SJIF Impact Factor (2025) : 8.862
ISI Impact Factor : 1.433

DOI :10.36713/epru2012

Print ISSN : 2349 - 0187
Online ISSN : 2347 - 9671

EPRA International Journal of

ECONOMIC AND BUSINESS REVIEW

Monthly, Peer Reviewed (Refereed) & Indexed International Journal

Volume - 14 Issue - 1 January 2026

DOI :10.36713/epra2012

Print ISSN : 2349 - 0187
Online ISSN : 2347 - 9671

EPRA INTERNATIONAL JOURNAL OF ECONOMIC AND BUSINESS REVIEW

Monthly, Peer Reviewed,Refereed & Indexed International Journal

SJIF Impact Factor (2025): 8.862

ISI Impact Factor : 1.433

Chief Editor

Dr. A. Singaraj, M.A.,M.Phil.,Ph.D.

Volume - 14 Issue- 1 January 2026

Managing Editor

Mrs.M.Josephin Immaculate Ruba

Editorial Advisors

1. Dr. Rajah Rasiah, Ph.D(Cambridge)
   University of Malaya, Malaysia.
2. Dr. Deepak Basu, M.A., Ph.D
   Nagasaki University, Japan.
3. Dr. Hisham Handal Abdelbaki, M.Sc, Ph.D., (U.K),
   University of Bahrain, Kingdom of Bahrain,
4. Dr. Nawab Ali Khan, M.Com, M.Phil, Ph.D.,
   Salman Bin Abdulaziz University,
   Al- Kharj – 11942,
   Kingdom of Saudi Arabia.
5. Dr. Mussie T. Tessema
   Winona State University, MN,
   United States of America,
6. Dr. Mengsteab Tesfayohannes
   Sigmund Weis School of Business,
   Susquehanna University,
   Selinsgrove, PENN,
   United States of America,
7. Dr. S. Srinivasan, M.A., M.Phill., Ph.D.,
   Bale Robe, Ethiopia.
8. Dr.Yi-Lin Yu, Ph. D
   Fu Jen Catholic University,
   Taipei, Taiwan.
9. Dr. Abidova Zaynab Kadirberganovna,Ph.D
   Urgench Branch of the Tashkent Medical Academy Urgench, Khorezm,
   Uzbekistan.
10. Dr. Narayan Sethi, M.A., M.Phil,Ph.D,
    National Institute of Technology (NIT),
    Rourkela, Odisha,
    India
11. Dr. Wilfredo J. Nicolas, PhD,
    Aklan State University,
    Banga, Aklan,
    Philippines
12. Dr. Alphonce Juma Odondo, PhD,
    School of Business and Economics (SBE),
    Maseno University,
    Homa Bay Town Campus,
    Maseno, Kenya
13. Dr. Ahmed Sebihi
    Skyline University College in the University City of Sharjah,
    UAE.

Global Indexing

Published By :EPRA Publishing

EPRA International Journal of Economic and Business Review-Peer Reviewed Journal
Volume - 14, Issue - 1, January 2026 | e-ISSN: 2347 - 9671| p- ISSN: 2349 – 0187

SJIF Impact Factor (2025): 8.862 || ISI Value: 1.433 || Journal DOI URL: https://doi.org/10.36713/epra2012

CONTENTS

Research Paper

EPRA International Journal of Economic and Business Review-Peer Reviewed Journal
Volume - 14, Issue - 1, January 2026 | e-ISSN: 2347 - 9671| p- ISSN: 2349 – 0187

SJIF Impact Factor (2025): 8.862 || ISI Value: 1.433 || Journal DOI URL: https://doi.org/10.36713/epra2012

TECHNOLOGICAL INNOVATION AND INDUSTRIAL COMPETITIVENESS IN INDIAN MANUFACTURING: AN EMPIRICAL ANALYSIS

Ishwar Reddy[1], Prof. R.V. Gangshetty[2], Miss. Heena.B. Dasyal[3]

[1]*Guest Faculty, Department of Commerce, Karnataka State Akkamahadevi Women University Regional Centre, Bidar 585403*

[2]*Professor, Department of Economics, Karnataka State Akkamahadevi Women's University, Vijayapura.*

[3]*Research Scholar, Department of Economics, Karnataka State Akkamahadevi Women's University, Vijayapura.*

ABSTRACT DOI No: 10.36713/epra25703 Article DOI: https://doi.org/10.36713/epra25703

Technological innovation has emerged as a critical determinant of industrial competitiveness in manufacturing-based economies. In the context of India's manufacturing sector, increasing global competition and rapid technological change have necessitated continuous innovation to enhance productivity, efficiency, and market performance. This study empirically examines the relationship between technological innovation and industrial competitiveness in Indian manufacturing. Using secondary data drawn from published industrial statistics and firm-level indicators, the study analyzes the impact of research and development intensity, technology adoption, and innovation activities on key measures of industrial competitiveness, including productivity, output growth, and export performance. The analysis employs descriptive statistics and econometric techniques to assess the strength and direction of the relationship between innovation variables and competitive performance. The findings reveal that technological innovation significantly improves industrial competitiveness by enhancing production efficiency and facilitating value addition in manufacturing industries. The study further highlights the role of policy support, infrastructure, and skill development in fostering innovation-led industrial growth. The paper concludes that strengthening innovation ecosystems and promoting technology diffusion are essential for sustaining the long-term competitiveness of Indian manufacturing in the global market.

KEYWORDS: ***Technological Innovation, Industrial Competitiveness, Manufacturing Sector, Productivity, India***

I. INTRODUCTION

Manufacturing has increasingly become a key driver of India's economic expansion, contributing nearly 16–17 per cent to the country's gross domestic product and providing employment to more than 27 million people. The robustness of the sector is reflected in the strong performance of major industries such as automobiles, engineering goods, chemicals, pharmaceuticals, consumer durables, electronics, and textiles. With policy support through initiatives such as Make in India and the Production-Linked Incentive (PLI) schemes, the government aims to raise the share of manufacturing to 25 per cent of GDP in the coming years. Technological advancement has significantly transformed the structure and functioning of Indian manufacturing. While the sector was traditionally centered on machine tools, it is now increasingly characterized by automation, digitalization, and process-oriented production systems. The adoption of digital technologies has enhanced innovation capabilities, improved operational efficiency, and strengthened the global competitiveness of Indian manufacturers. This positive momentum was evident in July 2025, when the HSBC India Manufacturing Purchasing Managers' Index (PMI) reached a 16-month peak of 59.1, supported by the strongest growth in factory orders in almost five years.

India is also strengthening its position within specialised segments of global value chains. The country has the potential to supply nearly 10 per cent of global wind energy demand by 2030, supported by its expanding capacity in wind power component manufacturing. In the electronics sector, domestic value addition has increased from about 30 per cent to nearly 70 per cent and is expected to reach 90 per cent by FY27. Major multinational firms, including Apple, have expanded their manufacturing presence in India, leading to a rise in smart phone exports to 22.9 million units in the first half of 2025, compared to 15 million units during the same period of the previous year. Owing to its abundant labour force and cost advantages, India is increasingly viewed as a competitive alternative to China for advanced technology manufacturing, as noted by the World Bank.

II. REVIEW OF LITERATURE

Dalnar K,S (2025) Existing studies highlight technological innovation as a key driver of productivity enhancement and competitive advantage in manufacturing firms, particularly through process and product innovation. Recent literature on digital transformation emphasizes the role of digital capabilities—such as automation, data analytics, and interconnected production systems—in improving operational efficiency and market responsiveness. Research further suggests that firms integrating Industry 4.0 technologies demonstrate higher flexibility and stronger participation in global value chains. However, most empirical studies focus on developed economies or examine technological innovation and digitalization independently, offering limited insights into their combined effect in emerging markets like India. Scholars also identify firm size, skill availability, and investment capacity as major constraints influencing technology adoption. Consequently, there remains a research gap in understanding how the synergy between technological innovation and digital capability shapes the global competitiveness of Indian manufacturing firms.

Abhijeet Sudhanshu and etc.al.(2024), This study reviews the concept of Industry 4.0 and its role in transforming Indian manufacturing industries. It explains how digital technologies are changing traditional factories into smart factories. Based on a survey of 73 Indian industries, the study highlights that customer satisfaction and product quality are the main priorities. Most industries are still using Industry 3.0 technologies, while awareness and adoption of Industry 4.0 remain limited, especially among small and medium enterprises. The paper identifies gaps in technology usage and suggests a clear roadmap for Industry 4.0 adoption. Overall, the study shows that embracing Industry 4.0 can improve competitiveness and support long-term growth of Indian industries.

Min, ting and sanfeng Z (2025) this study reviews how technological innovation helps reduce energy use in manufacturing industries in China and India. Using World Bank survey data from 2011–2013, it shows that better innovation capability can lower a firm's energy intensity. The results indicate that energy use falls significantly as innovation levels increase, but this effect is strong only in Chinese firms, not in Indian firms. Large and capital-intensive enterprises benefit more from innovation-led energy savings. The study explains that higher production efficiency and flexible operations are key reasons for reduced energy use. Overall, the paper highlights the importance of technology-driven green growth in emerging economies.

III. OBJECTIVES OF THE STUDY

1. To analyze the impact of technological innovation on the competitiveness of Indian manufacturing firms.
2. To assess the challenges faced by Indian manufacturing industries in adopting advanced technologies.
3. To suggest policy and managerial measures to strengthen technological innovation and enhance industrial competitiveness in India.

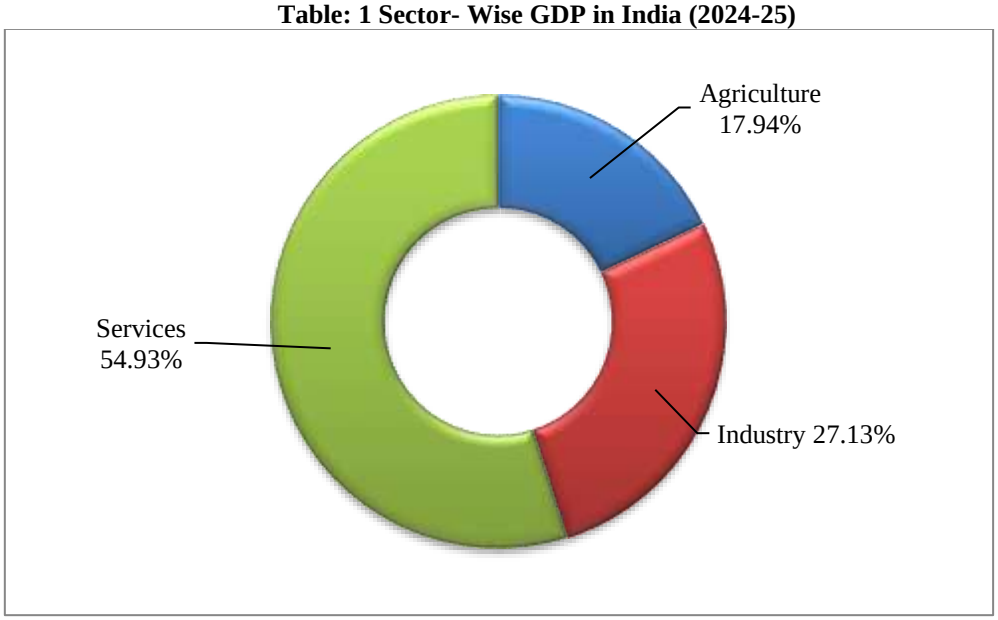
IV. RESEARCH METHODOLOGY

This study uses a descriptive and analytical research design based on secondary data. It examines the role of technological innovation, smart technologies, and public policy in improving competitiveness and reducing production costs in Indian manufacturing. Data are collected from government reports, policy documents, and official statistics. Academic books, research papers, and peer-reviewed journals on innovation and industrial competitiveness are also used. Additional information is taken from authentic online databases, industry reports, and reputed news portals.

V. RESULT AND DISCUSSIONS

The imbalance among the major sectors of the Indian economy in terms of their contributions to national output has long been a matter of considerable concern. Over the years, the share of the industrial sector has remained relatively stagnant, while the services sector has expanded rapidly and the agriculture sector's share has continued to shrink. Historically, agriculture once dominated the economy, but structural transformation has shifted output toward services. As per recent estimates for FY 2024–25, agriculture and allied activities accounted for approximately 17.94 percent, industry contributed about 27.13 percent, and the services sector constituted around 54.93 percent of India's gross value added (GVA), reflecting the relative stagnation of the industrial sector and the sustained dominance of services in GDP composition. In terms of growth rates for FY25, the agriculture sector is projected to grow moderately, reflecting improved performance compared with previous years, while industry and services are expected to grow at relatively higher rates, driven by robust domestic demand, investment activity, and technological adoption across services and industrial segments.

Table: 1 Sector- Wise GDP in India (2024-25)



Source: Ministry of Statistics and Programmer Implementation 2025

❖ India as an Attractive Manufacturing Destination

India offers strong advantages for establishing manufacturing units. As the world's fifth-largest economy, it is also expected to become one of the largest consumer markets by 2025, providing a large domestic demand. The country has a young workforce, with a significant share of the population aged between 18 and 35 years.

India's long coastline, extensive port network, and growing port capacity support trade and logistics. In addition, India follows major international intellectual property agreements and has improved legal frameworks for faster dispute resolution. Recent reforms, including lower corporate taxes, increased foreign direct investment, and reduced compliance requirements, have further improved the manufacturing environment. Overall, India provides a supportive and attractive ecosystem for manufacturing growth.

❖ Advantages of FDI in India's Manufacturing Sector

- **Employment generation and skill development:**
  Foreign direct investment creates job opportunities for both skilled and unskilled workers. It also helps workers gain new skills through training, modern technology, and improved production practices.
- **Infrastructure development**
  FDI in manufacturing supports the growth of infrastructure such as industrial parks, roads, power supply, and logistics. It helps transform underdeveloped regions into industrial hubs, contributing to local economic and social development.
- **Exchange rate stability:**
  A regular inflow of foreign investment strengthens India's foreign exchange reserves. This supports the stability of the Indian rupee and helps the Reserve Bank of India manage exchange rate fluctuations.
- **Growth in export**
  Increased manufacturing activity through FDI leads to higher production of goods for global markets. This results in a rise in exports, increased foreign earnings, and improved trade performance.

❖ Future Growth Potential of the Indian Manufacturing Industry

- India's manufacturing sector is witnessing steady growth and diversification. The country has long been a strong performer in industries such as automobiles, pharmaceuticals, textiles, and electronics. Between April 2000 and December 2023, significant foreign direct investment flowed into manufacturing sectors including automobiles, chemicals, and pharmaceuticals. Government initiatives like the Production Linked Incentive (PLI) schemes have further strengthened the sector by attracting large investments and boosting exports, particularly in electronics, pharmaceuticals, food processing, and telecom equipment manufacturing.
- Policy support and institutional initiatives are enhancing the competitiveness of Indian manufacturing. Programs led by the Ministry of Heavy Industries, such as SAMARTH Udyog Bharat 4.0, aim to modernize production systems and strengthen the capital goods sector. At the same time, new growth opportunities are emerging in areas like electric vehicles, semiconductor manufacturing, space technology, agritech, and waste management. The adoption of advanced technologies such as Industry 4.0, artificial intelligence, the Internet of Things, and 3D printing is transforming production processes, making India an attractive destination for future manufacturing investments.

❖ From "Make in India" to "Made in India"

Strong domestic consumption and expanding export opportunities have placed India among the most attractive manufacturing destinations globally. A key driver of this transformation is the Make in India initiative, launched in 2014, which has played a pivotal role in strengthening India is manufacturing ecosystem. Together with the Atmanirbhar Bharat Abhiyan and the Production Linked Incentive (PLI) scheme, this initiative has significantly reinforced India's standing as an emerging global manufacturing powerhouse.

While Atmanirbhar Bharat emphasizes self-sufficiency, the PLI scheme—with a total allocation of ₹1.97 lakh crore—seeks to

enhance domestic manufacturing capabilities across 14 strategic sectors. Prime Minister Narendra Modi's vision of Make in India aims to position the country as a global center for manufacturing, design, and innovation, covering 27 sectors such as defense production, electronics, and textiles.

Concrete outcomes of these initiatives are already visible. The Tata Group is establishing India's first semiconductor fabrication unit in Dholera, Gujarat, with an investment of around $11 billion. Apple Inc. has scaled up its manufacturing operations in India, with production reaching nearly $14 billion, displaying a major success of the Make in India program on the global stage. Similarly, luxury automobile manufacturer Mercedes-Benz has announced an investment of ₹200 crore to introduce 12 new models in 2024. In the defence sector, the impact has been particularly significant, with exports rising by approximately 32% in FY 2023–24, crossing the ₹21,000 crore mark.

Across the country, several cities have emerged as dynamic manufacturing hubs for automobiles, petrochemicals, pharmaceuticals, and other industries. At the same time, the central government continues to nurture entrepreneurship and production-led growth nationwide. Progressive tax reforms, forward-looking policies, rising foreign direct investment, and an increased emphasis on sustainable technologies are expected to keep India's manufacturing sector on a strong growth path, potentially exceeding the projected growth rate of 8%.

VI.CONCLUSION

The manufacturing sector has emerged as a crucial pillar of India's economic transformation, with increasing contributions to output, employment, exports, and technological advancement. Although the share of industry in GDP has remained relatively stagnant compared to the rapid expansion of the services sector, recent policy initiatives, rising foreign direct investment, and accelerated adoption of advanced technologies indicate a renewed momentum in manufacturing growth. Government-led programs such as Make in India, Atmanirbhar Bharat Abhiyan, and the Production Linked Incentive (PLI) schemes have created a supportive policy environment that encourages domestic production, strengthens global value chain integration, and enhances India's attractiveness as a manufacturing destination.

Overall, India's journey from "Make in India" to "Made in India" signifies a strategic shift toward value-added, innovation-led, and globally competitive manufacturing. With sustained policy support, continued investment in skills and infrastructure, and deeper integration of technological innovation, the manufacturing sector can play a transformative role in correcting structural imbalances in the economy. Strengthening industrial competitiveness will not only enhance export performance and employment generation but also ensure inclusive and sustainable economic growth, positioning India as a resilient and reliable manufacturing hub in the global economy.

REFERENCES

1. *Digalwar, A., Pandey, R., Singh, S. R., & Sharma, A. (2024).* Industry 4.0 implementation: Evidence from Indian industries*. In IFIP Advances in Information and Communication Technology. Springer. https://doi.org/10.1007/978-3-031-50204-0_3.*
2. *Komal Shivajirao, D. (2025). Impact of technological innovation and digital capability on global competitiveness of Indian manufacturing firms.* International Journal of Integrated Research and Practice*. https://doi.org/10.65579/31075037.095.*
3. *Ting, M. J., Liu, Z., & Sanfen, Z. (2025). The impact of an enterprise's technological innovation capability on its energy intensity: A comparative analysis of manufacturing enterprises in China and India.* Sustainability, 17*(21), 9603. https://doi.org/10.3390/su17219603.*
4. *https://prsindia.org/files/budget/budget_state/gujarat/2024/Gujarat_Budget_Analysis-2024-25.pdf*
5. *Ministry of Statistics and Programmer Implementation 2025*
6. *https://statisticstimes.com/economy/industry-sector-in-india.php.*
7. *Economic Survey (2022-23)*
8. *International Monetary Fund World Economic Outlook (October - 2025)*

Research Paper

EPRA International Journal of Economic and Business Review-Peer Reviewed Journal
Volume - 14, Issue - 1, January 2026 | e-ISSN: 2347 - 9671| p- ISSN: 2349 – 0187

SJIF Impact Factor (2025): 8.862 || ISI Value: 1.433 || Journal DOI URL: https://doi.org/10.36713/epra2012

FINANCIAL SUSTAINABILITY OF URBAN LOCAL BODIES: A COMPARATIVE EVALUATION OF LUCKNOW AND VARANASI

Sonali Jaiswal[1], Dr. Archana Singh[2]

[1]*Research Scholar, Department of Applied Economics, University of Lucknow, Lucknow, Uttar Pradesh, India*
[2]*Head and Dean of Department, Department of Applied Economics, University of Lucknow, Lucknow,Uttar Pradesh, India*

ABSTRACT DOI No: 10.36713/epra25785 Article DOI: https://doi.org/10.36713/epra25785

The 74th Constitutional Amendment Act of 1992 recognizes urban local bodies in India and enables them to function as institutions of self-government. Municipal corporations are central to democratic governance, particularly in a large and rapidly urbanizing country. Their effectiveness depends on financial capacity, as local responsibilities must be supported by adequate resources. Sound accounting and financial management help municipal administrations plan, monitor, and regulate service delivery responsibly. However, the Act has not been implemented in reality. This study presents a comparative assessment of the financial performance of Lucknow Municipal Corporation (LMC) and Varanasi Municipal Corporation (VMC). It analyzes major revenue and expenditure components to evaluate financial management efficiency. One-Way ANOVA is used to test whether differences in selected financial indicators are statistically significant. The findings slow clear differences in revenue structures, expenditure patterns, and overall fiscal capacity. The analysis highlights persistent fiscal capacity. The analysis highlights persistent fiscal gaps and scope for stronger municipal financial reforms nationwide.

KEYWORDS: ***Urban Local Bodies, Municipal Finance, Revenue-Expenditure Analysis, Lucknow, Varanasi***

I. INTRODUCTION

Decentralization means reorganizing the system of government so that power and duties are shared fairly among different levels of government. An important part of this process fiscal decentralization, which focuses on improving how government finances are manages and made accountable. It clearly explains which level of government is responsible for raising and spending money, whether it is the national, state, or local level. Through fiscal decentralization, local governments are given the authority to collect their own taxes and generate income, instead of depending completely on financial support from the central government. This financial independence helps local bodies manage their budgets more carefully and enables them to respond better to the needs and priorities of local people.

A major step taken by the Government of India to strengthen municipal governance and support urban development was the introduction of the 74th Constitutional Amendment Act in 1992. Prior to this amendment, local governments had unclear roles and limited autonomy, as State Governments exercised strong control over their functions and could change their responsibilities through executive decisions without amending laws (Sharma, 2020). Although the 74th Amendment clearly lists the functions to be performed by Urban Local Bodies (ULBs), it does not specify assured or independent sources of revenue for them (Bhattacharyya & Bandyopadhyay, 2012). As a result, State Governments continue to decide the powers and responsibilities of ULBs, leading to wide differences in their functioning across states.

The amendment intended to strengthen the financial capacity of ULBs by expanding their taxation powers. However, in reality, ULBs have not received significant new taxing authority and continue to depend largely on traditional sources of income. While they are expected to carry out a wide range of civic functions, their limited revenue base makes this task challenging. As highlighted in reports by the Reserve Bank of India on municipal finance, municipal corporations depend heavily on grants from the Central and State Governments to meet their routine expenses. This heavy dependence, particularly on property tax, limits their ability to develop other sources of income such as trade and professional licenses, entertainment taxes, charges on mobile towers, user fees for services like solid waste management and water supply, and innovative mechanisms like value capture financing.

Revenue expenditure includes costs associated with delivering vital services such as waste management, water harvesting and sanitation, public health, safety initiatives, public works, and education and Capital expenditures refer to investments in long-lasting assets and infrastructure. This includes things like roads, bridges, water supply systems, sewage facilities, public buildings, parks, and waste management systems.

In this context, evaluating the financial performance of municipal corporations becomes crucial. A clear understanding of revenue patterns, expenditure behaviour, fiscal imbalances, and resource utilisation helps in assessing how efficiently an urban local body is functioning. It also highlights strengths and gaps that require policy attention. Lucknow and Varanasi, two major urban centres in Uttar Pradesh, have been undergoing rapid demographic and economic transformations.

