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An Evaluation of Technological Transformation and Regulatory Reforms in Indian Stock Exchanges: Impact on Financial and Market Performance

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Abstract-- The Indian securities market has undergone significant evolution, transitioning from traditional trading systems to an advanced automated marketplace supported by state-of-the-art technology and stringent regulations. The National Stock Exchange of India (NSE) and BSE Ltd. (BSE) have spearheaded this transformation through the implementation of electronic trading platforms and algorithmic systems, which have improved order processing speeds. Key advancements in the market include the use of sophisticated data analytics, enhanced cybersecurity measures, and user-friendly digital interfaces. Additionally, the adoption of shorter settlement cycles, such as T+1 and T+0, has improved overall efficiency. The Securities and Exchange Board of India (SEBI) has strengthened the regulatory framework for market infrastructure institutions (MIIs), ensuring adherence to standards that promote transparency and integrity. This study aims to assess the impact of technological advancements and regulatory reforms on the financial health and performance of Indian stock exchanges. It employs descriptive and analytical research methods, relying on secondary data from NSE and BSE annual reports as well as SEBI publications. The focus areas include technological capabilities, algorithmic trading, cyber resilience, investor participation, trading volume, market share, and profitability metrics.

The study concludes that technology and regulation have acted as complementary forces rather than as independent determinants. However, the rapid growth of derivatives, algorithmic trading, and digital participation has also introduced new challenges. These challenges include issues related to cybersecurity, system capacity, market concentration, operational risk, and the responsible use of artificial intelligence.

Keywords-- Technological Transformation, Regulatory Reforms, NSE, BSE, Stock Exchanges, SEBI, Algorithmic Trading, T+0 Settlement, Financial Performance, Market Performance.

I. INTRODUCTION

Stock exchanges play a crucial role in the financial system, acting as essential mechanisms for capital formation, price discovery, liquidity, risk transfer, and investment opportunities.

Over the past thirty years, the landscape of stock exchanges in India has undergone a significant transformation. Traditional trading methods have increasingly been replaced by electronic platforms, automated processes, and data-driven market infrastructures.

This transformation in Indian exchanges should not be seen merely as the introduction of computers into trading. It represents a comprehensive institutional change characterised by numerous innovations, including electronic order matching systems, automated clearing and settlement processes, algorithmic trading techniques, and access through mobile and internet platforms. Furthermore, advancements in real-time surveillance, data analytics, cloud computing, distributed infrastructure, and enhanced cybersecurity measures have become integral components of this transformation, alongside the development of more sophisticated risk-management systems.

The Securities and Exchange Board of India (SEBI) plays a vital role in this ecosystem by recognising stock exchanges, clearing corporations, and depositories as Market Infrastructure Institutions (MIIs). These institutions are expected to uphold principles of transparency, fairness, and unrestricted access while ensuring market integrity and protecting investors' interests. SEBI's policy framework clearly indicates that the evolution of the securities market is closely linked to advancements in technology, governance practices, and operational resilience. As the market has expanded, the importance of technology has increased, mirroring the rapid growth in market participants. For example, the National Stock Exchange's (NSE) annual report for FY2024-25 indicates a striking 11.3 crore unique registered investors and approximately 22 crore investor accounts. This level of participation requires managing vast volumes of transactions, with peak processing exceeding 2,000 crore order messages in a single day and peak execution reaching 29.4 crore trades. Handling such substantial operations would be nearly impossible without high-capacity electronic systems, automated risk controls, and advanced surveillance mechanisms.



Thus, technology has emerged not only as an operational necessity but also as a source of competitive advantage and a focal point for regulatory oversight.

At the same time, the regulatory framework has significantly evolved. In 2021, SEBI introduced optional T+1 settlement, marking a shift in the Indian securities market toward this expedited settlement model across the cash market. Additionally, SEBI began rolling out optional T+0 settlement, initially on a limited scale and later expanding its applicability.

Regulatory oversight has broadened, moving from a focus on trading and disclosure rules to include system capacity, business continuity, cybersecurity threats, and algorithmic trading practices, as well as the integration of artificial intelligence and machine learning techniques. In 2024, SEBI's revised framework emphasised meticulous capacity planning and real-time performance monitoring for MIIs, while its cybersecurity guidelines mandated robust institutional mechanisms to address cyber threats and operational disruptions.

In light of these significant changes, this study aims to evaluate the extent to which technological advancements and regulatory reforms have influenced the financial dynamics and market performance of Indian stock exchanges.

II. OBJECTIVES OF THE STUDY

The study has the following objectives:

- To evaluate the technological transformation of Indian stock exchanges.
- To examine major regulatory reforms affecting NSE and BSE.
- To analyse the association between technological transformation and the financial performance of Indian stock exchanges.
- To examine the role of major regulatory reforms in improving the market performance and operational efficiency of Indian stock exchanges.
- To compare the performance of NSE and BSE in the technology-driven regulatory environment.

