upstream or downstream processes were not synchronously modernised. This mismatch resulted in operational bottlenecks, increased idle time, and inefficient utilisation of advanced machinery.

Centralised planning departments, where they existed, attempted to mitigate such inefficiencies. They played a critical role in coordinating technological upgrades and managing workflow alignment. However, such planning mechanisms remained exceptions rather than the norm.

Table 2: India Vs. Global- organisational aspects

Aspect	Traditional model	Modern approach
Decision-making	Top-heavy	Delegated to departments
Planning	Reactive	Proactive (ERP systems)
Coordination	Manual liaison	Automated alerts
Idle time mitigation	High (15% to 20%)	Low (5% to 8%)

Source: Authors conceptualisation from Ahmad

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A deeper structural issue, identified by P.S. Lokanathan, lay in the dominance of the managing agency system. These agents, often with limited personal investment in mill performance, prioritised immediate financial returns over sustained technological progress. Their commission-based procurement model incentivised the import of foreign machinery over the development or use of indigenous alternatives, reinforcing technological dependence. Moreover, the hereditary and non-technical nature of many agents created systemic inertia, with outdated machines and methods persisting despite available upgrades. Thus, organisational inertia, compounded by flawed governance structures, critically undermined technological progress and perpetuated low productivity across much of the Indian textile industry.

Spinning, Weaving and raw cotton

The persistently low productivity in the Indian textile industry was also significantly shaped by technological limitations in spinning, weaving, and raw cotton processing. Insights from the writings of Norris (pg. 126), Joshi (pg. 66), V.K.R.V. Rao (pg. 132), K.S. Rao (pg. 70), Roberts (pg. 60), and Burns (pg. 30) in the ITJ highlight how mismatches between imported machinery, local raw material properties, and limited technical expertise contributed to suboptimal performance across the production chain.

In spinning, the adoption of global technologies faced serious adaptation challenges. Machines like Richard Arkwright's water frame, designed for long-staple, low-impurity American cotton, proved ill-suited for India's short-staple, impurity-laden varieties. Modifications were necessary, but Indian mills lacked the institutional R&D capacity to develop consistent technological solutions. Similarly, Samuel Crompton's mule spinning, capable of producing fine yarns, demanded a level of skill and precision not widely available in Indian mills, limiting productivity and consistency in output.

The transition from mule to ring spinning frames offered a potential path to higher efficiency, but implementation was hampered by financial, managerial, and infrastructural constraints. While ring frames, developed in the U.S. in 1833, were more productive in continuous operation, their high capital costs discouraged widespread adoption. Managing agents, focused on short-term returns, were reluctant to invest in the large-scale replacements

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needed. Even by the late 1930s, despite the introduction of more durable features such as Rabbeth spindles (1869) and ball bearings (1932) that suited India's hot and humid conditions, many mills continued operating outdated machinery, resulting in frequent breakdowns, lower spindle speeds, and reduced output.

In weaving, productivity was similarly undermined by uneven technology integration and policy distortions. Although the industry shifted from handlooms to mill-based production, resulting in a tenfold increase in cloth output by 1938-39, technological improvement was often fragmented. Mill-produced yarn supplied to handloom weavers was frequently of inferior quality, reinforcing exploitative supply chains that stunted broader productivity growth. Furthermore, government policies such as the 1926 abolition of excise duty on mill cloth eliminated crucial protections for handloom producers, enabling mills to dominate markets without necessarily modernising their operations, thereby reducing the incentive to invest in cutting-edge weaving technologies.

The technological performance of both spinning and weaving was also heavily influenced by the quality of raw cotton. Indigenous cotton varieties often limited the efficiency of imported machinery. Efforts to address this through agricultural innovations, such as the introduction of Dharwad-American hybrids and systematic breeding programs by the Punjab Agricultural Department, were not yet universally effective. While irrigation schemes like the Lower Chenab and Jhelum canals expanded high-quality cotton cultivation, supply chain inconsistencies and uneven access meant that many mills continued working with low-grade fibre, constraining spinning speed, yarn strength, and overall productivity.

Technological Lag in Power and Chemical Processing

Even the transition from coal to hydroelectric power- highlighted by the Tata Hydro-Electric Project (1915)- failed to yield maximum productivity gains, as many mills retained inefficient transmission infrastructure and lacked skilled personnel to integrate cleaner, cheaper energy into fully optimised production systems. The shift from coal to hydroelectric power marked a turning point, with the Tata Hydro-Electric Project (1915) generating 360,000 horsepower and reducing costs by 40% while enabling consistent, pollution-free power for Bombay's

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mills. This transformation replaced 500,000 tons of coal annually by 1940, though Indian mills remained slow to adopt modern transmission systems

On the and chemical processing techniques conservative practices and limited technical expertise thwarted modernisation. Early mills relied on hemp ropes that frequently wore out, while upgrades to flat belts or V-ropes were delayed due to poor technical expertise and investment reluctance, causing energy losses. Similarly, global advances in cellulose chemistry, bleaching, and dyeing, like vat and Naphthol AS dyes, were slowly adopted. Dependence on imported knowledge and limited in-house research kept many mills technologically outdated.