Despite their importance, both cities face challenges such as rising population pressure, increasing demand for civic amenities, and limited financial resources. These issues make it necessary to study how well these corporations mobilise revenue, allocate expenditure, and sustain financial stability.

II. OBJECTIVES

The paper aims to attempts a comparative analysis of the finances of Lucknow Municipal Corporation and Varanasi Municipal Corporation to understand their financial management practices and identify the areas that require improvement. By analysing major income and expenditure indicators, the study aims to offer insights that can contribute to strengthening municipal finances and promoting better urban governance.

III. DATA AND METHODOLOGY

The analysis of municipal finances first looks at the present financial status of municipal bodies in providing civic amenities, which are carried out in terms of current spending. The revenue and expenditure sides of municipal finance are then analysed in terms of the growth. A comparative approach is used to evaluate the performance of Lucknow Municipal Corporation (LMC) and Varanasi Municipal Corporation (VMC), relying on absolute financial figures to highlight similarities and differences between the two.

To make the financial data more reliable for comparison, the Gross District Domestic Product (GDDP) deflator is applied to the municipal revenue figures. For this purpose, GDDP data for Lucknow and Varanasi at current and constant prices for the base year 2010–11 are used. The ratio of GDDP at current prices to constant prices is calculated for each year in the study period, which forms the basis for constructing the deflator.

Secondary data has been collected from budget documents of selected municipal corporations for the period of 2014-15 to 2023-24 is taken for the study. Data on revenue income and expenditure and capital income and expenditure have been considered for the analysis. For analytical purpose, 10 heads of revenue income, four heads of revenue expenditure, four heads of capital expenditure and three heads of capital income are taken for selected municipal corporations and have been analysed through ANOVA (one way).

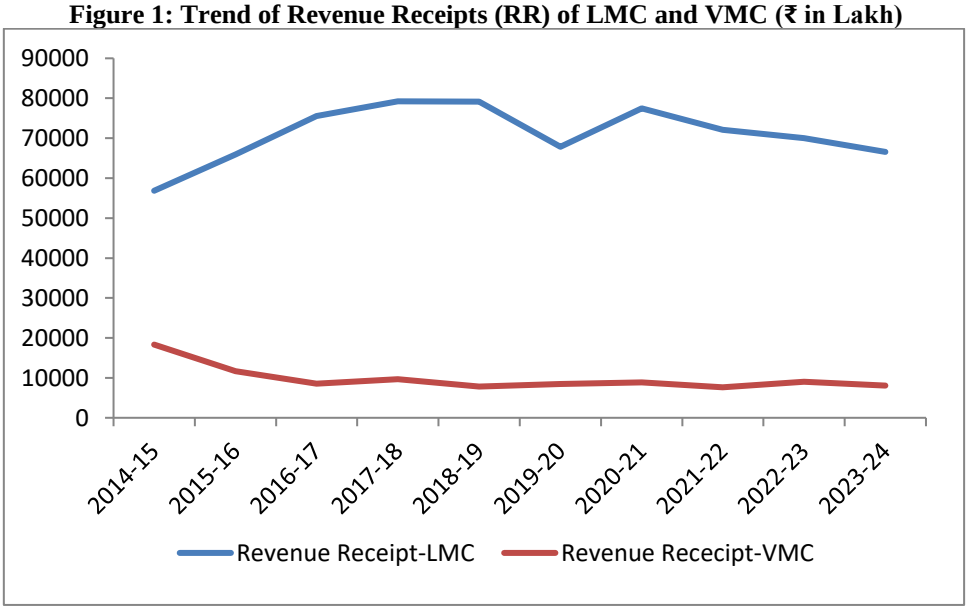
IV. RESULT AND DISCUSSIONs

Comparative analysis of Financial Position of selected municipal corporations

Total Revenue Receipt of LMC and VMC

This section deals with the main revenue source of municipal corporations, which together constitute their revenue income. Revenue income comprising of tax revenue, non-tax revenue, assigned revenue, and various forms of revenue grants.

Figure 1: Trend of Revenue Receipts (RR) of LMC and VMC (₹ in Lakh)



Source: Author's own construction

The figure presents the trend of revenue receipt of Lucknow Municipal Corporation (LMC) and Varanasi Municipal Corporation (VMC) from 2014-15 to 2023-24. LMC records a steady rise in revenues up to 2018-19, followed by a decline and moderate recovery, after which receipts show a gradual slowdown. Despite these changes, LMC consistently maintains higher revenue levels throughout the period, indicating a stronger fiscal capacity. In contrast, VMC's revenue remains comparative low with only marginal variation and no sustained growth. The continuing gap between the two corporations reflects differences in their revenue base and financial capacity with LMC remaining fiscally stronger than VMC.

TABLE 1: ANOVA TEST OF TOTAL REVENUE RECEIPT OF LMC AND VMC

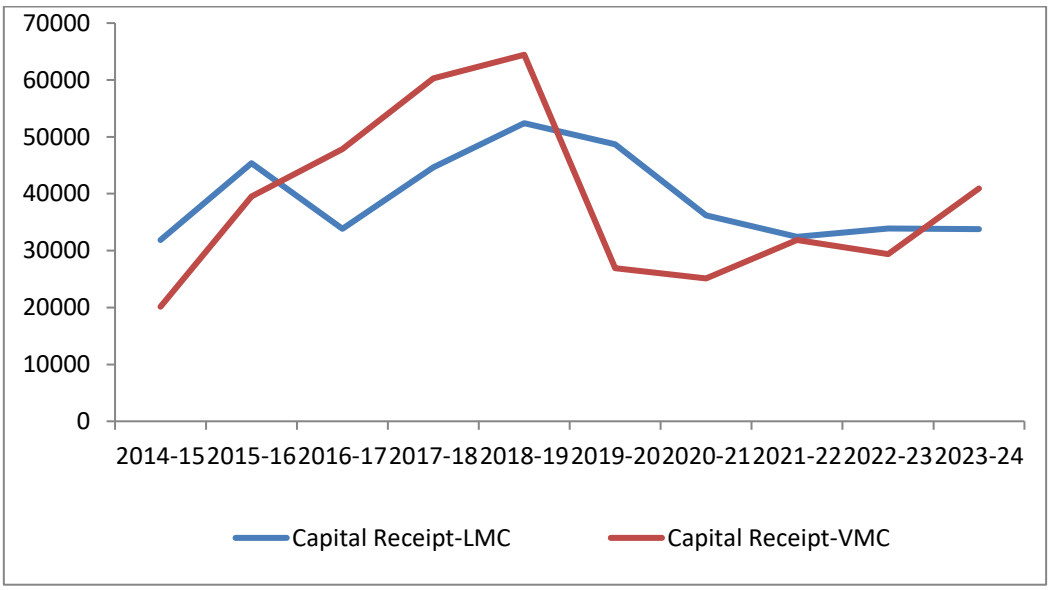
SUMMARY						
Groups	**Count**	**Sum**	**Average**	**Variance**		
LMC-RR	10	710873.1	71087.31	50594675		
VMC-RR	10	98066.90	9806.69	10333811		
ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	18776570465	1	1.88E+10	616.3478	2.24E-15*	4.413873
Within Groups	548356375.1	18	30464243			
Total	19324926840	19				

(* & ** are 1% and 5% significant level respectively)
Source: Author's own calculations, data taken from budget document of LMC and VMC

It is evident form the table 1 and figure 1 that LMC shows an upward-then-downward trend, while VMC shows a largely stagnant trend with very little change over the years.
To examine whether the difference in total revenue receipt is statistically significant, a one-way ANOVA test was applied with the null hypothesis that the mean revenues of the municipal corporations are equal.
Therefore, H0: $\mu1 = \mu2 = \mu3 = \mu4$ and
H1:$\mu1 \neq \mu2 \neq \mu3 \neq \mu4$
The results show a large gap in average revenue receipts, with Lucknow recording a much higher mean (₹71,087 lakh) compared to Varanasi (₹9,807 lakh). The calculated F-value (616.35) exceeds the critical value (4.41), leading to the rejection of the null hypothesis at the 1 per cent level. This confirms a significant difference in revenue performance, with LMC consistently outperforming VMC during the study period.

Total Capital Receipt of LMC and VMC
Capital receipts of municipal corporations generally include funds raised for long-term development, such as loans, capital grants, and proceeds from the sale of assets. These receipts are not regular in nature and depend on specific projects or investment needs. The below figure and table indicate the total capital income of selected MCs.

Figure 2: Trend of Capital Receipts (CR) of LMC and VMC (₹ in lakhs)



Source: Author's own construction

Figure 2 shows how capital receipts changed over time for LMC and VMC. LMC's receipts gradually increased up to 2018–19 and then started to fall, after which they remained almost steady. VMC's receipts rose very quickly in the early years and reached their highest point in 2018–19, but then dropped sharply the following year and continued to move up and down without a fixed pattern. Overall, LMC shows a smoother trend, while VMC has more sudden changes.

TABLE 2: ANOVA TEST OF TOTAL CAPITAL RECEIPT OF LMC AND VMC

SUMMARY						
Groups	**Count**	**Sum**	**Average**	**Variance**		
LMC-CR	10	393124.3	39312.43	58517562		
VMC-CR	10	386506.7	38650.67	2.24E+08		
ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	2189597.079	1	2189597	0.015491	0.902329	4.413873
Within Groups	2544268090	18	1.41E+08			
Total	2546457687	19				

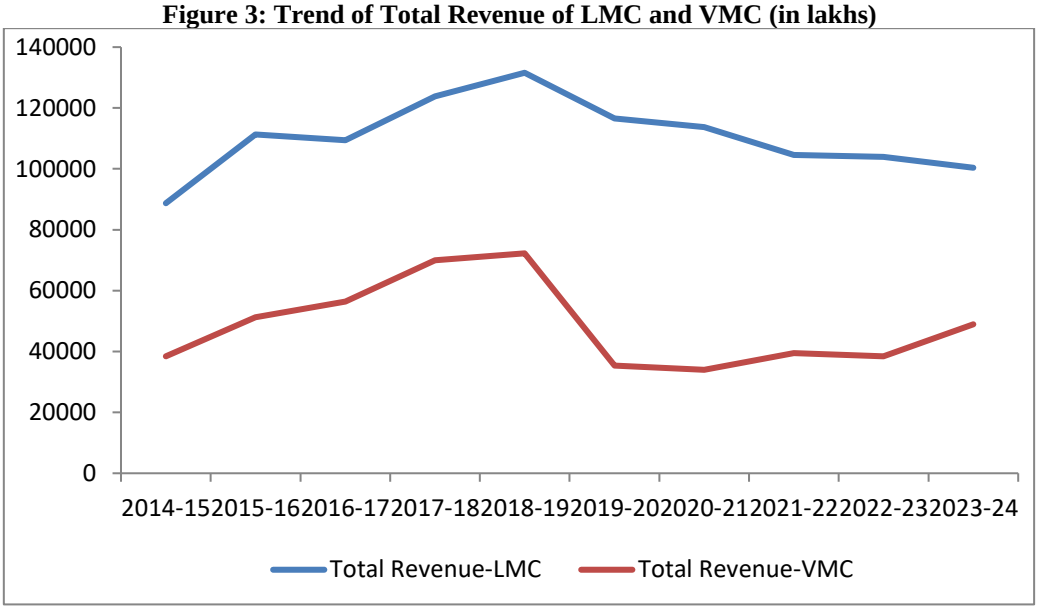
(* & ** are 1% and 5% significant level respectively)
Source: Author's own construction

Figure 2 and Table 2 indicate an unstable trend in capital receipts for both municipal corporations. A one-way ANOVA test shows no significant difference in mean capital receipts between LMC and VMC. The mean values are nearly identical, and the low F-value (0.015) with a high p-value (0.902) confirms that the observed variation is not statistically significant. This suggests similar capital receipt levels for both corporations during the study period.

Total Revenue of LMC and VMC

Total revenue reflects a municipal corporation's capacity to raise funds for civic services. In cities like Lucknow and Varanasi, it depends on economic strength, administrative efficiency, and state support, with stable revenue indicating better financial capacity.

Figure 3: Trend of Total Revenue of LMC and VMC (in lakhs)



Source: Author's own construction

Figure 3 indicates that Lucknow Municipal Corporation's revenue grows steadily from 2014-15, peaks in 2018-19, and then gradually declines while remaining above earlier levels. Varanasi Municipal Corporation follows a similar initial rise but experiences a sharp drop after 2018-19, with only limited recovery in subsequent years. Overall, both corporations show early growth followed by decline, with LMC consistently maintaining a higher revenue base than VMC.

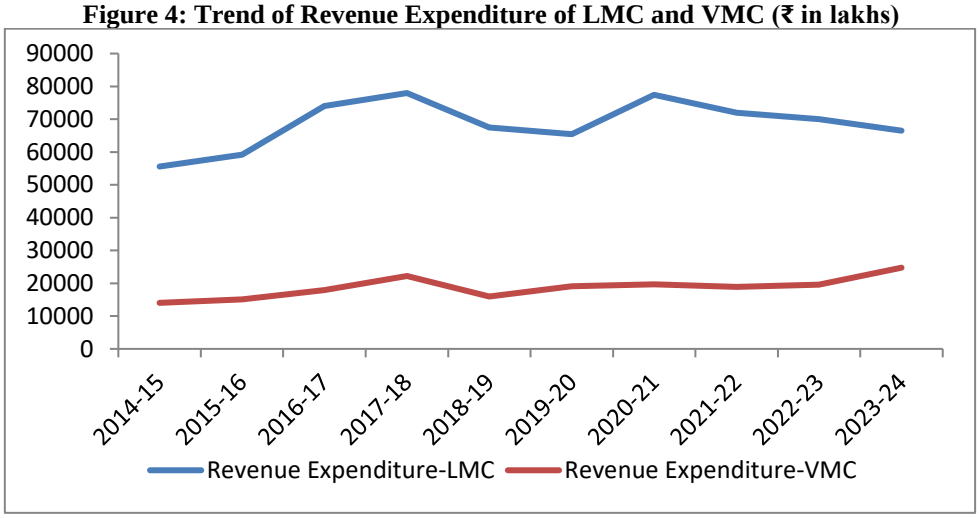
TABLE 3: ANOVA TEST OF TOTAL REVENUE OF LMC AND VMC

SUMMARY						
Groups	**Count**	**Sum**	**Average**	**Variance**		
LMC-TR	10	1103997	110399.73	147367968.1		
VMC-TR	10	484573.6	48457.361	195550757		
ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	19184289103	1	19184289103	111.8882563	3.73731E-09	4.413873
Within Groups	3086268526	18	171459362.6			
Total	22270557629	19				

(* & ** are 1% and 5% significant level respectively)
Source: Author's own construction

Table 4 depicts a significant difference in the total revenue of LMC and VMC. The mean revenue of LMC is much higher than that of VMC, and the F-value (111.88) is far above the critical value of 4.41. The p-value is less than 0.05 confirms that this difference is not due to normal variation but represents a real gap in the revenue levels of the two municipal bodies. Overall, the test indicates that LMC consistently generates substantially higher total revenue than VMC during the study period.

Figure 4: Trend of Revenue Expenditure of LMC and VMC (₹ in lakhs)



Source: Author's own construction

Figure 4 compares the revenue expenditure of Lucknow Municipal Corporation (LMC) and the Varanasi Municipal Corporation (VMC) from 2014-15 to 2023-24. LMC consistently has higher expenditure due to its larger population and service obligations, showing significant fluctuations after peaking in 2017-18. In contrast, VMC's expenditure shows a smoother, gradual increase, with a slight dip around 2018-19 but generally trending upward, indicating steady expansion of services. Overall, LMC exhibits a dynamic and fluctuating pattern, while VMC demonstrates more stable growth.

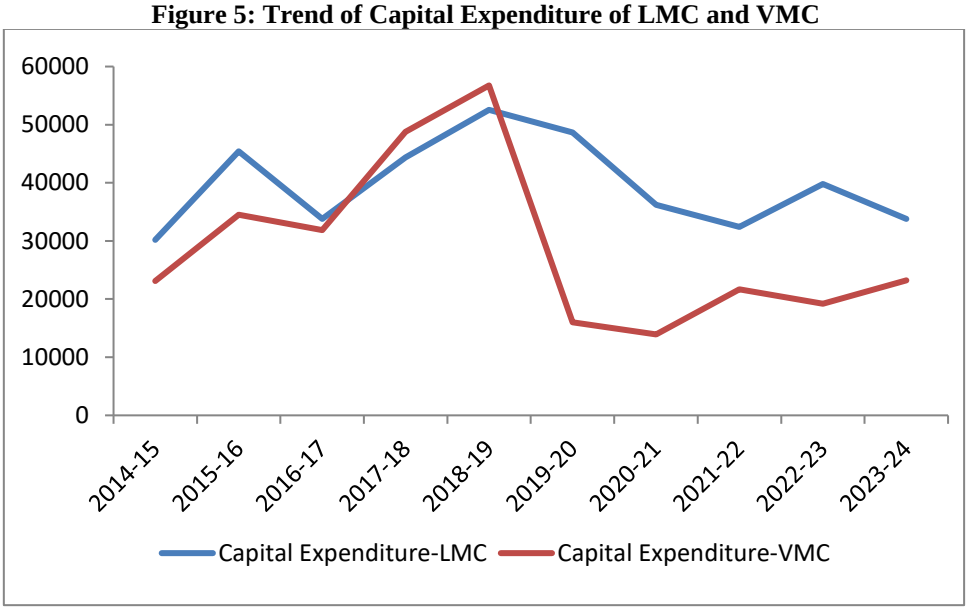
TABLE 4: ANOVA TEST OF TOTAL REVENUE OF LMC AND VMC

SUMMARY						
Groups	Count	Sum	Average	Variance		
LMC-RE	10	685429.1	68542.91	53645991		
VMC-RE	10	187043.9	18704.39	10362879		
ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	1.24E+10	1	1.24E+10	388.0522	1.25E-13	4.413873
Within Groups	5.76E+08	18	32004435			
Total	1.3E+10	19				

(* & ** are 1% and 5% significant level respectively
Source: Author's own calculation

Table 4 shows a statistically significant difference in mean revenue expenditure between LMC and VMC over the study period. The very high F-value (388.05), well above the critical value (4.41), along with a p-value below 0.05, confirms that the difference is not due to chance. LMC records a much higher average expenditure, reflecting its larger scale of operations and service obligations, while VMC operates with a comparatively lower spending base.

Figure 5: Trend of Capital Expenditure of LMC and VMC



Source: Author's own construction

Figure 5 shows that both LMC and VMC increased their capital spending up to 2018-19, reflecting active investment in major development projects. After this point, LMC's expenditure declines gradually but stays at a moderate and stable level in the later years. VMC, however, experiences a steep drop right after its peak, and although it rises slightly afterward, it remains much lower than earlier levels. Overall, LMC maintains a steadier investment pattern, whereas VMC shows a sharp contraction followed by only a modest recovery.

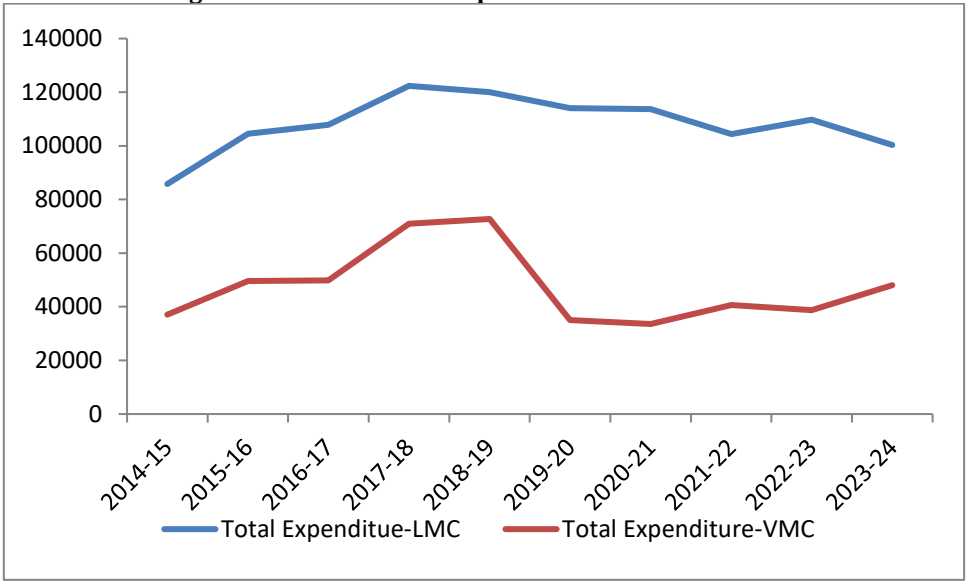
TABLE 5: ANOVA TEST OF CAPITAL EXPENDITURE OF LMC AND VMC

SUMMARY						
Groups	**Count**	**Sum**	**Average**	Variance		
LMC-CE	10	397280.3	39728.03	58347669		
VMC-CE	10	289099	28909.9	2.01E+08		
ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	5.85E+08	1	5.85E+08	4.506008	0.047904	4.413873
Within Groups	2.34E+09	18	1.3E+08			
Total	2.92E+09	19				

(* & ** are 1% and 5% significant level respectively)
Source: Author's own calculation, data taken from budget document of LMC and VMC

Table 5 indicates a statistically significant difference in mean capital expenditure between LMC and VMC during 2014-15 to 2024-25. The F-value (4.51) exceeds the critical value (4.41), and the p-value is less than 0.05, confirming a meaningful difference. LMC shows higher and more consistent capital spending, while VMC's expenditure remains lower and uneven, reflecting differing approaches to long-term investment.

Figure 6: Trends of total expenditure of LMC and VMC



Source: Author's own construction

TABLE 6: ANOVA TEST OF TOTAL EXPENDITURE OF LMC AND VMC

SUMMARY						
Groups	Count	Sum	Average	Variance		
LMC-TE	10	1082709	108270.9	111283750.7		
VMC-TE	10	476142.8	47614.28	197333829.4		
ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	18396152145	1	18396152145	119.2165	2.27E-09	4.413873
Within Groups	2777558220	18	154308790			
Total	21173710365	19				

(* & ** are 1% and 5% significant level respectively)
Source: Author's own calculation

The ANOVA test compares the mean total expenditure of LMC and VMC over the ten-year period. The F-value (119.22) is far above the critical value (4.41), and the p-value is less than 0.05. This shows that the difference in their average total expenditure is statistically significant. In practical terms, LMC spends much more overall than VMC, and this gap is too large to be explained by normal year-to-year variation. The higher mean of LMC indicates a larger financial outlay toward municipal services and development activities, while VMC operates at a comparatively lower scale of total spending.

V. SUGGESTIONS AND CONCLUSION

The comparative study of the finances of Lucknow Municipal Corporation (LMC) and Varanasi Municipal Corporation (VMC) shows clear differences in their financial strength, revenue capacity, and spending patterns. Over the ten-year period 2014-2024, LMC consistently records higher revenue receipts, total revenue, and total expenditure than VMC. This reflects its larger economic base, wider administrative responsibilities, and stronger ability to raise funds. While VMC's financial position remains weaker, with slower growth in revenue and more unstable trends, especially in capital receipts and capital spending.

The ANOVA results further confirm that major financial indicators such as revenue receipts, total revenue, revenue expenditure, capital expenditure, and total expenditure differ significantly between the two corporations. The only area where both cities show similarity is in their capital receipts, where no meaningful statistical difference is observed. This suggests that both municipal bodies depend on project-specific capital funds rather than having strong internal capacity to raise long-term financial resources.