III. BACKGROUND OF INDIAN STOCK EXCHANGES

The Indian equity market is heavily dominated by two main stock exchanges: the National Stock Exchange (NSE) and the Bombay Stock Exchange (BSE). These exchanges function within a well-established ecosystem that includes clearing corporations, depositories, and a widespread network of brokers and intermediaries, all contributing to seamless trading and market operations.

I. National Stock Exchange (NSE)

The National Stock Exchange has established itself as the largest exchange in India by various measures of trading activity across significant market segments. According to its disclosures for the financial year 2024-25, NSE commands an impressive market share of 93.6% in the Equity Cash segment, 87.4% in Equity Options based on premium value, and 99.9% in Equity Futures.

During this period, the NSE reported an average daily turnover that highlights its robust trading volume: approximately ₹1,12,963 crore in the cash market, ₹1,85,901 crore in equity futures, and ₹62,449 crore in equity options, measured on a premium-value basis.

Financially, NSE's performance has shown marked growth, with consolidated total revenue reaching ₹19,177 crore, which reflects a 17% increase compared to the previous year. Additionally, the profit after tax soared to ₹12,188 crore, demonstrating a substantial year-on-year growth of 47%. These figures underscore NSE's pivotal role in the Indian financial landscape, illustrating not just resilience but also potential for ongoing expansion.

II. Bombay Stock Exchange (BSE)

In parallel, the Bombay Stock Exchange has maintained a significant and integral position within India's securities market. In recent years, BSE has notably broadened its operations in the derivatives space, showcasing its adaptability to changing market dynamics. According to its latest annual report for FY2024-25, BSE has achieved an average daily equity cash turnover of approximately ₹7,766 crore, marking a notable increase of around 17% from ₹6,622 crore recorded in FY2023-24. This growth indicates a robust interest in trading on this platform and reflects its ongoing relevance in the marketplace.

Moreover, the BSE's annual report highlights an impressive surge in its net profit after tax, excluding exceptional items. This metric increased dramatically from approximately ₹288.32 crore to ₹1,112.45 crore, showcasing a remarkable growth rate of about 286%. Such financial achievements suggest not only strategic improvements in operations but also an efficient response to the evolving needs of market participants.

These advancements in both exchanges offer a valuable foundation for analysing how technological innovations, regulatory reforms, and shifts in market participation are shaping the overall performance of the Indian equity market. As the landscape continues to evolve, understanding these dynamics will be crucial for market participants and stakeholders alike.



IV. TECHNOLOGICAL TRANSFORMATION OF INDIAN STOCK EXCHANGES

- *Shift From Physical To Electronic Trading: -*

The most fundamental technological transformation has been the transition from physical trading floors to electronic order-matching systems. Electronic trading has improved the speed, transparency, scalability and standardisation of trade execution. The transition also facilitated national market access because investors and brokers could participate remotely rather than being physically located near exchange trading floors.

- *High-Speed Order Processing: -*

Modern financial exchanges are characterised by their ability to process vast volumes of transactions. For instance, the National Stock Exchange (NSE) has reported an astonishing capacity, managing over 2,000 crore order messages within a single day. During the fiscal year 2024-25, they experienced peak trading activity, with an impressive 29.4 crore trades executed on just one day. This remarkable feat illustrates the strong correlation between technological capacity and market performance. Enhanced technological infrastructure enables exchanges to accommodate higher order volumes while maintaining optimal system performance, preventing any significant degradation as trading activity surges.

- *Algorithmic And Automated Trading: -*

In today's securities markets, algorithmic trading plays a vital role. This automated approach allows for the generation and execution of orders based on predefined rules, complex mathematical models, and real-time market signals.

The Securities and Exchange Board of India (SEBI) has long recognised the significance of algorithmic trading within the broader market structure and its technology policy framework. Its Technical Advisory Committee has meticulously addressed various policy concerns, including wireless trading, co-location, algorithmic trading practices, smart-order routing, and the effective use of Application Programming Interfaces (APIs). However, the rise of automation is not without its challenges; it brings along a new wave of market and operational risks. SEBI's 2025 framework highlights its commitment to fostering safer participation of retail investors in algorithmic trading environments. This framework underscores its evolving focus on mitigating these risks, with the implementation timeline having been extended in September 2025.