Labour, Education, and Technological Inertia

Low productivity in India's cotton textile industry was not only a result of inadequate machinery but also deeply rooted in the technological limitations of its labour force, shaped by insufficient investment in education and skill development. While the workforce became increasingly indigenised- from 43% European technical staff in 1895 to just 16% by 1940- the shift often occurred without parallel improvements in technical training. Although institutions like the Victoria Jubilee Technical Institute (est. 1889) attempted to formalise textile education, their reach remained limited in an industry dominated by unskilled or semi-skilled labour.

Industrialists such as Lala Shri Ram (pg. 32) advocated modernisation through ring frames and automatic looms, yet technological upgrades outpaced worker capacity to manage and optimise these machines. Rationalisation measures aimed at streamlining production frequently led to deskilling. *Weavers, once central to craftsmanship, were reduced to passive machine operators.* R.D. Choksi's (pg. 100) 1939 survey underscored the productivity gap caused by lack of education. Only a handful of mills, like Buckingham and Carnatic Mills, invested in worker literacy and training, achieving 80% literacy compared to an industry average below 30%. Literate workers could better understand manuals, operate high-speed machines, and implement safety protocols.

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Yet most mills viewed education as a cost, not a necessity. Long shifts, managerial apathy, and cultural resistance prevented skill-building, leaving the majority of the workforce ill-equipped to support or sustain technological innovation, thereby suppressing productivity.

Ahmedabad: A Case Study in Technological Adaptation

Productivity in most of India's textile industry remained low due to resistance to technological change, inadequate capital planning, and unstable labour relations. Ahmedabad, however, emerged as a rare success story, demonstrating how technology-focused investment and industrial foresight could transform output.

Unlike Bombay, where overcapitalisation and frequent labour unrest hampered productivity, Ahmedabad channelled post-World War I capital into technological modernisation. The region systematically replaced mule spindles with ring frames, embracing high-draft spinning methods that enhanced efficiency and reduced reliance on multiple preparatory processes. While this transition involved costly experimentation, it fostered a culture of local innovation and learning, largely absent in other textile centres.

By the 1920s, as Sohrab K. Khan (pg. 178) observed, Ahmedabad's machinery was "as advanced as any in industrialised nations." This advancement was not due to mere equipment imports but to sustained investment in adapting and maintaining technology. Ahmedabad mill owners *allocated depreciation funds for continuous upgrades*, in contrast to other regions.

Labour-management relations also played a crucial role. The Ahmedabad 'Labour Arbitration Board' provided a mechanism for resolving disputes, ensuring production continuity and supporting technical integration-conditions lacking in Bombay and Sholapur, where strikes frequently disrupted operations.

By 1938, the widespread adoption of ring spindles positioned Ahmedabad's mills as globally competitive. Its success underscores the broader industry's failure: low productivity in most Indian mills stemmed from their inability to integrate appropriate technology, manage capital efficiently, and maintain labour stability- challenges that Ahmedabad overcame through strategic foresight.

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Conclusion

Through an analysis of the Indian Textile Journal's Golden Jubilee Edition, our study demonstrates how Indian textile entrepreneurs articulated productivity challenges and technological solutions, while also revealing the systemic barriers that limited their implementation. While the journal reflects an active engagement by Indian entrepreneurs, engineers, and policymakers with global technologies, it also exposes systemic shortcomings that hindered productivity improvements.

In the early decades (1890-1920), indigenous technicians showed remarkable adaptability by modifying imported machinery to suit local conditions. However, these innovations often lacked scale and institutional support. As industrialisation matured, the growing reliance on imported machinery reduced incentives for local R&D. By the 1930s, the industry struggled with technological obsolescence, particularly in spinning and weaving equipment, which contributed directly to low productivity.

Leaders like Sir Ness Wadia and Sir H.P. Mody recognised technology as critical to industrial success, yet their vision was often undercut by structural constraints. The managing agency system, driven by short-term profits and commissions, disincentivised capital-intensive upgrades. This led to minimal reinvestment in modern machinery, fragmentation in decision-making, and *poor coordination between engineering, finance, and operations*. Unlike firms that developed specialised departments for innovation, most mills lacked integrated planning needed for technological modernisation.

Moreover, poor labour-management relations and outdated work practices in key centres like Bombay further limited the gains from automation. In contrast, Ahmedabad emerged as a rare case of technological success where strategic capital infusion, stable labour relations, and continuous experimentation supported the adoption of, say, modern ring spindles and high-draft spinning.

Thus, productivity remained low in not due to technological ignorance, but because systemic institutional rigidities, managerial conservatism, and underinvestment curtailed the industry's technological potential. These findings highlight that Indian industrial

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entrepreneurs were not passive victims of colonial economic policy but actively engaged in diagnosing and attempting to solve productivity challenges.

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