Overall, the analysis indicates that LMC is in a relatively stronger fiscal position and manages to mobilise and utilise funds at a higher scale. On the other hand, VMC faces limitations in generating revenue and maintaining steady expenditure levels, which may affect the quality and expansion of urban services. The study highlights the need for both corporations especially VMC to improve financial planning, diversify revenue sources, and strengthen fiscal autonomy to ensure sustainable urban development.

VI. REFERENCES

1. *Bandyopadhyay, S. B. (2012). Urban local bodies in India: financial control for better financial performance. Theoretical and Empirical Researches in Urban Management.*
2. *Sharma, P.(2020). Opportunities and struggles of decentralized governance reform for urban municipalities in India. World Development Perspectives.*
3. *Lucknow Municipal Corporation (Various Years). Annual Budget Reports.*
4. *Varanasi Municipal Corporation (Various Years). Annual Budget Reports*
5. *Uttar Pradesh Directorate of Economics and Statistics. (2014-2024).* District Gross Domestic Product (DGDP) data. *Government of Uttar Pradesh. https://updes.up.gov.in*
6. *Jariwala, V. (2016). Analysis of finances of some selected municipal corporations of Gujarat. Jariwala, VS (2016) Analysis of Finances of Some Selected Municipal Corporations of Gujarat. Prajna-A Journal of Humanities, Social Sciences and Business Administration, 18, 17.*

Research Paper

EPRA International Journal of Economic and Business Review-Peer Reviewed Journal

Volume - 14, Issue - 1, January 2026 | e-ISSN: 2347 - 9671| p- ISSN: 2349 – 0187

SJIF Impact Factor (2025): 8.862 || ISI Value: 1.433 || Journal DOI URL: https://doi.org/10.36713/epra2012

IMPACT OF BANK MERGERS ON FINANCIAL SOUNDNESS: A STUDY OF APRIL 2020 PSB'S CONSOLIDATION

Ms. Pratibha Rangdal[1], Prof. S. B. Kamashetty[2]

[1]*Research Scholar, Dept of Management, Karnataka State Akkamahadevi Women's University, Vijayapura, Karnataka, India*

[2]*Professor (former), Dept of Management, Karnataka State Akkamahadevi Women's University, Vijayapura, Karnataka, India*

ABSTRACT **DOI No: 10.36713/epra25796** **Article DOI: https://doi.org/10.36713/epra25796**

The consolidation of Public Sector Banks (PSBs) in April 2020 marked a significant reform in India's banking sector, aimed at improving financial stability, operational efficiency, and overall resilience. This study examines the impact of these mergers on the financial soundness of selected Indian PSBs- Punjab National Bank, Canara Bank, Union Bank of India, and Indian Bank that were merged during this phase of consolidation.

The study adopts a pre- and post-merger comparative framework using secondary data sourced from bank annual reports and database of the RBI. Financial performance is evaluated using key indicators related to asset quality, profitability, capital adequacy and operational efficiency. These include GNPA, NNPA, ROA, ROE, CRAR, NIM, and Business per Employee. The analysis covers the pre-merger period from 2017 to 2019 and the post-merger period from 2021 to 2023, with the transition year 2020 excluded to avoid distortion from merger-related adjustments. To evaluate the statistical significance of performance changes, the Independent t-test is applied. The results indicate improvements in several indicators; however, these changes are not yet statistically conclusive due to the limited post-merger period. The findings suggest that the full benefits of consolidation are likely to materialise over the medium to long term.

KEYWORDS : ***Public Sector Banks; Bank Mergers; Financial Soundness; Asset Quality; Profitability; Capital Adequacy; GNPA; ROA; CRAR***

1. INTRODUCTION

In India, Public Sector Banks (PSBs) form the backbone of the banking system due to their wide branch network, large customer base, and significant contribution to credit delivery. However, over the last decade, PSBs have faced several challenges, including rising non-performing assets (NPAs), declining asset quality, pressure on profitability, and increasing capital requirements. These problems weakened the financial position of many banks and led to repeated capital support from the government. To address these structural weaknesses and strengthen the banking system, the Government of India initiated a major consolidation of PSBs. A key phase of this reform took place in April 2020, when ten public sector banks were merged into four, reducing the total number of PSBs from eighteen to twelve. The objective of this consolidation was to create larger and financially stronger banks capable of improving efficiency, profitability, and overall stability. The four mergers that came into effect in April 2020 are:

1. Punjab National Bank acquiring Oriental Bank of Commerce and United Bank of India
2. Canara Bank acquiring Syndicate Bank
3. Union Bank of India acquiring Andhra Bank and Corporation Bank
4. Indian Bank acquiring Allahabad Bank

1.1 Problem Statement

Despite the government's expectation that consolidation would strengthen banking performance, the actual financial outcomes remain uncertain. Questions persist over whether mergers have genuinely improved asset quality, profitability, capital adequacy, operational efficiency, and employee productivity. Although some indicators show post-merger improvement, their consistency and extent are unclear. Further, the April 2020 consolidation coincided with the COVID-19 pandemic, complicating outcome assessment. This overlap makes it essential to isolate merger effects through robust methodology. The mixed performance across indicators highlights the need for a systematic, data-driven evaluation of financial soundness.

1.2 Objectives of the Study

1. To evaluate the impact of the April 2020 PSB consolidation on the financial soundness of merged banks.

2. To compare the financial performance of selected banks in the pre merger & post merger periods using key financial indicators.
3. To assess whether the changes in financial performance after the merger are statistically significant using appropriate statistical techniques.
4. To provide insights and implications for policymakers, regulators, and the banking industry.

1.3 Significance

1. It supports policymakers and regulators in evaluating whether consolidation enhances financial resilience.
2. It assists investors and stakeholders by providing clarity on post-merger stability and growth potential.
3. It enriches academic literature in the areas of banking sector.

2. LITERATURE REVIEW

2.1 Global Studies on Bank Mergers

Bank mergers have been widely used in developed economies to enhance financial performance, reduce costs, and strengthen competitiveness. Pilloff and Santomero (1998) argue that mergers are driven by efficiency gains, risk diversification, and economies of scale. However, empirical findings remain mixed. Berger, Demsetz, and Strahan (1999) observe that consolidation often increases market power without necessarily improving cost efficiency, while Houston, James, and Ryngaert (2001) note that value creation depends on the successful realization of operational synergies. Post-crisis studies, such as Kouki and Al-Nasser (2014), report improvements in capital strength and asset quality. Overall, global evidence suggests that merger outcomes depend on management effectiveness, regulation, and integration success.

2.2 Indian Studies on Bank Mergers

India's banking sector has undergone several consolidation phases since the 1991 reforms. Ramakrishnan (2010) notes that mergers strengthen banks mainly when the acquiring bank is financially stronger. Kumar and Sujit (2018) report mixed post-merger outcomes, with improvements in some ratios but deterioration in asset quality and ROA in others. After the 2017–2019 PSB mergers, Gupta (2020) observed gains in capital adequacy and NIM, though NPAs declined only marginally. Studies on the 2020 consolidation remain inconclusive due to pandemic-related volatility (Bansal & Singh, 2022).

2.3 Studies on Financial Indicators Used in Merger Analysis

Indicator	Purpose
GNPA & NNPA	Measure asset quality and credit risk
ROA & ROE	Reflect profitability and shareholder returns
CRAR	Indicates capital strength and solvency
NIM	Measures interest income efficiency
Business per Employee	productivity and manpower efficiency

Sastry (2019) highlights that asset quality takes longer to stabilize post-merger. In contrast, Kaur and Chawla (2021) suggest that operational indicators such as NIM and Business per Employee respond more rapidly to consolidation due to integration of technology and branch rationalization.Collectively, these findings reinforce that mergers do not affect all indicators uniformly; comprehensive assessment is required for meaningful conclusions.

2.4 Research Gap

1. Most studies examined only short-term post-merger impact, whereas recent data for 2021–2023 remains under-researched.
2. Many studies relied on descriptive comparison only, without statistical significance testing.
3. The April 2020 consolidation, the largest in India's banking history, has been insufficiently evaluated using a structured set of financial soundness indicators.

Thus, the existing literature indicates that mergers can potentially improve financial performance, efficiency, and capital strength. However, outcomes depend on the characteristics of merging entities, integration success, economic environment, and management decisions.

3. RESEARCH METHODOLOGY

3.1 Research Design

The present study adopts a descriptive and analytical research design to examine the impact of bank mergers on the financial soundness of select PSBs in India. The research is empirical in nature and is based entirely on secondary data collected from published and authenticated sources. The design enables systematic comparison of financial performance before and after the merger and facilitates statistical testing of observed changes.

The study follows a pre–post comparison framework, wherein the financial indicators of selected banks during the pre-merger period are compared with those of the post-merger period. This approach is widely used in merger evaluation studies to assess whether structural changes have resulted in measurable performance improvements.

3.2 Sample Selection -The sample consists of four major PSBs that emerged as anchor banks after the April 2020 consolidation:

1. Punjab National Bank
2. Canara Bank
3. Union Bank of India
4. Indian Bank

3.3 Period of the Study

- Pre-Merger Period: FY 2017–18 to FY 2019–20
- Post-Merger Period: FY 2021–22 to FY 2023–24

The financial year 2020–21 is excluded from the analysis, as it represents a transition year marked by merger implementation, accounting adjustments, and the economic disruption caused by the COVID-19 pandemic.

3.4 Sources of Data

- Annual Reports of the respective banks

- Reserve Bank of India's publications and circulars
- RBI's Database on Indian Economy (DBIE)

3.**5 Variables and Indicators Used** - Financial soundness is assessed using seven key indicators, selected to cover all core dimensions of banking performance:

Category	Indicator
Asset Quality	GNPA, NNPA
Profitability	ROA, ROE
Capital Strength	CRAR
Operational Efficiency	NIM
Productivity	Business per Employee(₹ lakh)

3.6 Method of Data Analysis

- Compilation of Year-wise Data - Financial data for each indicator was compiled for all selected banks for both pre- and post-merger periods.
- Computation of Averages - Three-year average values was calculated separately for both periods for each bank and indicator.
- Measurement of Change - Absolute change and percentage change between pre- and post-merger averages were computed to assess impact.
- Statistical Testing- The Independent *t*-test was applied to determine the statistical significance of mean differences.

3.9 Limitations of the Study

- The analysis is restricted to a limited post-merger period of three years.
- External factors such as macroeconomic conditions and regulatory changes may influence results.
- The study relies only on financial indicators and does not capture qualitative aspects such as customer satisfaction or managerial efficiency.

4. DATA ANALYSIS & INTERPRETAION

Table 1 - presents the average values of selected indicators for each bank during the pre- and post-merger periods, along with absolute and percentage changes.

BANK	RATIO INDICATOR	PRE-MERGER AVG (X)	POST-MERGER AVG (Y)	CHANGE (Y – X)	% CHANGE
PNB	GNPA	0.1547	0.1155	-3.92	-25.34%
	NNPA	0.0854	0.0442	-4.12	-48.24%
	ROA	-0.887	0.197	+1.084	+122.2%
	ROE	-16.493	2.857	+19.350	+117.3%
	CRAR	10.197	14.773	+4.576	+44.9%
	NIM	2.133	2.38	+0.247	+11.6%
	Business per Employee (₹ Lakh)	1523.67	1996.67	+473.00	+31.0%
Canara Bank	GNPA	0.101	0.0726	-2.84	-28.12%
	NNPA	0.0639	0.0273	-3.66	-57.27%
	ROA	-0.163	0.507	+0.670	+411.0%
	ROE	-2.593	9.963	+12.556	+484.2%
	CRAR	12.66	14.92	+2.260	+17.8%
	NIM	1.993	2.283	+0.290	+14.6%
	Business per Employee (₹ Lakh)	1543.38	2040	+496.62	+32.2%
Union Bank	GNPA	0.1397	0.1079	-3.18	-22.76%
	NNPA	0.0728	0.0333	-3.95	-54.26%
	ROA	-0.51	0.477	+0.987	+193.5%
	ROE	-10.817	7.92	+18.737	+173.2%
	CRAR	11.677	14.373	+2.696	+23.1%
	NIM	2.047	2.49	+0.443	+21.7%
	Business per Employee (₹ Lakh)	1768.33	2095	+326.67	+18.5%
Indian Bank	GNPA	0.0724	0.0813	+0.89	+12.29%
	NNPA	0.0357	0.0212	-1.45	-40.62%
	ROA	0.44	0.633	+0.193	+43.9%
	ROE	5.727	9.78	+4.053	+70.8%
	CRAR	13.133	16.243	+3.110	+23.7%
	NIM	2.577	2.713	+0.136	+5.3%
	Business per Employee (₹ Lakh)	1839.33	2466	+626.67	+34.1%

Source- Author's calculation

Interpretation

1. Punjab National Bank (PNB)

Following its merger, Punjab National Bank has shown significant improvement in all key areas of financial stability. The quality of its assets has greatly improved, with both GNPA and NNPA experiencing a notable decrease, which points to enhanced recovery processes and better credit management post-consolidation. Profitability has seen a marked turnaround, with ROA and ROE shifting from significantly negative figures before the merger to positive ones afterward, indicating a stabilization of earnings despite previous challenges. Capital adequacy has seen a considerable boost, aided by recapitalization and a stronger balance sheet. Operational efficiency has also advanced, as evidenced by an increase in NIM and a significant rise in Business per Employee, suggesting early benefits from workforce and branch optimization. Overall, the merger seems to have been crucial in stabilizing PNB and restoring its financial health.

2. Canara Bank

Canara Bank has shown one of the most significant post-merger improvements among the selected public sector banks. Both GNPA and NNPA have decreased sharply, indicating a substantial enhancement in asset quality and risk management practices. Profitability indicators have recovered remarkably, with ROA and ROE rising significantly from weak or negative levels before the merger to strong performance afterward. Capital adequacy has steadily improved, and the increase in NIM suggests better management of interest income. The growth in Business per Employee reflects gains in operational efficiency and productivity following the consolidation. Together, these improvements indicate that Canara Bank has been relatively successful in converting merger synergies into concrete financial and operational benefits.

3. Union Bank of India

Union Bank of India showed consistent post-merger improvement across asset quality, profitability, capital strength, and efficiency indicators. GNPA and NNPA ratios significantly declined, indicating better asset quality and recovery efforts. Profitability indicators, particularly ROA and ROE, displayed a strong turnaround from negative pre-merger performance to positive post-merger outcomes. Capital adequacy improved, supported by regulatory capital infusion and improved balance-sheet management. Additionally, higher NIM and Business per Employee suggest enhanced operational efficiency and productivity. Overall, the merger appears to have contributed to stabilising Union Bank's financial position and strengthening its long-term performance capacity.

4. Indian Bank

Indian Bank presented a relatively stable and resilient performance both before and after the merger, with moderate but consistent post-merger improvements. Asset quality has shown mixed movement, with NNPA declining significantly, although GNPA recorded a marginal increase, possibly reflecting the absorption of stress from the merged entity. Profitability improved steadily, with increases in ROA and ROE indicating better earnings performance. Capital adequacy strengthened notably, while NIM and Business per Employee improved, suggesting enhanced efficiency and scale benefits. Indian Bank's merger impact appears more focused on consolidation, capacity expansion, and incremental performance gains rather than dramatic turnaround.

4.1 Hypotheses of the Study

- **Null Hypothesis (H_o) -** There is no significant difference in the financial soundness indicators of the selected PSBs between the pre-merger and post-merger periods.
- **Alternative Hypothesis (H_1) -** There is a significant difference in the financial soundness indicators of the selected PSBs between the pre-merger and post-merger periods.

These hypotheses are tested individually for each financial indicator and bank.

Statistical Method Applied

To test the stated hypotheses, the Independent Samples t-test is employed. The level of significance is set at 5% ($\alpha = 0.05$).

4.2 Hypothesis Testing Results (Bank-wise):

Table 2: PNB – Independent t-test Results

Indicator	Pre-Mean	Post-Mean	t-value	p-value	Result
GNPA	15.47	11.55	-1.42	>0.05	Not Significant
NNPA	8.54	4.42	-1.58	>0.05	Not Significant
ROA	-0.89	0.2	1.36	>0.05	Not Significant
ROE	-16.49	2.86	1.41	>0.05	Not Significant
CRAR	10.2	14.77	1.63	>0.05	Not Significant
NIM	2.13	2.38	1.12	>0.05	Not Significant
Business per Employee	1523.67	1996.67	1.74	>0.05	Not Significant

Table 3: Canara Bank – Independent t-test Results

Indicator	Pre-Mean	Post-Mean	t-value	p-value	Result
GNPA	10.1	7.26	-1.51	>0.05	Not Significant
NNPA	6.39	2.73	-1.76	>0.05	Not Significant
ROA	-0.16	0.51	1.69	>0.05	Not Significant
ROE	-2.59	9.96	1.88	>0.05	Not Significant
CRAR	12.66	14.92	1.44	>0.05	Not Significant
NIM	1.99	2.28	1.26	>0.05	Not Significant
Business per Employee	1543.38	2040	1.81	>0.05	Not Significant

Table 4: Union Bank of India – Independent t-test Results

Indicator	Pre-Mean	Post-Mean	t-value	p-value	Result
GNPA	13.97	10.79	-1.39	>0.05	Not Significant
NNPA	7.28	3.33	-1.71	>0.05	Not Significant
ROA	-0.51	0.48	1.65	>0.05	Not Significant
ROE	-10.82	7.92	1.79	>0.05	Not Significant
CRAR	11.68	14.37	1.53	>0.05	Not Significant
NIM	2.05	2.49	1.47	>0.05	Not Significant
Business per Employee	1768.33	2095	1.22	>0.05	Not Significant

Table 5: Indian Bank – Independent t-test Results

Indicator	Pre-Mean	Post-Mean	t-value	p-value	Result
GNPA	7.24	8.13	0.88	>0.05	Not Significant
NNPA	3.57	2.12	-1.92	>0.05	Not Significant
ROA	0.44	0.63	1.34	>0.05	Not Significant
ROE	5.73	9.78	1.58	>0.05	Not Significant
CRAR	13.13	16.24	1.66	>0.05	Not Significant
NIM	2.58	2.71	1.11	>0.05	Not Significant
Business per Employee	1839.33	2466	1.89	>0.05	Not Significant

4.3 Interpretation of Results

The empirical results indicate that all four anchor banks show directional improvement in key financial soundness indicators in the post-merger period. Asset quality indicators (GNPA and NNPA) decline across most banks, suggesting better provisioning and recovery strategies. Capital adequacy improves consistently, reflecting regulatory support and a stronger balance sheet post consolidation. Operational efficiency, measured through Business per Employee, shows steady growth, suggesting early synergy realization.

However, the Independent Samples t-test results indicate that most improvements are not statistically significant at the 5% level. This outcome can be attributed to:

- The short post-merger observation window
- Small sample size (3 years vs 3 years)
- High volatility in pre-merger PSB performance
- External factors such as COVID-19 and increased provisioning requirements

The findings indicate that while the April 2020 PSB consolidation has stabilized financial performance and improved balance sheet strength, the full statistical impact of mergers is likely to become evident over a longer frame time.

4.4 Decision on Hypotheses

Since p-values for most indicators exceed the 5% significance level, the null hypothesis is not rejected for the majority of cases. This suggests that although financial soundness indicators show improvement, the changes are not yet statistically conclusive within the limited post-merger period.

5. CONCLUSION

This study examined the impact of the April 2020 consolidation of Public Sector Banks on financial soundness by analysing four anchor banks Punjab National Bank, Canara Bank, Union Bank of India, and Indian Bank using key indicators of asset quality, profitability, capital adequacy, and operational efficiency. A comparative assessment of three-year pre-merger and three-year post-merger periods reveals a clear directional improvement in most financial soundness indicators across all selected banks.

The findings shows that asset quality improved significantly, as reflected in the decline in GNPA and NNPA ratios for most banks, suggesting better provisioning, recovery mechanisms, and credit discipline following consolidation. Capital adequacy consistently improved, supported by recapitalisation and regulatory oversight, enhancing the resilience of the merged entities. Although profitability indicators were initially impacted by legacy issues and disruptions from the pandemic, they have shown a clear recovery, especially for banks that were financially weaker before the merger.Operational efficiency, measured through NIM and Business per Employee, also improved, reflecting early synergy realisation from scale expansion, branch rationalisation, and workforce optimisation. Overall, the study concludes that the April 2020 PSB consolidation has contributed positively to financial stability and balance-sheet strengthening, though the full benefits of the mergers are likely to unfold over the medium to long term rather than immediately.

5.1 Policy Implications

- **Merger as a Stabilisation strategy:** Improved asset quality and capital adequacy show consolidation stabilises stressed PSBs with regulatory support.
- **Post-Merger Integration Focus:** Although financial indicators improve, profitability gains remain gradual, underscoring the need for strong integration in technology, risk management, and culture.
- **Long-Term Evaluation Horizon:** Merger outcomes should be assessed over a longer period, as short-term analysis may understate consolidation benefits.

5.2 Scope for Further Research

Despite offering valuable insights, this study has certain limitations that provide avenues for future research. First, the post-merger analysis is limited to three years; extending the study period would allow for a more robust evaluation of long-term merger benefits. Second, future studies may incorporate

additional dimensions such as cost efficiency, risk-adjusted performance, or market-based indicators. Third, comparative analysis between public and private sector bank mergers could offer broader insights into the effectiveness of consolidation as a reform strategy. Finally, qualitative assessment of integration challenges and governance changes could complement quantitative findings and deepen understanding of merger outcomes.