- *Cybersecurity And Cyber Resilience:*

As exchanges become increasingly reliant on sophisticated technology, the importance of cybersecurity has escalated, positioning it as a fundamental pillar of market stability. SEBI's comprehensive cybersecurity framework for Market Infrastructure Institutions (MIIs) mandates the establishment of robust cybersecurity and cyber-resilience mechanisms. This framework emphasises continuous reviews of cyber preparedness and incorporates rigorous vulnerability testing, response drills, and incident preparedness protocols. Furthermore, SEBI's technology framework guarantees round-the-clock security operations capabilities for MIIs, ensuring that the integrity of the market infrastructure remains intact.

Through this technological transformation, exchanges have experienced not only significant efficiency gains but also the emergence of new operational risks that demand diligent management.

- *Artificial Intelligence And Data Analytics*

The next phase in the evolution of technology within the securities markets involves the integration of Artificial Intelligence (AI), machine learning, and advanced data analytics.

In June 2025, SEBI released a consultation paper addressing the responsible utilisation of AI and machine learning technologies in Indian securities markets. This proposal acknowledges the promising applications of AI and machine learning while also emphasising the necessity for governance and controls concerning activities that could have direct implications for clients and investors.

AI and advanced analytics present vast potential benefits, including:

- Enhanced market surveillance capabilities
- Improved fraud detection measures
- Effective anomaly identification
- Timely cyber-threat detection
- Comprehensive risk management processes
- Enriched investor services
- Streamlined operational automation

Moreover, SEBI has identified data analytics, the establishment of data warehouses, and technology-driven market surveillance as key priorities in its strategic approach to harnessing technological innovation.



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V. MAJOR REGULATORY REFORMS

1. T+1 Settlement: -

One of the most important reforms has been the shortening of the settlement cycle. SEBI introduced optional T+1 settlement through its September 2021 circular, allowing exchanges to offer T+1 settlement subject to specified conditions. The settlement cycle was subsequently reduced from T+2 to T+1 across all scrips in the cash market from January 27, 2023. This reform reduced counterparty exposure and accelerated availability of funds and securities.

2. T+0 Settlement: -

SEBI subsequently introduced an optional T+0 settlement framework. In December 2024, SEBI expanded the scope of optional T+0 rolling settlement alongside the existing T+1 settlement cycle. The move toward same-day settlement represents a significant technological and institutional innovation because it requires close integration among exchanges, clearing corporations, depositories, brokers, banks and investors. By 2025, SEBI had expanded optional T+0 availability to a much broader group of securities.

3. Capacity Planning: -

As trading volumes rise, exchanges must ensure that system capacity remains ahead of expected demand. SEBI issued revised guidelines on Capacity Planning and Real-Time Performance Monitoring for MIIs in December 2024. The 2026 framework further stated that stock exchanges and clearing corporations should maintain trading-system capacity capable of handling substantial multiples of expected load and should undertake upgrades as trading speed and algorithmic activity increase.

4. Business Continuity and Disaster Recovery

Technology-driven markets cannot afford prolonged disruption. Accordingly, SEBI has strengthened business continuity and disaster recovery standards. The September 2024 reforms modified BCP and DR requirements for MIIs, while subsequent rules addressed business continuity for interoperable exchange segments.

5. Governance of Market Infrastructure Institutions

Recent reforms have also increased emphasis on governance. SEBI's 2025 consultation on strengthening governance of MIIs proposed stronger organizational accountability for critical operations, technology, regulatory compliance, risk management and investor grievances. This indicates that technology governance is increasingly being treated as a board-level institutional responsibility rather than merely an IT function.

VI. IMPACT OF REGULATORY REFORMS ON MARKET PERFORMANCE

❖ *Settlement Efficiency:* -

T+1 settlement reduced settlement exposure and accelerated completion of transactions.

T+0 represents an additional reduction in settlement time and demonstrates the increasing integration between regulatory innovation and technological capability.

❖ *Market Integrity*

Regulations covering algorithmic trading, surveillance, capacity and cybersecurity aim to preserve fairness and market integrity.

❖ *Investor Confidence*

A strong regulatory framework can increase investor confidence by reducing operational, fraud and settlement risks.

❖ *Institutional Resilience*

Capacity planning, disaster recovery and cyber-resilience rules reduce the probability that technical failure will disrupt the market.

Technology And Regulation As Complementary Forces

One of the central findings of this evaluation is that technology cannot be considered independently of regulation.

For example:

Algorithmic Trading

Technology → Faster execution

Regulation → Controls unfair practices and systemic risk

T+0 Settlement

Technology → Enables rapid processing

Regulation → Establishes framework and safeguards

AI

Technology → Improves surveillance and analytics

Regulation → Controls client-facing and high-risk applications

Cloud/Distributed Systems

Technology → Scalability

Regulation → Resilience, cybersecurity and business continuity

This complementary relationship is visible in SEBI's policy architecture, which increasingly combines technology requirements with governance and risk controls.