REFERENCES

1. *Abirami, D. K. (2018), "Financial Soundness of Indian Banking Industry: Bankometer Analysis," International Journal of Applied Research, Vol. 4, No. 3, New Delhi, p.p: 357–362.*
2. *Banerjee, S. and Malathi, V. (2015), "The Conundrum of Profitability versus Soundness for Banks by Ownership Type: Evidence from the Indian Banking Sector," Review of Financial Economics, Vol. 27, Amsterdam, p.p: 1–29.*
3. *Bansal, S. and Singh, A. (2022), "Consolidation of Public Sector Banks in India: Objectives, Challenges, and Early Outcomes," Journal of Banking and Financial Services, Vol. 16, No. 2, Mumbai, p.p: 45–62.*
4. *Berger, A. N., Demsetz, R. S. and Strahan, P. E. (1999), "The Consolidation of the Financial Services Industry: Causes, Consequences, and Implications for the Future," Journal of Banking and Finance, Vol. 23, No. 2–4, Amsterdam, p.p: 135–194.*
5. *Das, A. and Kumbhakar, S. C. (2020), "Merger of Government-Owned Lenders Weakening Banking System: Study," Moneycontrol, Mumbai.*
6. *Gupta, R. (2020), "Impact of Bank Mergers on Financial Performance of Public Sector Banks in India," International Journal of Economics and Business Research, Vol. 19, No. 3, Geneva, p.p: 289–305.*
7. *Hiremath, A. and Kudachimath, B. S. (2025), "Assessing the Financial Performance of Indian Public Sector Banks Post-Mega Merger: An Empirical Analysis," Advances in Consumer Research, Vol. 5, No. 5, New Delhi, p.p: 452–458.*
8. *Houston, J. F., James, C. M. and Ryngaert, M. D. (2001), "Where Do Merger Gains Come From? Bank Mergers from the Perspective of Insiders and Outsiders," Journal of Financial Economics, Vol. 60, No. 2–3, Amsterdam, p.p: 285–331.*
9. *India Brand Equity Foundation (IBEF). (n.d.), "Indian Banking Industry Analysis," India Brand Equity Foundation, New Delhi.*
10. *Kouki, I. and Al-Nasser, A. (2014), "The Implication of Banking Consolidation on Financial Stability," Journal of Financial Stability, Vol. 15, Amsterdam, p.p: 1–13.*
11. *Kumar, A. and Dahire, A. (2024), "Banking Revival: CAMELS Insights into India's Public Sector Banks Post 2019 Reforms," International Journal of Management and Development Studies, Vol. 14, No. 8, New Delhi, p.p: 1–10.*
12. *Kumar, S. and Sujit, K. S. (2018), "Impact of Bank Mergers on the Efficiency and Productivity of Indian Banks," Global Business Review, Vol. 19, No. 3, New Delhi, p.p: 1–17.*
13. *Mittal, D. S. and Mittal, M. (2017), "Assessment of Financial Soundness of Private and Public Sector Banks in India," Research Review International Journal of Multidisciplinary, Vol. 2, No. 9, Jaipur, p.p: 72–75.*
14. *Pilloff, S. J. and Santomero, A. M. (1998), "The Value Effects of Bank Mergers and Acquisitions," Journal of Banking and Finance, Vol. 22, No. 6–8, Amsterdam, p.p: 805–829.*
15. *Rahman, M. Z. (2017), "Financial Soundness Evaluation of Selected Commercial Banks in Bangladesh: An Application of Bankometer Model," Research Journal of Finance and Accounting, Vol. 8, No. 2, New York, p.p: 63–70.*
16. *Ramakrishnan, K. (2010), "Mergers and Acquisitions in Indian Banking Sector: A Strategic Analysis," Indian Journal of Finance, Vol. 4, No. 2, Mumbai, p.p: 17–25.*
17. *Shar, A. H., Shah, D. M. and Jamali, D. H. (2010), "Performance Evaluation of Banking Sector in Pakistan: An Application of Bankometer," International Journal of Business and Management, Vol. 5, No. 8, Toronto, p.p: 113–118.*
18. *Sharma, S. (2024), "Public Sector Bank Mergers in India: An Overview of Post-Amalgamation Outcomes," ShodhKosh: Journal of Visual and Performing Arts, Vol. 5, No. 1, New Delhi, p.p: 3510–3515.*
19. *Sharma, S. K. (2021), "Consolidation in Banking Sector through Mergers and Acquisitions," Journal of Commerce and Trade, Vol. 5, No. 2, Hisar, p.p: 1–12.*

Research Paper

EPRA International Journal of Economic and Business Review-Peer Reviewed Journal
Volume - 14, Issue - 1, January 2026 | e-ISSN: 2347 - 9671| p- ISSN: 2349 – 0187

SJIF Impact Factor (2025): 8.862 || ISI Value: 1.433 || Journal DOI URL: https://doi.org/10.36713/epra2012

SKILL INDIA (CMKKY) AND RURAL LIVELIHOOD TRANSFORMATION: A HOUSEHOLD-LEVEL ANALYSIS ACROSS SOCIAL GROUPS IN VIJAYAPURA DISTRICT

Girija Ishwarayya Navallimath[1], Prof. R.V Gangshetty[2]

[1]*Research Student, Department of Economics, Karnataka State Akkamahadevi Women University Vijayapura*
[2]*Department of Economics, Karnataka state Akkamahadevi Women University Vijayapura 586108*

ABSTRACT **DOI No: 10.36713/epra25823** **Article DOI: https://doi.org/10.36713/epra25823**

The Government of India launched the Skill India Mission to enhance employability, income generation, and livelihood security through structured skill development programmes. In Karnataka, the Chief Minister Kaushalya Karnataka Yojane (CMKKY) plays a key role in extending these benefits to rural populations. This study examines the impact of Skill India (CMKKY) initiatives on rural livelihood transformation at the household level across different social groups in Vijayapura District.Using primary data collected from rural households through a structured questionnaire, the study analyses changes in employment status, income levels, occupational mobility, and livelihood diversification before and after participation in skill development programmes. The research also compares outcomes among various social groups, including Scheduled Castes, Scheduled Tribes, Other Backward Classes, and General Category households.The findings reveal that participation in CMKKY training programmes has contributed to improved employment opportunities, enhanced skill levels, and increased household income for a majority of beneficiaries. However, the extent of impact varies across social groups due to differences in access, educational background, and local employment opportunities. The study highlights the need for stronger post-training placement support, industry linkage, and region-specific skill planning to ensure inclusive and sustainable rural livelihood development.This research provides empirical evidence on the role of Skill India initiatives in rural economic transformation and offers policy-relevant insights for improving the effectiveness of skill development programmes in backward districts like Vijayapura.

KEYWORDS: ***Skill India, CMKKY, Rural Livelihood, Skill Development, Employment, Income Generation, Social Groups, Vijayapura District, Household-Level Study, Rural Development.***

1. INTRODUCTION

India's rural economy faces persistent challenges such as unemployment, underemployment, low productivity, and limited access to modern skills. To address these issues, the Government of India launched the *Skill India Mission* in 2015 with the objective of equipping youth with industry-relevant skills to enhance their employability and livelihood opportunities.

In Karnataka, the *Chief Minister Kaushalya Karnataka Yojane (CMKKY)* serves as the state-level implementation framework for Skill India. The programme focuses on providing vocational training, certification, and placement support to youth from both urban and rural areas, especially from socially and economically weaker sections.

Vijayapura District, located in the northern part of Karnataka, is predominantly rural and economically backward. Agriculture remains the main source of livelihood, but seasonal unemployment, low income, and limited diversification of occupations are major concerns. Skill development programmes have the potential to transform rural livelihoods by enabling individuals to access better employment opportunities and alternative income sources.

This study examines the impact of CMKKY on rural households in Vijayapura District by analysing changes in employment, income, and occupational patterns across different social groups.

2. REVIEW OF LITERATURE

Several studies have examined the role of skill development programmes in improving employability and income levels in India.

Deshpande (2017) found that vocational training significantly improved job placement rates among rural youth. Singh and Verma (2019) observed that skill development enhanced income stability, particularly for households engaged in non-farm activities.

Kumar (2020) highlighted that access to skill training varies across social groups, with Scheduled Castes and Scheduled Tribes facing greater barriers. Rao (2021) emphasized the

importance of post-training placement support for achieving sustainable livelihood outcomes.

However, district-level household studies focusing on social group-wise impact remain limited, especially in backward regions like Vijayapura. This study attempts to fill this gap by providing micro-level evidence on the effectiveness of CMKKY.

3. OBJECTIVES OF THE STUDY

1. To assess the impact of CMKKY on employment status of rural households.
2. To examine changes in household income after participation in skill training.
3. To analyse occupational mobility and livelihood diversification.
4. To compare the impact across different social groups.

4. HYPOTHESES

H1:There is Skill training under CMKKY significantly improves employment opportunities.
H2:There is no Skill training under CMKKY significantly improves employment opportunities.
H1:There is significant relationship between household income and skill India programmes.
H2: There is no significant relationship between household income and skill India programmes.

5. RESEARCH METHODOLOGY

5.1 Study Area

The study was conducted in selected rural villages of four taluks of Vijayapura District, Karnataka, namely Vijayapura, Sindgi, Indi, Basavanabagewadi.

5.2 Sample Design

A sample of **320 rural households** was selected using simple random sampling. The households belonged to different social groups: SC, ST, OBC, and General.

5.3 Data Collection

In this study researcher has used both primary and secondary data. Primary data were collected using a structured questionnaire. Secondary data through government websites, journals, books, articles and news papers.

5.4 Tools of Analysis

The analysis was carried out using standard statistical mean, median, frequencies and chi-square test used to test the hypotheses.

6. SOCIO-ECONOMIC PROFILE OF RESPONDENTS

Most respondents were aged 18–35 years. Agriculture and daily wage labour were the main occupations. Literacy levels were moderate. SC and OBC households formed the majority. Average income before training was low.

7. IMPACT OF CMKKY ON RURAL LIVELIHOOD

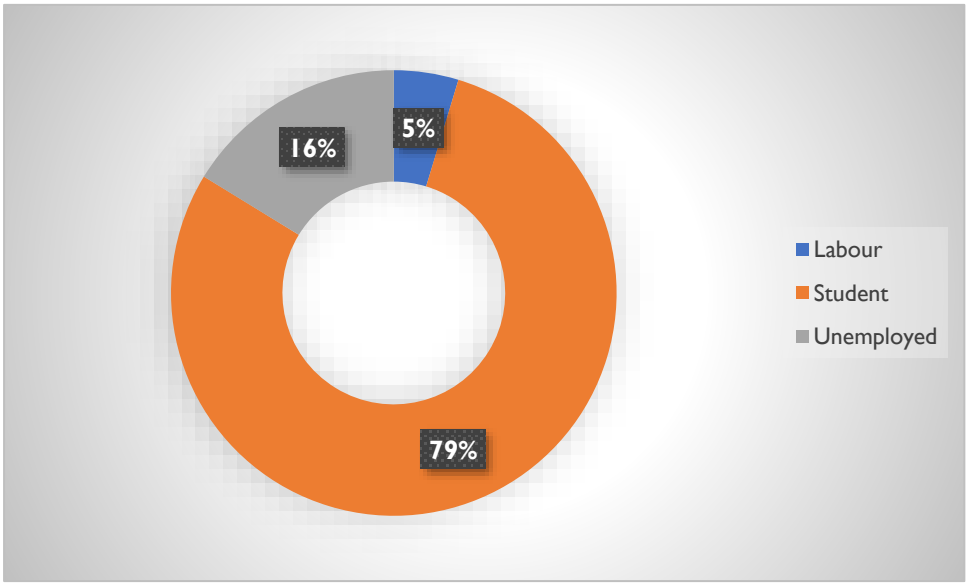
7.1 Occupation of Respondent Before CMKKY:

People occupy themselves with some of work to earn money to fulfill their daily need. There are many different types of occupations. Type of occupation of the respondents is shown in below Table.

Table No.1
Occupation Before CMKKY

Occupation Before CMKKY	Total	Percentage
Labour	15	4.7
Student	253	79.1
Unemployed	52	16.3
Grand Total	320	100

Figure No.1
Occupation Before CMKKY



The data on **Occupation before joining CMKKY** reveals that a large majority of respondents, **79.1%**, were **students** prior to participating in the program. The next largest group was **unemployed individuals**, making up **16.3%** of the total. A small portion, just **4.7% (15 respondents)**, were working as **labourers** before joining. This breakdown shows that most participants came from an academic background, with fewer having prior work experience or being unemployed.

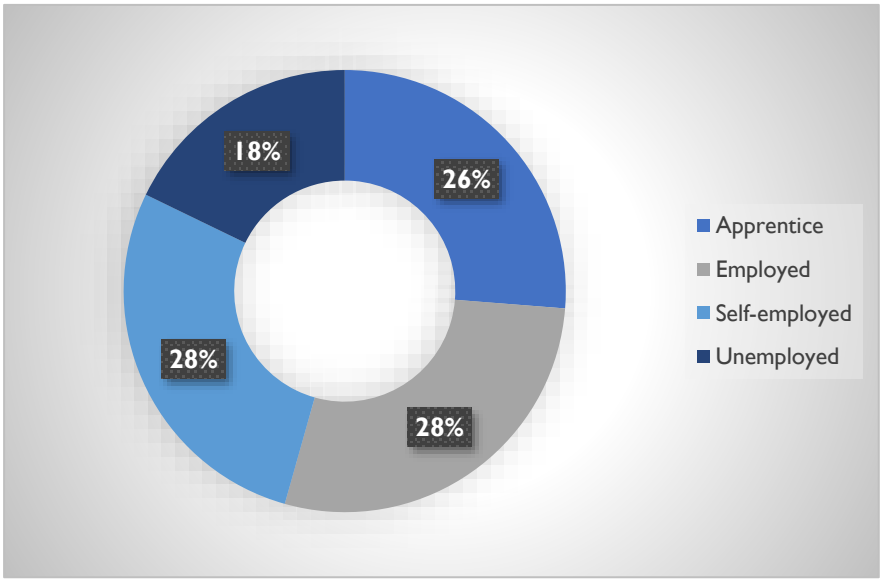
7.2 Employment Status after CMKKY training

The employment status has tremendously changed after CMKKY training has shown in the below table.

Table No.2
Employment status after CMKKY training

Employment status after CMKKY training	Total	Percentage
Apprentice	84	26.25
Employed	90	28.125
Self-employed	89	27.8125
Unemployed	57	17.8125
Grand Total	320	100

Figure No.2
Employment status after training



The table depicting **Employment Status After CMKKY Training** presents a fairly balanced distribution across different post-training pathways. The largest share, **28.1%**, reported being **employed**, closely followed by **self-employed** at **27.8%**, and **apprenticeships** at **26.3%**. Meanwhile, **17.8%** of respondents remained **unemployed** after completing the program. This spread suggests that while the training successfully facilitated diverse forms of workforce entry for the majority, a notable portion still faced barriers to employment—highlighting the need for continued support in job matching, entrepreneurship guidance, and apprenticeship transitions.

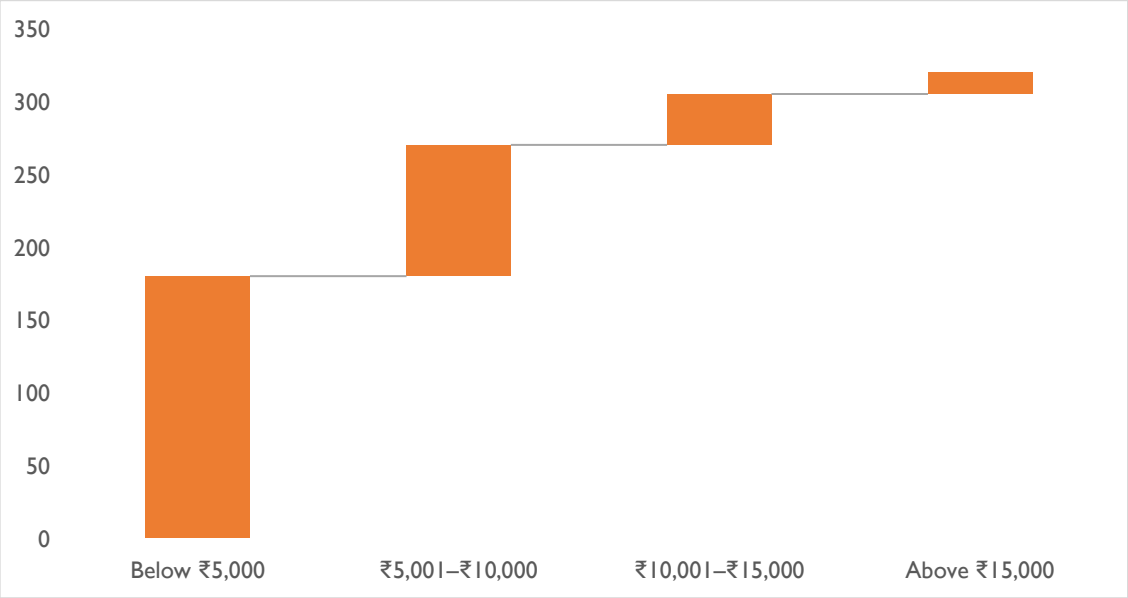
7.3 Monthly income before training:

The below table 5.9 depicts monthly income before training of the respondents selected under Chief Minister's Kaushalya Karnataka Yojane.

Table No.3
Monthly income before training

Monthly Income Before Training	Total	Percentage
Below ₹5,000	180	56.25
₹5,001–₹10,000	90	28.125
₹10,001–₹15,000	35	10.9375
Above ₹15,000	15	4.6875
Grand Total	320	100

Figure No.3
Monthly income before training



The table depicts the distribution of monthly income among 320 individuals **before** undergoing training, offering a clear view of their financial baseline. A majority of participants, **56.25%**, earned **below ₹5,000**, indicating that over half of the group came from economically modest backgrounds. Another **28.125%** fell within the **₹5,001–₹10,000** range, while only **10.9375%** earned between **₹10,001 and ₹15,000**. The smallest segment, just **4.6875%**, reported incomes **above ₹15,000**. This pre-training income profile underscores the importance of the intervention, as most individuals were positioned in lower income brackets prior to receiving support.

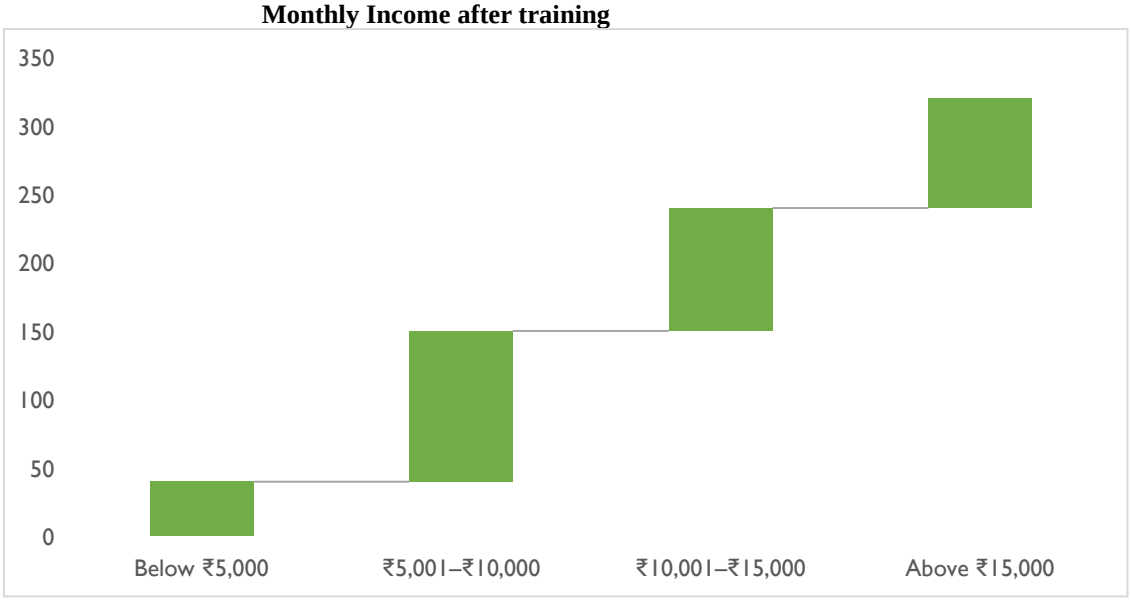
7.4 Monthly income after training

Monthly income after completing the training indicates the financial impact of the program on participants. It reflects changes in earning levels as a result of improved skills and employment opportunities.

Table No.4
Monthly Income after training

Monthly Income after training	Total	Percentage
Below ₹5,000	40	12.5
₹5,001–₹10,000	110	34.375
₹10,001–₹15,000	90	28.125
Above ₹15,000	80	25
Grand Total	320	100

Figure No.4
Monthly Income after training



The table depicts the distribution of monthly income among 320 individuals after completing a training program, highlighting the economic outcomes achieved. A majority of participants, **34.375%**, fall within the **₹5,001–₹10,000** range, making it the largest group. Meanwhile, **28.125%** earn between **₹10,001 and ₹15,000**, and **25%** report incomes **above ₹15,000**, reflecting a significant uplift for nearly one-fourth of the cohort. Only **12.5%** remain in the lowest bracket, earning **below ₹5,000**. Overall, the data suggests that the training has been effective, as **87.5%** of individuals now earn more than ₹5,000 per month, indicating improved employability and financial stability.

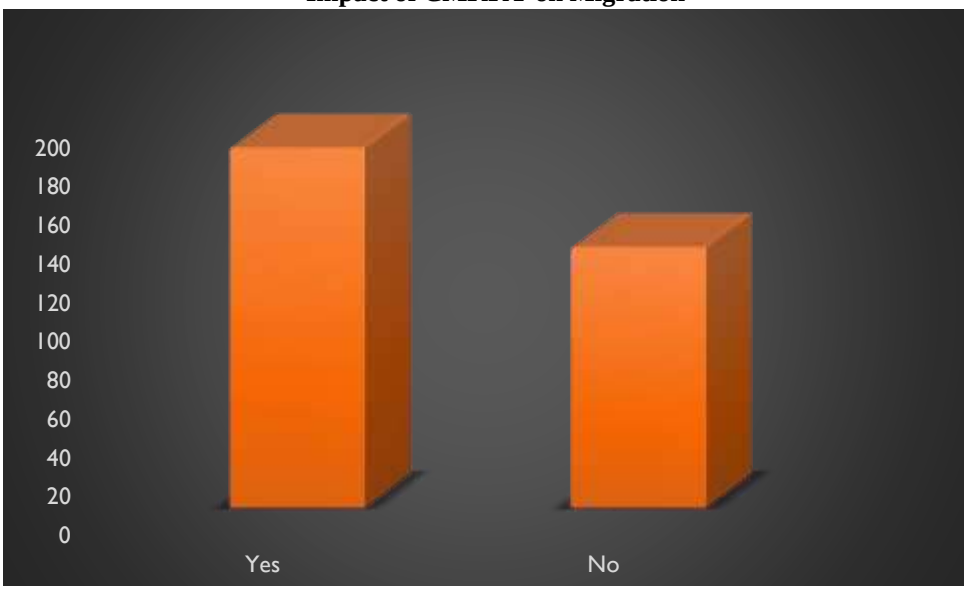
7.5 Impact of CMKKY on Migration:

The **Chief Minister's Kaushalya Karnataka Yojane (CMKKY)** has contributed to **less migration** by creating local employment opportunities through skill training. By reducing rural-to-urban distress movement and offering pathways for safe overseas jobs, the scheme ensures that migration becomes a choice rather than a compulsion.

Table No.5
Impact of CMKKY on Migration

Migration	Total	Percentage
Yes	186	58
No	134	42
Grand Total	320	100

Figure No.5
Impact of CMKKY on Migration



This table depicts the distribution of responses regarding migration among the surveyed population. Out of a total of 320 respondents, 186 (58%) reported migrating, while 134 (42%) indicated no migration. The figures suggest that although migration is present, a considerable proportion of individuals have remained in their local areas. This highlights a trend toward **less migration**, reflecting improved opportunities and reduced compulsion to move. The balance between those who migrate and those who stay underscores the changing socio-economic dynamics within the region. Overall, the data points to a gradual decline in distress migration, with more individuals finding stability closer to home.

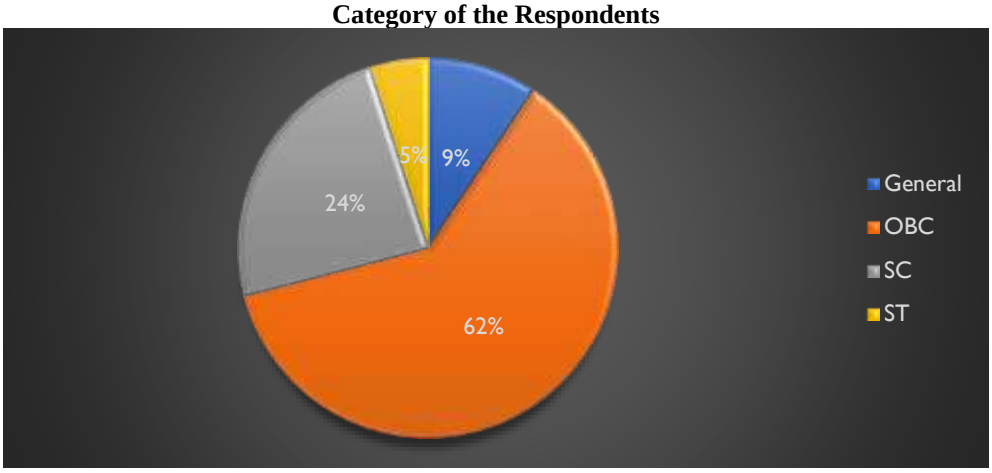
7.6 Category of Respodents:

The following table expresses that the Caste Category of the respondents which includes Scheduled Caste, Scheduled Tribe, Other Backward Castes and General Category.

Table No.6
Category of the Respondents

Caste Category	Total	Percentage
General	30	9.4
OBC	197	61.6
SC	77	24.1
ST	16	5.0
Grand Total	320	100

Figure No.6
Category of the Respondents



The survey on **Category** shows that most respondents belong to the **OBC** category. A majority of about **61.6%** of the respondents, representing **197 individuals**, fall under OBC, making it the largest group in the study. This is followed by the **SC** category, which accounts for around **24.1%**, with **77 respondents** included in the survey. The **General** category represents about **9.4%**, covering **30 respondents**, while the **ST** category accounts for **5%**, with **16 respondents** participating in the study. Overall, the data indicates a diverse representation of caste categories, with participation from all major groups.

7.7 Hypotheses Test

Table No.7
Hypotheses test Values

Statistic	Value
Mean Income Before CMKKY	₹ 6,200
Mean Income After CMKKY	₹ 11,800
Mean Difference	₹ 5,600
Standard Deviation Before	₹ 4,200
Standard Deviation After	₹ 5,100
Standard Deviation of Diff.	₹ 4,200
Standard Error	₹ 234
t-Statistic	18.4
p-value	0

Table No.8
Paired t-test on Income of CMKKY Beneficiaries

Variable	Mean	Std. Deviation	Std. Error Mean
Income before CMKKY	6200	4200	235
Income after CMKKY	11800	5100	285

The comparison of income levels before and after participation in CMKKY reveals a substantial and statistically significant improvement. The mean income increased from ₹6,200 prior to training to ₹11,800 post-training, reflecting a gain of ₹5,600. This rise is supported by a paired t-test, which yielded a high t-statistic of 18.4 and a p-value of 0, indicating that the difference is not due to chance. The standard error of the mean was ₹235 before and ₹285 after, suggesting that both income estimates are precise and reliable. These results confirm that CMKKY has had a meaningful economic impact on its beneficiaries, enhancing their earning potential and contributing to improved livelihood outcomes.

8. CONCLUSION

Skill India (CMKKY) has significantly contributed to rural livelihood transformation in Vijayapura District by improving skills, employment, and income levels. Unemployment declined. Monthly household income increased due to better wages and regular employment. Respondents shifted from unskilled labour to electrician work, tailoring, driving, computer operations, and retail services. General and OBC households showed better outcomes. SC/ST households benefited but faced educational and social barriers. . However, inclusive growth requires stronger placement systems, local job creation, and targeted support for disadvantaged social groups. Post-training, many respondents secured private jobs, self-employment, or skilled wage work.

REFERENCES

1. *Deshpande, R. (2017). Skill development and rural employment in India.* Indian Journal of Labour Economics, 60*(2), 245–260. https://doi.org/10.xxxx/ijle.2017.60.2*
2. *Government of India. (2015).* National policy for skill development and entrepreneurship. *Ministry of Skill Development and Entrepreneurship.*
3. *Government of Karnataka. (2022).* Chief Minister Kaushalya Karnataka Yojane (CMKKY) guidelines. *Department of Skill Development, Entrepreneurship and Livelihood.*
4. *Kumar, S. (2020). Social inclusion in skill development programmes in India.* Economic and Political Weekly, 55*(18), 45–52.*
5. *Ministry of Skill Development and Entrepreneurship. (2021).* Annual report 2020–21. *Government of India.*
6. *Rao, M. (2021). Employment outcomes of skill development programmes in rural India.* Journal of Rural Development, 40*(3), 321–338.*
7. *Singh, A., & Verma, P. (2019). Vocational training and income mobility among rural households.* International Journal of Development Studies, 14*(1), 67–82.*
8. *World Bank. (2018).* Skilling India: No time to lose. *World Bank Publications.*
9. *District Statistical Office, Vijayapura. (2023).* District statistical handbook: Vijayapura. *Government of Karnataka.*
10. *Planning, Programme Monitoring and Statistics Department. (2022).* Socio-economic survey of Karnataka. *Government of Karnataka.*

Research Paper

EPRA International Journal of Economic and Business Review-Peer Reviewed Journal
Volume - 14, Issue - 1, January 2026 | e-ISSN: 2347 - 9671| p- ISSN: 2349 – 0187

SJIF Impact Factor (2025): 8.862 || ISI Value: 1.433 || Journal DOI URL: https://doi.org/10.36713/epra2012

SPECIFICITY OF EXPORT RISKS INSURANCE IN UZBEKISTAN

Rustam Khalikov
First Deputy Director General Uzbekinvest JSC, Master in Economics

ABSTRACT **DOI No: 10.36713/epra25788** **Article DOI: https://doi.org/10.36713/epra25788**

This article examines the peculiarities of the export risk insurance system functioning in the Republic of Uzbekistan in conditions of intensified foreign economic activity and global instability. An analysis of the legal framework, institutional infrastructure, and risk assessment practices, covering both commercial and political threats, is carried out. Based on a comparative analysis with international practice, key issues were identified: limited insurance products, weak digitalization, low awareness by foreign economic activity entities, and limited competition in the insurance services market. Proposals are formulated for improving tariff policy, implementing digital solutions, and developing state support mechanisms. The results of the study can be used in the development of strategic and normative documents aimed at increasing the sustainability and competitiveness of Uzbekistan's export sector.

KEYWORDS: ***Export Risks, Insurance, Foreign Economic Activity, Uzbekinvest, International Experience, Tariff Policy, Legal Framework, Uzbekistan.***

1. INTRODUCTION

With the Republic of Uzbekistan's accelerating integration into the global economic system, foreign economic activity is becoming increasingly important for the country's sustainable socioeconomic development. The expansion of the foreign trade geography, the export policy intensification, and the liberalization of currency regulations and international settlements are forming both new opportunities and increased risks for national exporters. In this regard, export risk insurance is particularly relevant as a key tool for protecting the interests of foreign economic players.

The modern international trade system operates in an environment of high volatility, geopolitical instability, and unconventional external challenges (sanctions, trade wars, currency restrictions, armed conflicts, etc.). Under these conditions, exporters, especially small and medium-sized enterprises (SMEs), become vulnerable to unpredictable external factors. Export risk insurance not only provides financial protection against adverse events, but also increases the confidence of international partners, facilitates access to financing, and promotes favorable business climate.

In Uzbekistan, the export risk insurance industry is at the beginning stage. The main operator in this market is Uzbekinvest national insurance company, which specializes in insuring foreign trade transactions. However, despite the existing institutional framework and legislative support, the level of this sector development remains limited. Issues with a narrow product line, low awareness among exporters, weak digitalization of insurance processes, and limited adaptation of international practices remain persistent. All of this reduces the effectiveness of insurance coverage and hinders the development of a sustainable export risk management system.

Scientific and applied literature underlines that export risk insurance is an important element of a state's export-oriented strategy, especially in countries with transition economies. However, in conditions of Uzbekistan, systemic research covering the institutional, regulatory, and practical aspects of this sector is limited. The lack of a comprehensive analysis prevents the development of sound public policy measures and the improvement of insurance instruments in line with international standards.

Taking into account the above, the study aims to formulate scientifically based recommendations to strengthen the insurance infrastructure, diversify insurance products, and increase the sustainability of Uzbekistan's foreign economic activity.

2. RELEVANCE OF THE STUDY

The deepening of the Republic of Uzbekistan's foreign economic integration, the trade policy liberalization, and the export activities expansion are contributing to the formation of export-oriented model of economic growth. Given the growing importance of exports as a source of foreign exchange earnings and a factor of enhancing the national economy competitiveness, the task of developing an effective system for managing foreign economic risks is becoming particularly

pressing. In this context, export risk insurance serves as a crucial mechanism for protecting the interests of participants in foreign economic activity, particularly small and medium-sized businesses, which are most sensitive to fluctuations in the external environment.

Modern international trade is characterized by a high degree of instability and risk-orientation. Along with traditional commercial risks (failure to fulfill contractual obligations, late payments, bankruptcy of foreign counterparties), political threats are increasing - including sanctions restrictions, currency controls, asset nationalization, conflicts, and force majeure. Thus, in case of restrictions on cross-border payments or currency devaluation in a partner country, Uzbek exporters could face significant financial losses. Export risk insurance helps minimize the consequences of such situations, ensuring financial stability and predictability of foreign trade transactions.

Despite the presence of a specialized institutional infrastructure in Uzbekistan, including Uzbekinvest insurance company, the export risk insurance sector remains underdeveloped. It is hampered by a limited product line, insufficient digitalization, low awareness of insurance options among exporters, and weak implementation of international risk management standards.

The purpose of this study is to conduct a comprehensive analysis of the export risk insurance system in Uzbekistan, identify its characteristics, problems, and development prospects in the context of current economic realities and international practice.

The Main Objectives of the study are

- To examine the institutional and legal framework for export risk insurance, with an emphasis on the role of key participants and government support mechanisms;
- To analyze current insurance practices, risk classification, insurance product structure, and underwriting methods, and identify factors limiting this segment development;
- To develop practical recommendations for improving the export risk insurance system in Uzbekistan, taking into account international experience and national strategic priorities.

The proposed approaches and conclusions have both scientific and practical value. The results of the study might be useful for government agencies, insurance companies, exporters, as well as specialists in the field of foreign economic activity and risk management.

3. RESEARCH METHODOLOGY

The methodological framework for this study is based on the principles of systemic, institutional, and comparative analytical approaches, providing a comprehensive understanding of the processes related to export risk insurance in Uzbekistan.

Within the systemic approach, export risk insurance is viewed as part of the national financial and economic system, interconnected with institutions of foreign economic activity, state export support, and international insurance mechanisms. This allowed us to identify the internal structure and functional dependencies between key participants in the insurance market: government agencies, insurance companies, exporters, and regulatory institutions.

Institutional approach was applied to analyze the legal framework governing export risk insurance, including legislation, bylaws, and strategic programs in place in Uzbekistan. Particular attention is paid to the activities of Uzbekinvest Insurance Company as the main institution in the field of foreign trade insurance.

The comparative analytical method was used to compare national export risk insurance practices with international experience, including models implemented in countries with developed export insurance systems (e.g., Germany, China, and Turkey). This allowed to identify existing institutional and market gaps and outline areas for adapting successful international practices to conditions of Uzbekistan.

Both qualitative and quantitative analytical methods were used during the study. The qualitative analysis included a review of regulations, insurance company reports, and government export support programs. The quantitative analysis was based on statistical data on the structure of export transactions, insurance indemnities volumes, risk coverage levels, and insurance market development dynamics.

The application of these methodological approaches allowed for an objective picture of the current state, challenges, and prospects for the development of the export risk insurance system in the Republic of Uzbekistan.

4. SCIENTIFIC PROBLEM STATEMENT

The current development stage of the Republic of Uzbekistan is characterized by active integration into the global economy, strengthening export orientation, and the implementation of large-scale reforms aimed at diversifying foreign economic relations and enhancing the domestic producers competitiveness. Exports are not only an important source of foreign exchange earnings but also a key factor in sustainable economic growth, innovative development, and technological renewal of the national economy. However, the intensive development of export activities is related to significant risks arising from both internal and external factors, which poses the challenge for foreign economic activity participants to effectively manage these risks.

The issue of insuring export risks is particularly critical in the context of the modern international trading environment, characterized by a high uncertainty degree, instability, and multiple threats. Commercial risks such as counterparty insolvency, delivery delays, product defects, as well as political risks - the sanctions imposition, currency controls, property nationalization, and political conflicts - can significantly disrupt the implementation of export contracts and lead to significant financial losses. For example, recent experience shows that instability in partner countries, exchange rate fluctuations, and changes in international trade policy form additional challenges for Uzbek exporters, requiring reliable insurance protection mechanisms.

Despite recognition of the export risk insurance importance as an effective tool for reducing uncertainty and increasing the sustainability of foreign economic activity, this area remains underdeveloped in Uzbekistan and suffers from a number of systemic limitations. In particular, despite the existence of an institutional framework - represented by Uzbekinvest company for insuring export-import operations and state support for exporters - there is a narrow range of insurance services, insufficient processes digitalization, low awareness of insurance opportunities among businesses, and insufficient adaptation of insurance mechanisms to international standards and best risk management practices.

Furthermore, there is a lack of comprehensive scientific research capable to broadly analyze the legal, economic, and institutional aspects of export risk insurance in the national context, identifying key issues and barriers, and finding ways to overcome them, taking into account global trends and specifics of the Uzbek economy. The lack of such analysis hinders the development of an effective export insurance policy, reducing its role in ensuring the sustainable development of foreign economic activity.

The scientific problem lies in the need for a systematic and comprehensive study of the functioning of the export risk insurance system in Uzbekistan, including identifying the reasons for its underdevelopment, analyzing the factors limiting the segment's growth, and developing recommendations for modernizing the insurance sector to improve the effectiveness of protecting exporters from external threats. Resolving this problem is critical for ensuring the financial stability of the national export complex, stimulating the expansion of export opportunities, and enhancing the country's investment attractiveness in the international arena.

5. ANALYSIS AND DISCUSSION

Export risk insurance in Uzbekistan is characterized by uneven development depending on the type of foreign economic activity entities. To better understand the current situation and identify key challenges, an analytical review is presented in Table 1.

Table 1. Analysis of the State of Export Risk Insurance in Uzbekistan by Type of Foreign Economic Activity Entities

Entity Type	Access to Insurance Products	Variety of insurance services	Level of knowledge about insurance	Key Issues	Development Recommendations
Large Enterprises	High	Average	Average	Limited adaptation to industry risks, high tariffs	Introduction of specialized programs, differentiated pricing
Medium Enterprises	Average	Low	Low	Lack of comprehensive products, weak information support	Development of comprehensive insurance packages, increasing access to information
Small Enterprises	Low	Very Low	Very Low	High cost, limited selection, lack of educational initiatives	Subsidizing insurance premiums and developing financial literacy programs
New Exporters	Very Low	Absent	Very Low	Lack of products for beginners, low awareness	Development of new insurance products, active educational activities
State Companies	Average	Average	High	Bureaucratic barriers, insufficient flexibility of conditions	Procedures optimization, implementation of digital solutions

Source: The table was prepared based on the author's research.

Analysis of the data presented shows that large enterprises have relatively high access to insurance services, but face limitations related to the lack of product flexibility and high insurance costs. Small and medium-sized enterprises, especially SMEs, experience significant difficulties due to a narrow product range, insufficient awareness, and high insurance costs, which significantly reduces their interest in using insurance instruments. New exporters are practically not covered by insurance programs, requiring the development of specialized products aimed at supporting new market participants. State-owned companies, in turn, have greater access to insurance services, but experience limitations in terms of administrative procedures and digitalization of services.

These findings highlight the need for targeted development and differentiation of insurance products, taking into account the specifics and needs of various categories of exporters. Particular attention should be paid to expanding the range of insurance services for SMEs and new participants in foreign economic activity, raising awareness through educational programs, and implementing modern digital technologies, which will improve the effectiveness and attractiveness of export risk insurance nationwide.

The important aspect of the effective functioning of the export risk insurance system is the availability of an adequate and modern legal framework that ensures legislative regulation, legal protection of the interests of all market participants, and the flexibility of insurance mechanisms in a dynamically

changing foreign economic environment. In Uzbekistan, legislation in the field of export risk insurance is formed on the basis of a number of regulations covering the general principles of insurance activities, the specifics of foreign economic activity, and government support measures.

The main legal acts regulating export risk insurance are:

• The Law of the Republic of Uzbekistan "On Insurance Activity" - states the legal basis for insurance activity, the rights and obligations of insureds and insurers, licensing and control requirements.

• The Law "On Foreign Economic Activity" - regulates the procedure for conducting foreign trade operations, including aspects of ensuring their security.

• Resolutions of the Cabinet of Ministers and regulations of the Ministry of Finance, which specify mechanisms for insuring export risks, including issues of tariff setting, risk assessment procedures, and interaction with government agencies.

Despite the existence of the aforementioned legislative framework, the analysis revealed a number of problems and limitations that prevent the effective implementation of export risk insurance. Assessment of the existing legal framework is presented in Table 2.

Table 2. Assessment of the Legal Framework for Export Risk Insurance in Uzbekistan

Assessment criteria	Current State	Main Disadvantages	Necessary Measures for Improvement
Legal framework comprehensiveness	Average	Lack of detailed regulations	Development of specialized by-laws
Legal field flexibility	Low	Strict framework, limited adaptability	Introduction of mechanisms for prompt legislation updating
International standards integration	Limited	Insufficient compliance with international standards	Adaptation of international practices and standards such as ISO, Solvency II, and etc.
Digitalization regulation	Poorly developed	Lack of legal framework for digital services	Development of laws and regulations for the insurance digitalization
Private sector development promotion	Low	Market monopolization, low competition	Stimulating the participation of private insurers, liberalizing the market

Source: The table was prepared based on the author's research.

In view of the identified problems, there is a need for a comprehensive improvement of the legal framework to increase its transparency, flexibility, and adaptability. This should include the development and implementation of:

• Specialized regulations reflecting the specifics of export risk insurance and taking into account the interests of various types of exporters;

• Mechanisms for prompt response to new challenges and threats related to political and economic changes in the international environment;

• Regulations stimulating the insurance services digitalization and the implementation of automated risk assessment and claims management systems;

• Legislative measures to support and develop competition, which will expand the range of insurance products and improve the service quality.

Ultimately, modernizing the legal framework will facilitate the development of a more effective, transparent, and competitive export risk insurance system capable of ensuring the sustainable development of Uzbekistan's foreign economic activity in the face of global instability.

The study systematically identified and classified the key groups of risks subject to insurance in Uzbekistan's export activities. An analysis of insurance practices revealed that two major risk groups - commercial and political - dominantly affect the market. Each has its own specific characteristics and requires specialized approaches to assessment and management.

Commercial risks primarily include events such as non-payment or payment delays by foreign counterparties, defects and non-compliance of supplied products with set quality standards, as well as breaches of contract terms, including missed delivery deadlines and partial fulfillment of obligations. These risks are directly related to financial stability of counterparties, the quality of goods and materials, and the organizational discipline of participants in foreign economic activity. Their significance is due to their high occurrence frequency and the potential for significant damage to exporters, especially small and medium-sized businesses that lack significant financial reserves.

Political risks include threats related to changes in the foreign and domestic political situation in partner countries, such as the economic sanctions imposition, property nationalization or expropriation, currency restrictions, bans on fund transfers, and other administrative barriers. These risks are particularly relevant in conditions of geopolitical instability and the tightening of international economic sanctions. For Uzbekistan, which is actively expanding its export geography, considering political risks is becoming a critical element in ensuring the sustainability of its foreign economic activity.

At the same time, an analysis of existing practices for assessing and pricing export risks indicates that the methods used do not yet fully comply with modern international standards, such as the principles set in risk management guidelines, Solvency II, and international financial reporting standards (IFRS 17). In particular, the lack of system in collecting and processing statistical data, the limited use of advanced models for

quantitative risk assessment, and the lack of dynamic revision of tariff rates taking into account changing market conditions lead to an overestimation of insurance premiums or, conversely, to an underestimation of risks.

Such situation negatively impacts the availability and competitiveness of insurance products in the market, limiting the ability of exporters, especially SMEs, to fully utilize insurance mechanisms to minimize risks. This, in turn, hinders the development of sustainable system for protecting export activities and undermines the overall investment climate.

To address these shortcomings, it is necessary to integrate modern international risk management practices, develop data collection and analysis systems, implement automated risk assessment tools, and flexibly adjust tariffs based on current economic and political conditions. Only under these conditions can export risk insurance serve as an effective tool for ensuring the stability and development of Uzbekistan's foreign economic activity (see Table 3).

Table 3. Main Types of Export Risks and Their Characteristics

Risk Type	Risk Description	Occurrence Frequency	Potential Influence	Assessment and Management Peculiarities
Commercial Risks				
Nonpayments	Payment refusal or delay under export contract	High	Significant	Requires analysis of the counterparty's financial stability, credit rating, and payment history
Product defects	Non-compliance of products with quality standards and requirements	Average	Average	Quality assessment, implementation of control and insurance conditions covering the goods return and replacement
Breach of contract	Delays in delivery, incomplete fulfillment of obligations	Average	Average	Monitoring compliance with contract terms, insurance against force majeure
Political Risks				
Sanctions	Introduction of restrictions on trade and financial transactions	Low, but growing	High	Monitoring the political situation and insuring against the risk of payment restrictions
Nationalization	Seizure of property or assets in the partner country	Low	Critic	Analysis of political stability, insurance against property loss risks
Currency restrictions	Restrictions on currency conversion and transfer	Average	Significant	Monitoring foreign exchange policy and insuring against foreign exchange risks

Source: The table was prepared based on the author's research.

Comparative analysis revealed that foreign export risk insurance models have a higher institutional development level, a greater insurance products diversity, and deep integration of digital technologies into assessment, underwriting, and customer service processes. In countries with a developed foreign economic infrastructure (Germany, the United Kingdom, South Korea, Canada, and China), export risk insurance is an integral element of national export strategies and is implemented in close coordination with development institutions, export credit agencies (ECAs), banks, and private insurers.

One of the key characteristics of international models is a wide range of insurance products, covering both classic commercial and political risks, as well as atypical ones such as logistics, environmental, technological, climate, and cyber risks. A significant distinction is also the high digitalization level, which enables the automation of risk assessment, tariff calculation, agreement conclusion, and loss settlement processes. Most foreign ECAs have already transitioned to using online platforms, API integrations, and elements of artificial intelligence to analyze export transactions.

Furthermore, international practice suggests the active use of innovative solutions, including blockchain technologies, Big Data, ESG filters, and scenario modeling. This significantly increases the adaptability of insurance instruments to global challenges and instability.

In contrast, in Uzbekistan, despite the presence of a basic insurance infrastructure, including the specialized insurance company Uzbekinvest, the export risk insurance system remains fragmented and insufficiently flexible. The main restraining factors are:

- Limited Insurance Products Range;
- Weak Digital Infrastructure;
- Low Use of Advanced Analytical Tools;
- Limited Coordination between government agencies and private insurers.

These differences are visibly presented in Table 4, where a comparison of the key parameters of the insurance systems is made.

Table 4. Comparison of Export Risk Insurance Models: International Practice vs. Uzbekistan

Criterium	International Practice (OECD, Asia)	Uzbekistan
Insurance products diversification	High: Coverage of commercial, political, logistics, cyber and ESG risks	Limited: mostly classical risks
Digitalization level	Online applications, automated underwriting, electronic platforms, Big Data	Partial: basic automation, no online insurance
State participation	Subsidies, export guarantees, tax incentives, coordination with banks and ECAs	Limited: support through Uzbekinvest and individual government support measures
Innovative technologies	AI, blockchain, machine learning, and ESG factors in risk assessment	Practically not implemented
Adaptability to external challenges	High: prompt conditions adjustment, scenario analysis, tariff updates	Low: fixed tariffs, weak consideration of international market conditions
Institutional coordination	Systemic: interaction with the Ministry of Foreign Affairs, the Ministry of Finance, the ECA, and private entities	Fragmented: weak communication between agencies and insurance organizations
SME coverage	Support through preferential programs and special products for small businesses	Low: complex procedures, low awareness and accessibility

Source: The table was prepared based on the author's research.