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VII. MAJOR FINDINGS

The study identifies the following broad findings:

- *Technology has become a core determinant of exchange competitiveness*

Modern exchanges compete not only on product offerings but also on system speed, reliability, scalability, capacity and investor accessibility.

- *Technological transformation has supported revenue growth*

The substantial increase in NSE's transaction revenue and profitability is consistent with the growing scale of technology-enabled market activity.

- *Regulatory reforms have improved settlement efficiency*

The shift from T+2 to T+1 and subsequent development of T+0 represent major improvements in settlement architecture.

- *Cybersecurity has become a strategic issue*

As dependence on technology increases, cybersecurity is no longer merely an IT concern. It has become an element of systemic market stability.

- *NSE demonstrates stronger scale advantages*

NSE's market-share and activity figures indicate strong economies of scale in both cash and derivatives markets.

- *BSE has demonstrated strong growth potential*

Despite lower overall equity cash turnover than NSE, BSE's rapid derivatives growth and substantial profitability improvement demonstrate successful competitive adaptation.

- *AI introduces a new phase of market transformation*

SEBI's 2025 AI/ML consultation demonstrates that regulation is increasingly responding to emerging technology rather than merely established technologies.

VIII. CHALLENGES

Despite significant progress, Indian stock exchanges face several challenges.

- *Cybersecurity Threats*

Higher technological dependence increases exposure to cyberattacks, ransomware, data breaches and operational disruption.

- *Algorithmic and High-Frequency Trading Risks*

Extremely fast automated systems can amplify volatility, create unfair advantages or generate unexpected market behaviour.

- *Technology Concentration*

A small number of exchanges and technology providers can create concentration risks.

- *Regulatory Complexity*

Frequent reforms can increase compliance costs for exchanges and intermediaries.

- *AI Governance*

AI systems may introduce:

model risk;
bias;
lack of explainability;
data-quality problems;
privacy concerns;
accountability challenges.

- *Digital Inclusion*

Greater digitalization must not exclude investors with lower digital literacy or inadequate digital access.

IX. INFORMATIVE SUGGESTIONS FOR REGULATORY IMPROVEMENT

1. Develop a Unified Technology-Resilience Framework

Regulatory bodies like SEBI should strengthen standards for critical technology infrastructure across exchanges, clearing corporations, and depositories. This framework would ensure greater stability and security within the financial ecosystem.

2. Strengthen AI Governance

Implementing a risk-based governance framework is essential. This framework should clearly differentiate between various applications of AI, including internal use, surveillance initiatives, customer-facing interactions, and automated investment or trading decisions. SEBI's proposed tiered approach is a promising starting point.

3. Increase Real-Time Regulatory Surveillance

Regulators should leverage advanced technologies such as AI, machine learning, and big-data analytics to enhance real-time market surveillance. This will enable quicker detection of anomalies and more effective responses to market dynamics.



4. Strengthen Algorithmic Trading Safeguards

Access to algorithmic trading for retail investors should be managed with appropriate controls, thorough testing, and mechanisms for traceability and accountability. This will help maintain market integrity while allowing participation in algorithmic trading.

5. Improve Interoperability and Resilience

It's vital that business continuity plans are structured such that disruptions in one area of technical infrastructure do not lead to extensive market failures. This approach would enhance overall market resilience.

6. Promote Investor Digital Literacy

With the rapid pace of technological change, a robust program for systematic investor education should accompany these advancements. Enhancing digital literacy among investors will empower them to navigate the evolving financial landscape effectively.

7. Encourage Healthy Competition

Maintaining competition between major exchanges, such as NSE and BSE, is crucial. Such competition can drive innovation, improve service quality, and foster greater efficiency within the market.

X. CONCLUSION

The study concludes that technological transformation and regulatory reforms have significantly reshaped Indian stock exchanges, transitioning them from conventional trading to sophisticated, technology-driven systems. Advancements in technology have improved speed, capacity, accessibility, and operational efficiency, allowing exchanges to handle large volumes of transactions with greater accuracy. This democratization of financial markets has made them more accessible to investors across various locations through digital platforms. Regulatory reforms have strengthened the securities market's framework, focusing on investor protection, settlement efficiency, and system resilience. The Securities and Exchange Board of India (SEBI) has been crucial in fostering a regulatory environment that promotes innovation while ensuring market integrity. Milestones like the T+1 settlement system mark significant progress in modernizing capital markets, enhancing capital efficiency and reducing settlement risks.

The financial performance of exchanges like the National Stock Exchange (NSE) and Bombay Stock Exchange (BSE) in FY 2024–25 illustrates the benefits of this transformation, with substantial revenues and active investor participation. Future competitiveness will rely on the integration of technology with regulation, governance, and risk management, ensuring ongoing efficiency and protection for investors in India's evolving securities market.

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