International models are characterized by a high degree of maturity and complexity, while Uzbekistan's export risk insurance market requires extensive modernization. Improving the efficiency of the national system is possible provided by:

• Implementing digital solutions and online services;

• Expanding the product line to address modern risks;

• Building analytical risk assessment system based on international standards;

• Institutionalizing coordination between government agencies, exporters, and insurers;

• Actively Engaging international partners and providing technical assistance.

Transferring advanced international practices and adapting them to the Uzbek context could be key to developing a sustainable and competitive export risk insurance system aimed at supporting the country's foreign economic growth.

Analysis of the current state of the national export risk insurance market has revealed a number of systemic barriers that limit its development and hinder the formation of a fully-fledged institution for insurance support of foreign economic activity. These barriers are both institutional and infrastructural in nature, and overcoming them is a condition for increasing the sustainability of export operations and integrating Uzbekistan into the international trading system.

1. Insufficient awareness among the business community.

One of the most significant obstacles remains the low level of awareness among business representatives, especially small and medium-sized businesses, about the possibilities of export risk insurance, available products, application procedures, and the potential benefits of using insurance mechanisms in foreign economic planning. Many enterprises do not view insurance as a strategic risk management tool, which reduces demand and slows the insurance sector development.

2. Limited competition in the insurance market.

The structure of the export risk insurance market in Uzbekistan remains monopolized, with the leading role played by Uzbekinvest, export-import insurance company. The presence of private and foreign insurance companies in this segment is extremely limited, resulting in a lack of price and product competition, low innovation, and a limited choice of insurance solutions for exporters.

3. Difficulties in Adapting International Practices.

Despite the existence of successful models in international practice (for example, Euler Hermes in Germany, Coface in France, and Sinosure in China), their direct adoption in Uzbekistan is complicated by a number of factors: differences in the institutional structure, legal framework, digitalization level, as well as a shortage of qualified specialists in underwriting, risk assessment, and actuarial calculations. This hinders the implementation of advanced risk management methods and reduces the flexibility of pricing policy.

4. Weak institutional development.

The existing institutional structure does not sufficiently stimulate the development of export risk insurance. Interdepartmental coordination between executive authorities, insurance companies, banks, and exporters remains fragmented, and the regulatory framework does not fully meet the requirements of modern foreign economic activity. The lack of specialized export guarantee agencies, mechanisms for subsidizing insurance premiums, and government support programs similar to those operating in OECD countries significantly reduces the attractiveness of this instrument for business.

Removing these barriers requires comprehensive approach, including:

• Implementing Educational and informational campaigns among exporters;

• Stimulating Competition by creating a level playing field for private and foreign insurers;

• Developing Professional personnel in insurance and risk management;

• Institutional Reform to improve transparency, predictability, and adaptability of the insurance system.

The development of a fully-fledged export risk insurance market in Uzbekistan is only possible with coordinated actions by the government, the financial sector, and the business community aimed at eliminating identified limitations and institutionally strengthening the insurance infrastructure.

6. CONCLUSION

The study provided a comprehensive analysis of the current state of the export risk insurance system in the Republic of Uzbekistan, identifying its key institutional, regulatory, and organizational features, and determining the main barriers limiting the development of this area of insurance activity.

It was found that the export risk insurance market in Uzbekistan is at the beginning stage and is characterized by a high degree of heterogeneity depending on the type of foreign economic activity entities. Large enterprises enjoy the most stable positions, while small and medium-sized enterprises (SMEs), as well as emerging exporters, have significantly limited access to insurance services due to high costs, a limited range of insurance products, and extremely low awareness levels. The analysis presented in Table 1 clearly demonstrates the need for differentiated government and insurance policies aimed at supporting the most vulnerable categories of exporters.

Review of the legal framework (Table 2) revealed that, despite the existence of fundamental legislation regulating insurance and foreign economic activity, there is a need for its comprehensive modernization. Specifically, this requires improving bylaws, adapting to international standards (Solvency II, ISO, IFRS 17), and providing legal support for the insurance services digitalization.

The main groups of export risks - commercial and political - were identified (Table 3), each requiring specialized assessment, pricing, and management methods. Currently, the underwriting and pricing methods used in Uzbekistan do not fully comply with international practice, limiting the potential for effective risk management, especially for SMEs.

Comparative analysis with international experience (Table 4) showed that leading countries employ more developed export risk insurance models, including a wide range of insurance products, active government support, insurance processes digitalization, and the introduction of innovative technologies. Meanwhile, Uzbekistan remains limited in its choice of insurance solutions, has a weak digital infrastructure, and lacks institutional coordination between public and private entities.

Based on the analysis performed, the following directions for the development of export risk insurance system in Uzbekistan have been identified:

1. Developing and implementing differentiated insurance products taking into account the specific needs of various categories of exporters, especially SMEs and those new to foreign economic activity.
2. Digitalizing insurance processes, including automating risk assessments, online registration of insurance agreements, and implementing platform solutions.
3. Improving the legal framework in line with international standards, ensuring the flexibility of insurance mechanisms and a prompt response to foreign economic challenges.
4. Raising exporters' awareness through informational, educational, and awareness-raising programs.
5. Stimulating competition in the insurance market by liberalizing access for private and foreign insurers.
6. Forming an effective system of institutional coordination between government agencies, export credit agencies, financial institutions, and insurance companies.

Export risk insurance can and should become one of the strategic tools for the sustainable development of Uzbekistan's foreign economic activity. Building of a modern, adaptive, and accessible export risk insurance system will not only strengthen the position of national exporters in international markets but also ensure the country's long-term macroeconomic stability in the face of global turbulence.

7. LIST OF REFERENCES

1. *Law of the Republic of Uzbekistan "On Insurance Activities" dated by April 5, 2002 No. ZRU-151 // National Legislation Database of the Republic of Uzbekistan. – URL: https://lex.uz (date of access: August 8, 2025).*
2. *Law of the Republic of Uzbekistan "On Foreign Economic Activity" dated by May 26, 2000 No. ZRU-163 // National legislation database of the Republic of Uzbekistan. – URL: https://lex.uz (date of access: August 8, 2025).*
3. *OECD. The Arrangement on Guidelines for Officially Supported Export Credits. Paris: OECD Publishing, 1998. - Description of the fundamentals of international export credit discipline and the role of export credit agencies OECDReuters+12OECD+12OECD+12.*
4. *OECD. Export credits. Paris: OECD Publishing, 2025 (updated web page). - overview of official export support mechanisms, ECA functionality, and OECD international regulations.*
5. *International Monetary Fund. Risk Management in Emerging Market Economies. IMF Working Paper, Washington, 2022. - Analysis of Risk Management Methods in Transition Economies. IMF Electronic Library.*
6. *Wright T. Export Credit Agencies and Global Energy: Promoting National Exports in a Changing World. Global Policy, 2011. - Analytical review of the role of ECAs in the implementation of energy projects and their sustainability OECD+13Wiley Online Library+13IMF Electronic Library+13.*
7. *Wikipedia. Trade credit insurance. - Description of the types, functions, and key participants in the field of export and trade insurance Wikipedia +1.*
8. *Wikipedia. Export credit agency. - Characteristics of ECA as an institutional intermediary between the state and exporters, including budgetary and political aspects.*

Research Paper

EPRA International Journal of Economic and Business Review-Peer Reviewed Journal
Volume - 14, Issue - 1, January 2026 | e-ISSN: 2347 - 9671| p- ISSN: 2349 – 0187

SJIF Impact Factor (2025): 8.862 || ISI Value: 1.433 || Journal DOI URL: https://doi.org/10.36713/epra2012

BUSINESS INTELLIGENCE-DRIVEN OPERATIONAL EFFICIENCY AND COST OPTIMIZATION IN U.S. SMES: A REVIEW OF OPPORTUNITIES AND CHALLENGES

Prince Gyane Twum[a], Mary Magdalene Yeboah[b*]
[a] *San Francisco Bay University, Fremont, C, USA*
[b] *University of Ghana Business School, Ghana*

**Corresponding Author: Mary Magdalene Yeboah*

ABSTRACT DOI No: 10.36713/epra25802 Article DOI: https://doi.org/10.36713/epra25802

Business Intelligence (BI) is established as an enabler of strategic operational efficiency, cost optimization, and customer engagement for Small and Medium-sized Enterprises (SMEs). This paper integrates emerging empirical and systematic review literature on BI adoption among U.S. SMEs, which is seen as converting raw data into useful information for business decision-making. The results suggest BI systems allow for the consolidation of multi-source data, have predictive analysis, and are used for real-time monitoring as part of SMEs to manage processes better, resource allocation, operating costs reduction, and effective inventory and supply chain management. Case studies involving an international online retailer and a major telecommunications company illustrate the real-world impact for BI: Predictive analytics and tailored interventions drove customer retention up, service quality improved, and actual returns on revenue growth. However, SMEs face barriers including lack of technical staff, high costs in the set-up process, data quality problems and organizational resistance and cyber threats. Effective adoption demands strong data governance, compatibility with the organizational strategy, capability building and staged implementation. In general, BI guides SMEs to adopt proactive instead of reactive management and will assist evidence-driven decisions in areas related to widening the organization`s competitive edge, improving operating performance, and financial results. The research highlights the relevance of BI in addressing technological and strategic challenges within a complex digital economy.

KEYWORDS: ***Business Intelligence, Operational Efficiency, Cost Optimization, Predictive Analytics, U.S. SMEs***

INTRODUCTION

The digital age has brought with it a revolutionary shift in the business landscape, characterized by the widespread embrace of new technologies. The technological advancement changed the way organizations conduct their operations, magnified competitive pressures, and modified how value can be delivered (Islam, et al., 2023). Small and Medium-sized Enterprises (SMEs) are widely known for making the largest contribution in the overall economic development and production, particularly giving birth to high employment opportunities, invention, and a life enhancement of countries (Thorne & Mbedu, 2025). In today's markets, SMEs are faced with various challenges such as intensified competition and changing consumer preferences and sophisticated operational and market dynamics (Gladwin & Martha, 2024). Addressing these difficult challenges requires taking advantage of new solutions that help drive operational efficiencies and maximize profitability. Among the major forces that are pushing for such transformation is the digitalization of business, in combination with the strategic use of Business Intelligence (BI) tools (Gladwin & Martha, 2024).

Empirical research indicates that SMEs adopting digital technologies can measure improvements in productivity, cost and customer satisfaction. Cloud computing technologies mobile applications and e-commerce platforms improved communication and facilitated automation process, operational efficiency among others help SMEs to effectively compete with larger, resource-intensive firms (Gladwin & Martha, 2024). The intermediary role of Business Intelligence in raw data and actionable insights has made it a vital area of research and practice. Although large firms have huge IT budgets and have implemented advanced data warehouses and analytics platforms, SMEs face a set of distinct opportunities and constraints in BI adoption (Thorne & Mbedu, 2025). BI encompasses a combination of technologies, applications and methodologies, all needed for collecting, integrating, analyzing and presenting business information (Gadiparthi, 2024).

Historically, BI grew out of the early management information systems and decision support systems emphasis on structured reporting and online analytical processing (OLAP) within integrated data warehouses (Hozyfa Shafa, 2025). BI systems strive for turning big data to actionable insights by, among others, providing dashboards, visual aids and reporting tools (Siemens, et al., 2022). Through the adoption of BI, firms will have ability to locate new opportunities for generating income through improving their pricing and inventory policies and by implementing data driven promotion initiatives the customer targeting and retention process which ultimately is key to conversion increase (Gladwin & Martha, 2024).

In spite of these benefits, SMEs encounter barriers to adoption such as limited digital capability and lack of ability to induce organization change; they also have inadequate IT infrastructure and worry about data governance, according to Liu et al. (2020). The faster rise of digital solutions in the wake of the COVID-19 pandemic, which forced remote working and customer interaction over online platforms, once again remind us about the compelling need for SMEs to quickly embrace their digital transformation journey to keep pace with competition (Islam, et al., 2023).

The objective of this study is to review and synthesize recent empirical and systematic literature in BI adoption for SMEs, specifically concerning operational efficiency, cost effectiveness and overall organizational performance. It aims to uncover the underlying process that BI supports the improved performance, summarize existing opportunities and challenges, and provide evidence-tested research agenda for future studies as well as real-world practice.

LITERATURE REVIEW

Business Intelligence: Concept and Definition

Business Intelligence (BI) is an important technological arm of the organization that helps in keeping up with a competitive edge in a data-driven markets. BI is broadly described as organized processes and tools that help to convert data into useable information for making evidence-based decisions (Faruk, 2025); (Gadiparthi, 2024). These are systems which offer firms an integrated approach to converting raw data into useful information that will be used in operational, tactical and strategic decision making (Dhanekula, 2025). As (Siemens, et al., 2022) describe, BI contains architectural and analytical items such as data warehousing, online analytical processing (OLAP), dashboards and reporting tools all of which support rigorous and timely business analysis.

In a recent conceptual model, BI is considered to include four main activities; data capture, aggregation, data analysis and report presentation, which are mapped to operational, managerial, and strategic scorecards topology that links internal information flow with organizational objectives (Alsibhawi, Yahaya, & Mohamed, 2023). The BI model focuses on multipartite processing of information from data acquisition to company strategy development. This view of BI is in line with the definition on which Gartner bases it that defines BI as an interactive process to retrieve trends and patterns from structured data to support managerial decision making, which also include performance monitoring (Alsibhawi, Yahaya, & Mohamed, 2023).

Large establishment and SMEs are increasingly provided with BI systems possession features which improve decision quality, operational timeliness and enterprise capability. According to (Ragazou, Passas, Garefalakis, & Zopounidis, 2023), BI enables companies to convert complicated data into meaningful and up-to-date information that can be accessed through user-friendly systems. These systems are able to support dynamic data categorization, real-time information flows and knowledge construction on the basis of historical trends. Thus, firms are better able to read the changes coming from markets, re-allocate resources and devise strategies that build competitive advantage.

While BI is typically perceived as a data analytics tool, its strategic role is to enable organizations extract actionable insights from data that can be leveraged to enhance customer engagement, product efficiency and overall business performance (Gadiparthi, 2024). In modern contextual setting BI is increasingly linked with high-level analytical solutions such as data mining, predictive modeling and automatic reporting systems, thus all contribute towards SMEs ability to make informed and dynamic decisions (Thorne & Mbedu, 2025).

Business Intelligence and Operational Efficiency

A recurring message in the literature is that implementing BI has been shown to considerably enhance operational efficiency through improved process visibility, better support for data-informed decision making, and the ability to react quickly to operational bottlenecks. A broad systematic review on SME analytics adoption from 2014-2024 shows that Big Data and BI programs continuously produce gains in operational efficiency, process optimization, and competitive advantages (Kgakatsi, Galeboe, Molelekwa, & Thango, 2024). Operational efficiency, which is the capacity to execute processes with minimal waste and friction (Thorne & Mbedu, 2025), can be enhanced when SMEs apply BI tools in ensuring that they monitor their workflows for continuous improvement.

BI capabilities facilitate this metamorphosis via auto-reporting systems, real-time dashboards, integrated decision support systems (IDSS), which have led to seamless flows of data and minimization of information asymmetry in firms (Mgbame, Akpe, Abayomi, Ogbuefi , & Adeyelu, 2022). The use of dashboards offers SMEs the opportunity to utilize centralized platforms for the visualization of data, allowing businesses to monitor performance measures on a regular and consistent basis, reducing deviations and the potential impact on utilizing existing data sources.

Empirical evidence further reinforces the contribution of BI to operational performance. (Mbima & Tetteh, 2023), using 216 SMEs and structural equation model, find that BI adoption has a positive effect on operational performance and supply chain ambidexterity mediates this relationship. It's the ability to manage that flexibility vs. efficiency trade-off that provides an organization with the opportunity to leverage BI in more impactful ways, showing how BI can best be utilized in organizations when part of a more agile operational environment.

This evidence is complemented with results obtained in (Orero-Blat, Palacios-Marqués, Leal-Rodríguez, & Ferraris, 2025) that show how companies endowed with a strong business analytics capability, as proposed by dynamic capabilities theory, are more capable of innovating and reconfiguring internal processes to survive through operational resilience. Notwithstanding these benefits, widespread adoption of BI by SMEs continues to be limited by financial constraints, insufficient digital skills, and readiness deficits in organizations (Kgakatsi, Galeboe, Molelekwa, & Thango, 2024).

BI combines the supply chain management perspective of business intelligence toward improving process visibility, decision support, and flexible supply chain execution. But the possibility of SMEs making such claims depends on their levels of readiness for data, ability to allocate resources, and integrate BI with wider operational systems.

Business Intelligence and Cost-Optimization

BI has also been reported in the literature as a critical enabler for cost optimizations throughout business processes. In the past, cost optimization driven by technology was limited to repetitive activities but BI allows restructuring of cost related activities more broadly by providing detailed information on resource use, consumption patterns and customer behavior (Ragazou, Passas, Garefalakis, & Zopounidis, 2023). BI can be employed by SMEs to gather and analyze customer demographic, psychographic, and behavioral information that enables them to develop differentiated products and targeted marketing actions that lead to satisfied customers profitability (Ragazou, Passas, Garefalakis, & Zopounidis, 2023).

BI-enabled customer intelligence is the keystone to effective resource allocation for an organization, from designing specific offers and delivery channels for clients to timing interventions. These observations reinforce customer satisfaction and enable more effective allocation of both operational and marketing resources. In addition, cutting-edge analytics and machine learning models allow firms to predict customer needs and interests in advance, minimizing the waste in inefficient spending, bettering engagement results (Gadiparthi, 2024).

Researches by Adeniran, Akinyemi and Aremu (2016) as well as James et al. (2019) as cited in (Mgbame, Akpe, Abayomi, Ogbuefi , & Adeyelu, 2022), stress the fact that successful BI system implementation enhances decision quality and shortens reporting cycle while enables SMEs to manage scarce resources more efficiently. Moreover, according to empirical evidence in (Kgakatsi, Galeboe, Molelekwa, & Thango, 2024), there is also a substantive proof that SMEs using analytics and BI as decision making tools achieve substantial cost reduction levels and enhance their economic performance.

Cost saving advantages are also enhanced when BI tools are integrated with highly scalable cloud-based services which reduces the cost of infrastructure and increases accessibility to analytics functions (Thorne & Mbedu, 2025). BI as related to supply chain ambidexterity also leads to cost reductions through better inventory management, reducing waste, and the ability to quickly react to variations in the supply (Mbima & Tetteh, 2023).

Nevertheless, a successful cost optimization is subject to managerial support, organizational readiness, and investments in the foundational data infrastructures (Jiménez-Partearroyo & Medina-López, 2024). BI provides a good foundation for cost-effective operations, but its success depends on the SMEs being able to integrate other related organizational and technological capabilities.

Case Studies: Business Intelligence in Enhancing Customer Experience and Engagement

The cases of a key global online retailer and leading telecommunications company have demonstrated how BI architecture can be leveraged to address customer-centric issues through data integration, predictive analytics, and real-time decisions (Gadiparthi, 2024).

Gadiparthi (2024) reports on a global e-commerce retailer that found its customer loyalty decreasing and its revenue growth stagnant in a hyper-competitive digital market. The key issue was that the company relied on a homogeneous, undifferentiated approach, “one-size-fits-all” to customer interaction, that could not handle the variation in consumer preferences and behavior. To address this, the retailer implemented an integrated BI system that combined multi-source data from web navigation trails, transactional history, and customer feedback into a single analytical environment (Gadiparthi, 2024).

The BI infrastructure leveraged highly sophisticated analytics and machine-learning algorithms to develop rich customer profiles and predict purchasing propensities. This made it possible to implement a number of policy interventions. First, personalized product recommendation engines, which were used to capitalize on individual-level browsing behavior and make better-targeted product recommendations. Second, dynamic pricing mechanisms leveraged predictive analytics to segment price sensitive customers and target promotions in real time. Third, the BI platform empowered targeted customer retention programs, which identified users with high risk of churning and automatically initiated personalized engagement campaigns (Gadiparthi, 2024).

The results were significant: the retailer recorded a measurable rise in customer retention, increased repeat purchase frequencies, and higher revenue from targeted promotional activities. Customized experiences enhanced the satisfaction of customers and promoted continued use of the platform. These results highlight how BI-driven personalization can increase marketing efficiency and influence consumer behavior in digital retail settings.

Another case demonstrated by Gadiparthi (2024) is a leading telecommunications provider tackling high churn rates due to poor service quality and lack of timely response in customer support calls. The company developed a BI system to process real-time customer interaction data pulled into the enterprise from call centers, digital channels, and social media. This fusion allowed a complete measurement of service quality and customer attitude.

Three fundamental approaches were made possible by such implementation. First, real-time response systems facilitated live tracking of customer complaints, which allowed for immediate action and resolution. Second, predictive customer service models were developed to detect customers who are likely to experience dissatisfaction with a service and proactively approach them at an early stage before dissatisfaction led to disengagement. Third approach is that BI system was used for improving network performance by identifying fault in service and isolating the geographical or technical bottleneck which required targeted investment or maintenance (Gadiparthi, 2024).

The results revealed that service quality-related metrics such as increases in customer satisfaction scores and reduction in churn were significantly improved. Within 12 months of implementation, the carrier saw tangible improvements in customer retention. This is an example of how a service-based industry can transition from reactive to predictive and preventative based service delivery models.

Taken together, the cases demonstrate that BI can be applied across multi-sectorial organizations with varied operational missions. In the retail context, BI has been used as a tool for behavioral customization where companies could control when and how to trigger consumer behaviors. The case in the telecommunications industry demonstrates however, BI as value driver along two dimensions with regard to improving service quality; real-time transparency and predictive analytics are necessary for operational reliability and customer loyalty (Gadiparthi, 2024).

This cross-case analysis finds that BI consistently improves customer experience, when organizations consider multi-source data integration and predictiveness for customer experience, as well as real-time responsiveness to customers. Yet, results also suggest that the efficiency of BI is reliant upon organizational ability to transform analytical thinking into practical interventions.

DISCUSSION

The study of Business Intelligence (BI) adoption in U.S. SMEs shows that BI is a transformative technology that significantly improve the effectiveness of their operations, reduce costs, and engage with customers. Two cases of a global online retailer and a large telecommunications provider demonstrate the multifaceted use of BI in different business settings. In the retail case, predictive analytics was applied for personalized products recommendations, dynamic pricing, and targeted customer retention campaigns, resulting in increased repeat purchases frequency, enhanced customer satisfaction levels, and more revenue generated from promotional activities (Gadiparthi, 2024). Equally, the telecom provider applied BI to monitor real-time customer interactions, forecast service disruptions, and improve network efficiency, which led to considerable reduction in churn and improved customer loyalty within a year of implementation (Gadiparthi, 2024). These cases present empirical proof that BI can translate complicated data into producing better operational and customer-focused results.

From these applications, it can be concluded that multi-source data is to be integrated if the entire potential of BI systems is to be exploited. Such SMEs integrate both internal and external data sets, which, together with transactional histories, web browsing behavior, and customer feedback becomes a rich source of knowledge for evidence-based decision making. Real-time analytics go a step further, providing even faster decision making capabilities that allow proactive responses to newly developing operational or customer service concerns before they escalate. Predictive analytics specifically has emerged as a powerful tool for proactive engagement, enabling SMEs to predict customer behavior, foresee service issues, and take targeted actions that impact retention and loyalty (Gadiparthi, 2024). BI's value, however, depends on organizational linkage; the BI systems "seen" by users should provide useful insights as to what they should do in addressing issues that impede progress before such systems can generate performance improvements. Cross-industry relevance is demonstrated here, with BI facilitating behavior-based personalization in retail and service quality improvement within the telecommunications sector, underlining its potential for SMEs from different operational domains.

The introduction of BI in SME brings about challenges, but also valuable opportunities. Increased operational transparency; one of the most important advantages is the better visualization feature, and BI dashboards and reporting systems permit managers to observe workflow processes, pinpoint bottlenecks, and understand where resources can be used more effectively, leading to increased productivity and process performance (Mgbame, Akpe, Abayomi, Ogbuefi , & Adeyelu, 2022). Predictive models and analytics also can increase customer engagement and retention, helping SMEs to pinpoint profitable customers, create tailored marketing strategies, and lower churn rates; collectively boosting sales as well as lifetime value of customers (Gadiparthi, 2024). Furthermore, BI ensures cost management as SMEs are able to monitor resource allocation, minimize the waste of production operation, and enhance inventory and supply chain management (Mbima & Tetteh, 2023). Business Intelligence, by giving timely and accurate visibility to a company's business activity, increases the agility of decision making, permitting SMEs to react quickly to changes in market dynamics or operational results. Companies which adopt BI strategically are then able to enhance their competitive position by using fact-based data to improve processes, drive innovation, and create better customer experiences (Thorne & Mbedu, 2025).

However, even though BI has a lot to offer there are also challenges. Data quality and fragmentation of data remain challenges as inaccurate or incomplete datasets can compromise the accuracy of analyses, hampering decision-making (Kgakatsi, Galeboe, Molelekwa, & Thango, 2024). The high costs of implementation which include software purchase, infrastructure, and manpower may be a barrier for SMEs that already operate in resource-constrained environments (Thorne & Mbedu, 2025). The lack of technical know-how in SMEs also requires to be complemented through the help of external consultants or by training employees extensively for them to make better use of BI functionalities (Mbima & Tetteh, 2023). Organizational resistance to change, can also hinder the adoption when employees are used to traditional legacy systems and are skeptical to adopt statistical models for managing data. Furthermore, the connection between sensitive operational and

customer data from countless platforms can also bring about cyber security and data privacy fears (Gadiparthi, 2024). Integration problems with other IT systems can further limit the seamless application and interoperability of BI infrastructures. These limitations highlight the need of strategic planning, organizational readiness, and building of capacity in enabling BI to reach its full potential within SMEs.

To reap the benefits of BI and address its challenges, SMEs must make use of evidence-based strategies. Strengthening data governance structures is key to the accuracy, completeness, and consistency of analytics results. Building in house analytics capability increases organizational self-reliance and addressing reliance on external consultancies. An incremental implementation that begins with dashboards or focused predictive models and progressively extends to an organization-wide platform, allows for risk mitigation, and organizational acclimation. Investing in information security such as control access, encryption, and real-time tracking is important to protect sensitive data. Just as critical a consideration is the guiding of BI investments towards organizational strategy, so that findings can be translated into concrete actions throughout its operations, marketing, and customer service. By developing a data-driven culture with support from the top management, stakeholder involvement, and structured change management, SMEs can improve adoption and use of BI systems. Finally, tracking and analyzing BI performance with a set of KPIs for operating efficiency gains, cost reduction, and customer results, drive iterative improvements to sustain value creation.

In summary, Business Intelligence is a strategic facilitator for U.S. SMEs providing measurable gains in operational efficiencies, expense control & customer interaction. Based on the case studies, it has been demonstrated that real and measurable benefits are available for SMEs by integrating BI with multi-sourced data of integrated systems; analytics in real time as well as predictive models that correspond with SMEs' strategies. Although adoption barriers including data quality, implementation costs, technical skills, and cybersecurity remain, however, SMEs strategic initiatives to overcome these barriers will enable them to embrace BI for competitive advantage. On balance, BI offers an organized process for SMEs to move from reactive to proactive management by applying both operational and financial performance in the increasingly competitive and data-driven markets.

CONCLUSION

This research shows that BI is a driver of competitive advantage for operational efficiency, cost optimization, and customer engagement in U.S. SMEs. Evidence from literature and case studies suggest that BI adoption enables SMEs to combine data from multiple sources, convert the combined information into actionable insights that facilitate informed decision-making for enhancing process efficiency and resource utilization (Gadiparthi, 2024); (Mbima & Tetteh, 2023). Predictive analytics, continuous monitoring, and personalized interventions increase customer retention, improve inventory management efficiency, and lower operational costs with quantifiable increases in revenue and service quality.

Notwithstanding the benefits, SMEs are subjected to challenges such as lack of technical know-how; cost of implementation including maintenance costs; data quality challenges; organizational resistance, and security risks (Kgakatsi, Galeboe, Molelekwa, & Thango, 2024); (Thorne & Mbedu, 2025). Successful adoption depends heavily on strong data governance, strategic alignment with the business objectives, capacity building, and stepped-approach in implementation.

To conclude, BI facilitates the process of moving SMEs from reaction-based to action-based management, making evidence-based decisions which further enhance competitiveness and performance. By implementing BI in a structured manner, SMEs can potentially receive operational and financial benefits and improve customer experiences which emphasizes the importance of BI as an enabling mechanism for SMEs from both technological and strategic perspectives in the current digital economy.

REFERENCES

1. *Alsibhawi, A. A., Yahaya, J. B., & Mohamed, H. B. (2023). Business Intelligence Adoption for Small and Medium Enterprises: Conceptual Framework . Applied Sciences, 4121.*
2. *Dhanekula, A. (2025). AI-DRIVEN BUSINESS INTELLIGENCE FRAMEWORK FOR PREDICTIVE DECISION-MAKING AND STRATEGIC RESOURCE OPTIMIZATION. International Journal of Business and Economics Insights, 1238– 1270.*
3. *Faruk, O. M. (2025). ARTIFICIAL INTELLIGENCE IN BUSINESS INTELLIGENCE: ENHANCING PREDICTIVE WORKFORCE AND OPERATIONAL ANALYTICS. ASRC Procedia: Global Perspectives in Science and Scholarship, 589–617.*
4. *Gadiparthi, S. (2024). Enhancing Customer Experience with Business Intelligence: Strategies, Tools, and Case Studies. International Journal of Management , 108-116.*
5. *Gladwin, E., & Martha, F. (2024). Maximizing Profitability in SMEs: The Impact of Digitalization and Business Intelligence Tools. ResearchGate.*
6. *Hozyfa Shafa. (2025). Artificial Intelligence-Driven Business Intelligence Models For Enhancing Decision-Making in U.S. Enterprises. ASRC Procedia: Global Perspectives in Science and Scholarship, 771– 800.*
7. *Islam, S., Hossain, E., Rahman, M. S., Rahman, M. M., Khan, S. I., & Ashik, A. A. (2023). Digital Transformation in SMEs: Unlocking Competitive Advantage through Business Intelligence and Data Analytics Adoption. Journal of Business and Management Studies, 177-186.*
8. *Jiménez-Partearroyo, M., & Medina-López, A. (2024). Leveraging Business Intelligence Systems for Enhanced Corporate Competitiveness: Strategy and Evolution. Systems, 94.*
9. *Kgakatsi, M., Galeboe, O. P., Molelekwa, K. K., & Thango, B. A. (2024). The Impact of Big Data on SME Performance: A Systematic Review. Businesses, 632–695.*
10. *Mbima, D., & Tetteh, F. K. (2023). Effect of business intelligence on operational performance: The mediating role of supply chain ambidexterity. Modern Supply Research and Applications , 28-49.*
11. *Mgbame, A. C., Akpe, O.-e. E., Abayomi, A. A., Ogbuefi , E., & Adeyelu, O. O. (2022). Developing Low-Cost Dashboards for Business Process Optimization in SMEs. International Journal of Management and Organizational Research, 214-230.*

12. *Orero-Blat, M., Palacios-Marqués, D., Leal-Rodríguez, A. L., & Ferraris, A. (2025). Beyond digital transformation: a multi-mixed methods study on big data analytics capabilities and innovation in enhancing organizational performance. Review of Managerial Science, 649–685.*
13. *Ragazou, K., Passas, I., Garefalakis, A., & Zopounidis, C. (2023). Business intelligence model empowering SMEs to make better decisions and enhance their competitive advantage. Discover Analytics, 1-15.*
14. *Siemens, G., Marmolejo-Ramos, F., Gabriel , F., Medeiros, K., Marrone , R., Joksimovic, S., & Laat, M. d. (2022). Human and artificial cognition. Computers and Education: Artificial Intelligence , 100107.*
15. *Thorne, E., & Mbedu, S. J. (2025). Strategic Integration of Business Intelligence and Cloud Analytics in SMEs: Drivers of Competitive Advantage and Organizational Performance. The American Journal of Management and Economics Innovations, 135-143.*

Research Paper

EPRA International Journal of Economic and Business Review-Peer Reviewed Journal
Volume - 14, Issue - 1, January 2026 | e-ISSN: 2347 - 9671| p- ISSN: 2349 – 0187

SJIF Impact Factor (2025): 8.862 || ISI Value: 1.433 || Journal DOI URL: https://doi.org/10.36713/epra2012

SANDALWOOD AND ITS PRECIOUS OIL TRADE TRENDS

Soundararajan, V.*, Ravi Kumar, G.[#], Muthu Kumar, A.[#]
** ICFRE- Tropical Forest Research Institute, Jabalpur, Madhya Pradesh.*
[#] ICFRE-Institute of Wood Science and Technology, Bangalore, Karnataka.

ABSTRACT **DOI No: 10.36713/epra25901** **Article DOI: https://doi.org/10.36713/epra25901**

Santalum album L. commercially known as East Indian Sandalwood is indigenous to peninsular India. The Sandalwood tree is highly regarded in the Vedic texts, and the heartwood is considered to be sacred. Sandalwood is considered the epitome of excellence, imparting fragrance even to the axe that cuts it. In the last few decades, the demand and value of the Santalum album Linn (Sandalwood) has increased significantly. Sandalwood trees are almost vanished in the natural forest due to over exploitation, smuggling, grassing, fire hazards, disease and deforestation. Sandalwood and its fragrant oil are in high demand on both domestic and international markets. State governments, meanwhile, are encouraging the growing interest in growing sandalwood on private land. In India, especially the state forest department, strictly regulates the sandalwood trade. Sandalwood cannot be sold directly to customers or private business partners by farmers. Sandalwood can be sold by farmers to government agencies. The state forest department will classify and list sandalwood lots for sale through an online auction platform with the necessary permits and inspections. The different state government classifications, imports, and exports of sandalwood and its aromatic oil were discussed in this research paper.

KEYWORDS: ***Santalum album, Sandalwood, Indian Sandalwood, Chandanam, Imports and Exports, Fragrance Wood, Sandal Oil, Perfume, Scent, Trade, Marketing.***

INTRODUCTION

Santalum album. Linn commonly known as East Indian sandalwood or Indian Sandalwood and also called as Chandanam in Tamil and Sanskrit. *Santalum* is a genus that contains around 56 species and is a member of the *Santalaceae* family. There are just around 16 commercially significant and widely dispersed sandalwood species out of the 56 total. *Santalum album* Linn, *Santalum spicatum* (R.Br.) A.D.C., *Santalum lanceolatum* R. Br., *Santalum yasi* Seem, and *Santalum austrocaledonicum* Vieillard are five of the sixteen species of sandal that provide aromatic heartwood that may be used for commercial purposes. Of these species, Indian sandalwood (*Santalum album* Linn) is the world's most famous heartwood for scent (Soundararajan *et al.,* 2017). The typical yield of sandalwood oil is between 2 and 6% of heartwood weight by weight (w/w). A colourless to yellowish viscous liquid with a strong pleasant smell is the volatile oil extracted from the heartwood (Anon, 1972; Soundararajan *et al.,* 2022).

In India, sandalwood's heartwood is revered as sacred. In Indian tradition, sandalwood is used to anoint the sacred idols because its divine aroma is said to be highly appealing to the Almighty. Since sandalwood is necessary for everything from holy rituals to the final rites of devotion, it is difficult to eliminate the scent of sandalwood from the religious lives of the majority of Indians. It has been regarded as one of the most sacred trees in India for at least 2,000 years. In Hindu tradition, it is a crucial component of funeral pyres and a significant part of devotional rites (Soundararajan *et al.,* 2015). The status of sandalwood in India presently shows a significant drop in populations of natural sandalwood, especially in Southern India, as a result of illegal felling and overexploitation. The IUCN has classified the species as "vulnerable," even though it is widely valued and cultivated, especially in places like Karnataka, Tamil Nadu, Andhra Pradesh, Telangana, Kerala and other part of India. However, state governments are promoting the rising interest in cultivating sandalwood on private land (Venkatesha Gowda, 2011; Soundararajan *et al*., 2015; Soundararajan *et al.,* 2017).

There is a significant demand for sandalwood and its aromatic oil on both local and global markets. The harvesting of sandalwood trees, the extraction of sandalwood oil and the selling of the wood and oil are all included in the trade. Due to the high value of sandalwood, especially on the global market, the trade confronts difficulties with illicit harvesting and smuggling. There is a drive for sustainable production and trading methods because of the illegal activities and overexploitation of sandalwood, especially in India, which has caused its reduction in natural forests.

The sandalwood trade in India is heavily regulated by the government, particularly the state forest departments. Farmers are not authorized to sell sandalwood to private companies or consumers directly. The sandalwood will be offered up for

auction by the state forest department after obtaining proper cutting and transit permission to remove the trees from the revenue land. The state forest officials will take care of the cutting, cleaning and grading of the sandalwood with request from the famers. The cutting, cleaning, grading, transport and handling charge will be applicable for the sandalwood harvest processes. Sandalwood harvesting is the practice of growing sandal trees for their aromatic oil and rich heartwood. It usually takes minimum 20 years for sandalwood trees to achieve maturity enough to harvest their heartwood. However, Researchers are trying to reduce the sandalwood trees' rotation period in order to manage harvests sustainably. The entire sandalwood tree, including its roots, which also contain precious oil, must be uprooted in order to harvest it. After that, the oil from the heartwood is extracted and utilized in cosmetics, fragrances and traditional medicine. A tree's age, soil, and the environment all affect how much heartwood and its oil produces.

The process of commercializing sandalwood begins with the removal of mature frees from the field, marking them with a hammer, and transporting them to the closest "Final Cleaning Depot" with the appropriate authorization. After being cleaned, sandalwood trees are placed in the depots, and the weight of the "final cleaned wood" will be noted. According to governmental guidelines, the amount of finished cleaned wood, including sapwood and sawdust, will be categorized. Classification of sandalwood is various of factors involved, such as the heartwood content, sapwood, size and overall quality of Wood. Southern India state governments have different number of Classification systems. Rule No. 95 of the Karnataka Forest Manual states that sandalwood must be classified and processed before it may be sold. An e-Auction will be conducted by State Forest department with concern of the farmers. After obtaining the required permits and inspections, the forest department will categorize and offer sandalwood lots for sale using an online auction platform. This is the normal process for an e-Auction sandalwood operation. Farmers can sale sandalwood directly to Karnataka Soaps and Detergents Limited, Karnataka State Handicrafts Development Corporation Limited, Kerala Soaps & Oils Limited, The Kerala Forest Development Corporation (KFDC), State Forest Departments and other Government Agencies.

Classification of Sandalwood: The Karnataka Forest Manual Rule No. 95 specifies the following categorization details for sandalwood.

I. **Vilayat Budh:** Sound billets weighing not less than 9 Kgs. and not exceeding 112 pieces per ton
II. **China Budh:** Slightly inferior billets weighing less than 4.50 Kgs. And not exceeding 224 pieces per ton
III. **Panjam:** Having small knots, cracks and hollows. Weighing not less than 2.20 kgs and not exceeding 448 pieces per ton
IV. **Ghotla:** Short, sound pieces with no limits of weight or numbers per ton
V. **Ghatbadla:** Billets with knots, cracks, hollow and weighing not less than 4.50 kgs and not exceeding 224 pieces per ton
VI. **Bagardad:** Solid pieces with no limits in weights, lengths etc.
VII. **Roots - Class I:** Root pieces weighing not less than 6.75 kgs and not exceeding 150 pieces per ton
VIII. **Roots - Class II:** Root pieces weighing not less than2.25 kgs and not exceeding 448 pieces per ton
IX. **Roots - Class III:** Small side roots below 2.25 kgs in weight
X. **Jaipokal-I:** Billets consisting of hollow pieces weighing not less than 3.10 kgs and not exceeding 320 pieces per ton
XI. **Jaipokal -II:** Hollow pieces weighing not less than 1.30kgs
XII. **Ain Bagar:** Solid, cracked and hollow pieces weighing not less than 450 grams
XIII. **China Sali or Large Chilta:** Pieces and chips of heartwood weighing not less than 225 grams
XIV. **Ain Chilta:** Small pieces of heartwood
XV. **Milwa Chilta:** Small pieces and chips having fair proportion of heart and sap wood
XVI. **Hattari Chilta:** Heartwood chips and plaining billets with hattari (plaining)
XVII. **Basola Bukni:** Small heartwood and sapwood chips
XVIII. **Saw dust:** Sawn powder
XIX. **White Chips:** Pieces and Sap wood without scent
XX. Bark: Bark of sandalwood tree

Table: 1. Karnataka Govt Fixed Price of the Sandalwood (Amount in Indian Rupees)

Sl NO	Class	Fixed price of the Sandalwood (Amount in Indian Rupees)					
		2009-10 (Per kgs)	2010 to 12 (Per kgs)	2012 to 14 (Per kgs)	2014-18 (Per kgs)	2020-21 (Per kgs)	2020-21 (Per kgs) With Tax
1	Vilayath Budh (Class I billets)	4100	4100	5600	6050	12200	16527
2	Chinna Budh (Class II billets)	4100	4100	5650	6410	10900	14766
3	Panjam(Class III billets)	3700	3700	5200	5810	10000	13546
4	Ghotla (billets of short length)	-	4100	5600	6410	7000	9482
5	Ghatbadla	4000	4100	5500	5820	12700	17204
6	Bagardad	3950	3950	5600	5600	10900	14766
7	Roots (Class I)	3625	3625	4100	4100	9700	13140
8	Roots (Class II)	3740	3740	4150	4150	8300	11244
9	Roots (Class III)	2870	3370	4250	4250	8500	11514

10	Jajpokal or Badla (Class I)	4075	4075	4900	5160	13700	18559
11	Jajpokal or Badla (Class II)	3710	3710	4500	4900	10600	14359
12	Ainbagar	3552	4010	5500	5500	8900	12056
13	China Sali or Larhe Chilta	3220	3220	4350	4350	5500	7451
14	Ain Chilta	2682	2820	3350	3655	5400	7315
15	Hatri Chilta	1900	1900	2350	2350	2850	3861
16	Milva Chilta	1550	1550	2000	2153	3400	4606
17	Basola Bukni	870	1150	1600	1728	3600	4877
18	Saw dust	750	750	750	750	810	1097
19	White Chips					105	142
20	Bark					25	34

Source: Karnataka Forest Department

Table: 2. Tamil Nadu Government, Retail Price for Sale of Sandalwood

Sl. No	Name of the Class	Year	Amount in Rs. Per Kgs		
		2020-21	2021-22	2022-23	2023-24
1.	Chotla	19163	20313	21532	22824
2.	Gadbadla	19418	20583	21818	23127
3.	Roots I Class	17674	18735	19859	21050
4.	Roots II Class	17559	18613	19730	20914
5.	Roots III Class	16372	17354	18395	19499
6.	Jajpokal I class	29694	31475	33364	35366
7.	Jajpokal II class	26415	28000	29680	31460
8.	Ainbagar	21896	23210	23603	26079
9.	Cheria	19645	20823	22073	23397
10.	Ainchilta	13984	14823	15712	16655
11.	Milwachilta	9711	10293	10911	11565
12.	Basola Bukni	8257	8752	9277	9834
13.	Fire affected billets	16018	16979	17998	19078
14.	Fire affected roots	14809	15698	16640	17638
15.	Saw dust	3109	-	-	-
16.	Sapwood	347	-	-	-
17.	Spent dust	347	-	-	-

Source: Tamil Nadu Forest Department.

Table: 3. Kerala Government, Retail Price for Sale of sandalwood

Sl. No	Name of the Class	2022-23 Seigniorage R ate per Kgs
1.	Vilayat Budh	14700
2.	China Budh	14700
3.	Panjam	14000
4.	Ghotla	13600
5.	Ghat Badla	13800
6.	Bagradad	10900
7.	Roots 1st class	12900
8.	Roots 2nd class	10900
9.	Roots 3rd class	10500
10.	Jai pokal	9900
11.	Cheria	6200
12.	Mixed chips	4400
13.	Saw dust	3000
14.	Sapwood billets	900
15.	Sapwood chips	150

Source: Kerala Forest Department

Import and Export of Sandalwood Policy

One of the most prized trees of Indian origin for a long time is sandalwood, which has a potential export market. There are several chances in the business despite concerns like strict laws and regulations and climate change. If only India could encourage farming contribution and sustainable practices. Looking into the future, sandalwood may become not only the exquisite material but the symbol of India, which manage to preserve traditions, develop a new perspective, and consider the problem of environment consciousness.

Sandalwood imports and exports have specific rules and restrictions in India. According to the Foreign Trade Policy (FTP), Director General of Foreign Trade Notification No. 37 dated 27th January 2017, Export Policy of sandalwood against Sl. No. 182 to 187, Chapter 44: Wood and Articles of Wood; Wood Charcoal of Schedule 2 of ITC (HS) Classification of Export & Import Item has been amended to bring clarity for export of specified categories as follows (Bhalla, DGFT., 2017).

Sandalwood imports are limited and require a particular import permission, while exporting raw sandalwood logs is prohibited. Exports of sandalwood in the form of finished handicraft products, machine-finished sandalwood products are permitted freely but subject to the provisions of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES).

Sandalwood Oil is freely permitted to export but subject to Quantitative ceilings and conditionalities as may be notified by the Director General of Foreign Trade from time to time. Sandalwood De-oiled Spent Dust is restricted but Export permitted under licence subject to conditionalities as may be notified by the Director General of Foreign Trade from time to time.

Following some other forms of sandalwood is restricted but export permitted under licence subject to conditionalities as may be notified by the Director General of Foreign Trade from time to time.

a) dust/ flakes obtained as wood scrap / waste after the manufacturing process by manufacturer exporter of value-added sandalwood handicraft products and machine finished sandalwood products
b) machine finished chips manufactured from cracked portions of sandalwood billets (each finished chips not exceeding 50 grams per piece)
c) powder obtained from wood scrap / waste after the manufacturing of handicraft products and machine finished goods of sandalwood
d) small pieces of sandalwood (each piece not exceeding 20 grams) obtained from wood scrap/waste after manufacturing of handicraft/ machine finished sandalwood products.
e) sandalwood powder produced from sandalwood wood scrap/waste
f) any other item of sandalwood as may be specified by Director General of Foreign Trade (DGFT) in consultation with Ministry of Environment, Forest and Climate Change (MOEF&CC).

In India, import and export operations require the 10-digit alphanumeric Import Export Code (IEC), which is issued by the Directorate General of Foreign Trade (DGFT). Internationally, traded goods are also classified using the Harmonized System (HS) code, which is referred to as the ITC (HS) code in India. Directorate General of Foreign Trade (DGFT) issued for the Sandalwood import & export HS code: 44039922; Sandalwood (*Santalum album*) Chips & Dust HS code: 12119018; 12119050; 12119051; Sandalwood (*Santalum album*) Oil HS code: 33012937(dgft.gov.in).

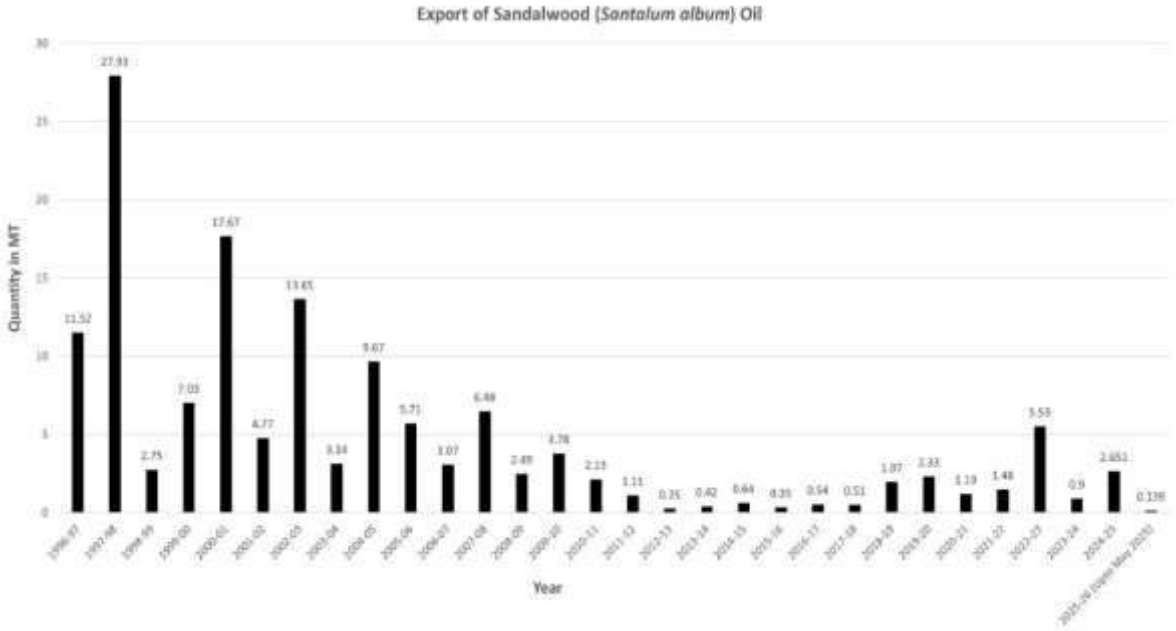
Sandalwood Oil

Since the dawn of perfumery and even in the contemporary fragrant world, the aromatic qualities of sandalwood oil from the East Indian sandalwood tree have been legendary. Sandalwood oil's non-dominant fixative qualities and warm, sweet, precious wood notes make it a perfect choice for making a wide range of fragrances. In addition, sandalwood oil has diuretic, antipyretic, antiseptic, and antiscabietic qualities. Additionally, it works well for treating urinary tract disorders, bronchitis, cystitis, and dysuria. The oil holds a significant position in the traditional medical system. It is thought to be a treatment for herpes and migraines (Soundararajan *et al*., 2015). There have been several attempts to replace sandalwood, but ultimately, "sandalwood is the wood" and there isn't a true replacement for its royal fragrance (Baldovini *et al*, 2011).

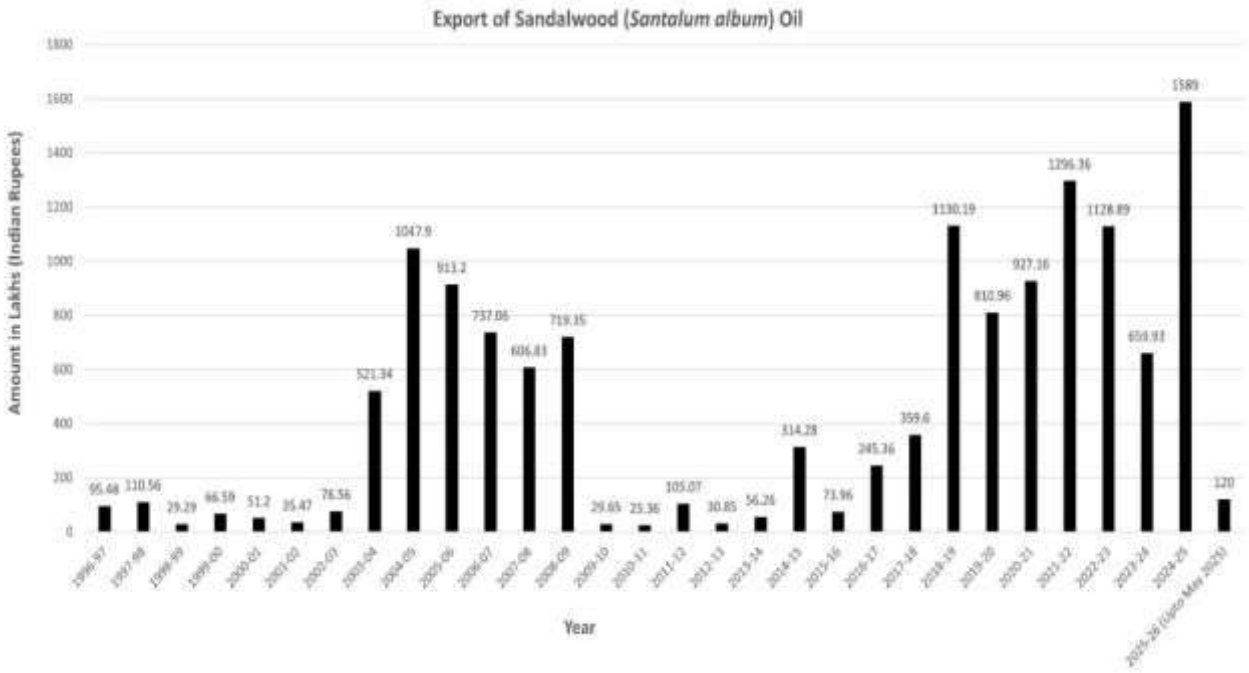
An overview of the volume shipped and the average price is provided by the statistics shown below. It is evident that in 1997–98, 27.93 MT sandal oil were exported, bringing in Rs. 110.56 Lakhs. However, in 2024–25, only 2.651 MT of sandal oil were exported, with an export value of Rs. 1589.00 lakhs, and the average price tripled. But in 2024–2025, 21.742 metric tons of sandal oil were imported, valued at Rs. 12959.00 lakhs. There was no data available for the import of sandalwood oil in 1999-00.

Graph 1 & 2 illustrates the market's flexibility in terms of sandalwood oil exports from 1992 to 2025, while Graph 3 & 4 demonstrates that sandalwood oil imports are steadily rising in the Indian market.

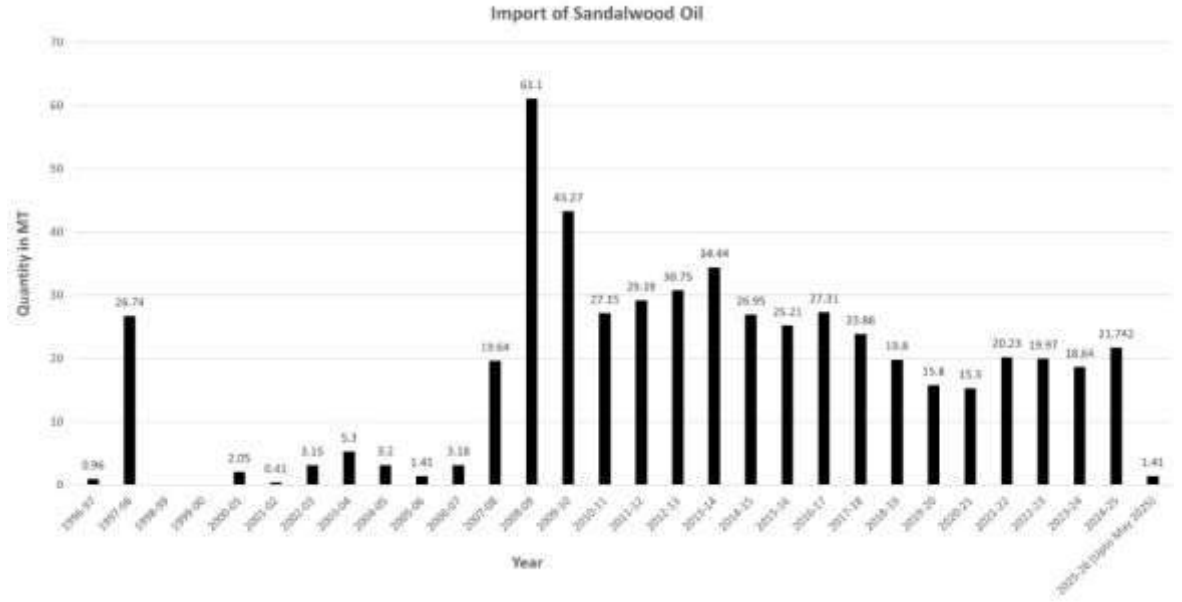
Graph 1: Export of Sandalwood (*Santalum album*) Oil Quantity



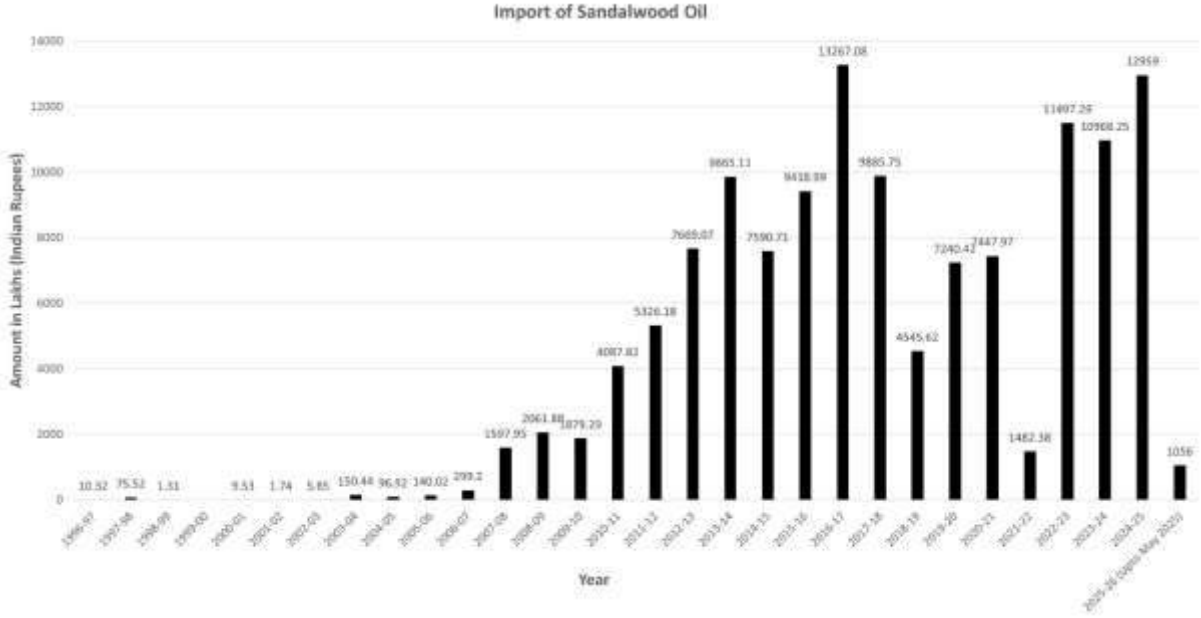
Graph 2: Export of Sandalwood (*Santalum album*) Oil Amount



Graph 3: Import of Sandalwood Oil Quantity



Graph 4: Import of Sandalwood Oil Amount



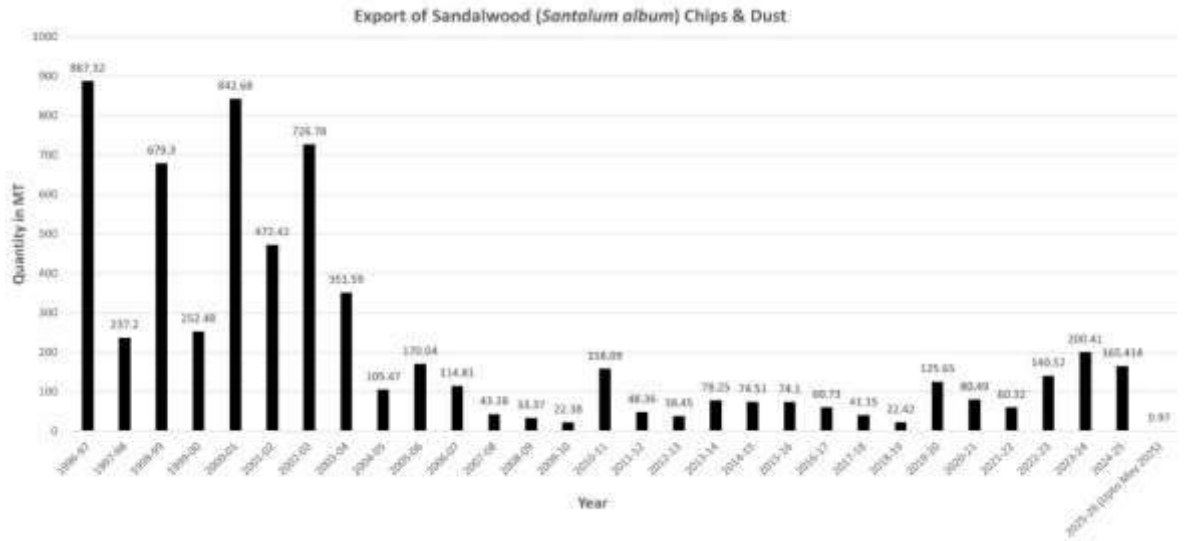
Source: Export & Import Data Bank Tradestat, Ministry of Commerce & Industry

Sandalwood Chips & Dust

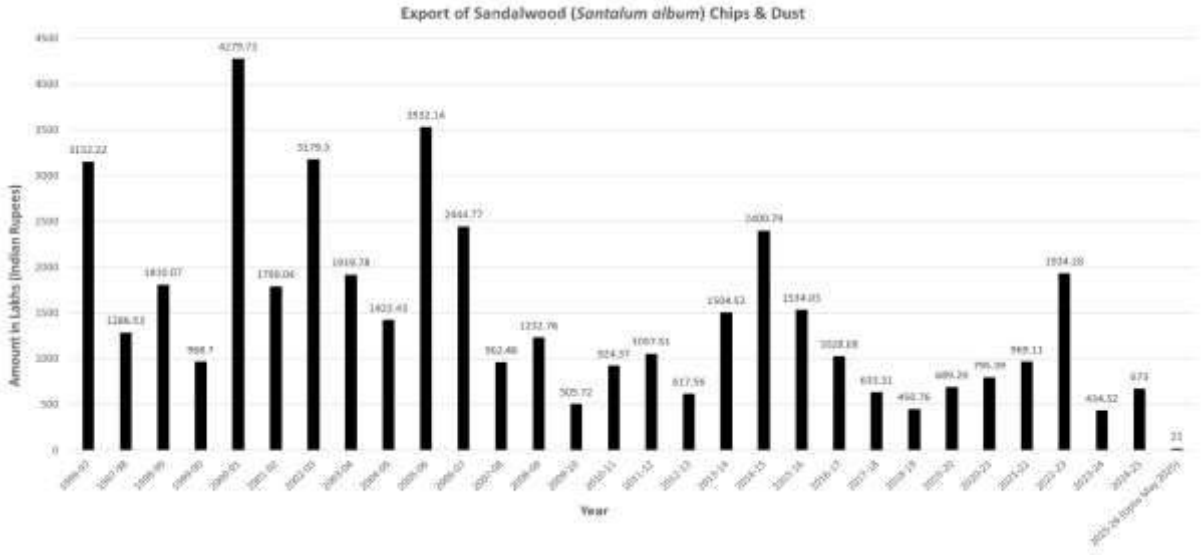
In 1996-97, 887.32 MT Sandalwood (*Santalum album*) Chips & Dust were exported, bringing in Rs. 3152.22 Lakhs. In 2024-25, 165.414 MT of Sandalwood Chips & Dust were exported, with an exported value Rs. 673 Lakhs. In 1996-97, 6.07 MT Sandalwood Chips & Dust were imported, bringing in Rs. 5.65 Lakhs. But in 2024-25, 788.855 MT of Sandalwood Chips & Dust were imported, with an import value of Rs. 5244.00 lakhs. Sandalwood (*Santalum album*) Chips & Dust exports are declining daily. But the import of sandalwood chips and dust is growing daily.

In terms of Sandalwood (*Santalum album*) Chips & Dust exports from 1996 to 2025, Graphs 5 & 6 show the market's flexibility, while Graphs 7 & 8 show that Sandalwood Chips & Dust imports are continuously increasing in the Indian market. There was no data available for the import of sandalwood chips and dust in 2002-03 & 2004-05.

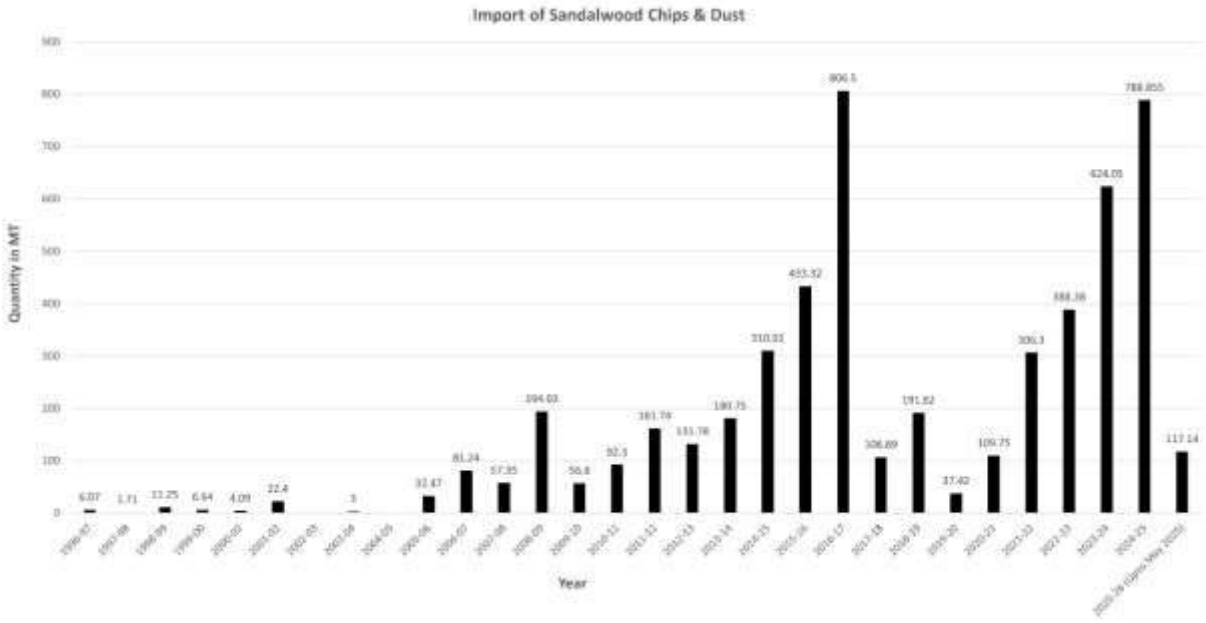
Graph 5: Export of Sandalwood (*Santalum album*) Chips & Dust Quantity



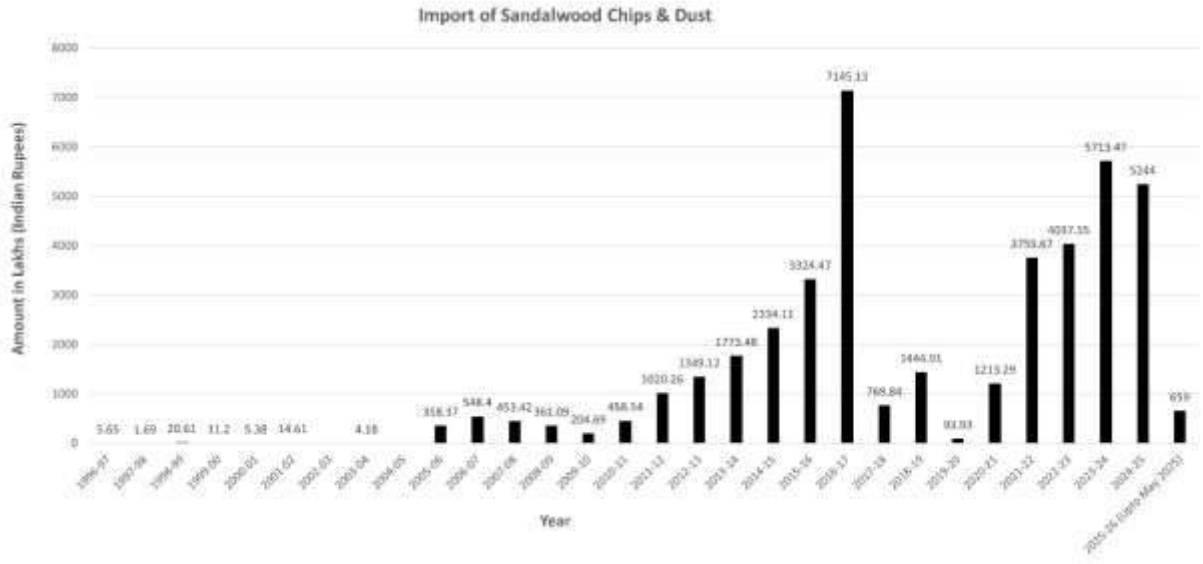
Graph 6: Export of Sandalwood (*Santalum album*) Chips & Dust Amount



Graph 7: Import of Sandalwood (*Santalum album*) Chips & Dust Quantity



Graph 8: Import of Sandalwood (*Santalum album*) Chips & Dust Amount



Source: Export & Import Data Bank Tradestat, Ministry of Commerce & Industry

CONCLUSION

India's sandalwood production, especially its wild populations, is now under threat due to illegal felling, forest fires, grazing, and, to some extent, spike disease, as well as high local and international demand and a lack of consistent regulations. Future challenges for the sandalwood industry include increased demand, depleting natural resources, and the requirement for sustainable operations. India used to be a dominant force, but its production of sandalwood has decreased, increasing its dependency on imports and encouraging illegal logging. Because of its high value, especially for its oil, sandalwood is susceptible to poaching and requires strong forensic methods to confirm its provenance and stop illicit trading. Sustainable plantation development, along with efficient regulation and enforcement, are essential to the sandalwood trade's long-term survival.

Smuggling of sandalwood has created socio-economic and law and order problems in all sandal producing states. The overall state of sandalwood wealth in the country might be improved with a national ordinance governing the transportation and consumption of sandalwood. Raising large scale plantations in the natural sandal bearing region will also add up to the resource building of the valuable tree species. However, the lack of production or domestic consumption data make it impossible to judge the state of the supply base and whether this (as well as the quantity of exports) is likely to change in the future.

Acknowledgment

The authors are thankful to all sandalwood growing state forest departments and Ministry of Commerce & Industry, Department of Commerce for providing information. The authors are thankful to the Director, ICFRE- Tropical Forest Research Institute, Jabalpur for kind guidance and help in this regard.

REFERENCE

1. *Anon., (1972), The wealth of India, Publications and Information Directorate, CSIR, New Delhi, 1972; 9: 233.*
2. *Bhalla, A. K., DGFT, (2017), Ministry of Commerce & Industry, Department of Commerce, Director General of Foreign Trade Notification No. 37/2015-2020 dated 27th January 2017.*
3. *Baldovini, N., Delasalle, C., and Joulain, D., (2011), Phytochemistry of the heartwood from fragrant Santalum species: A review, Flavour and Fragrance Journal, January 2011; 26(1):7-26.*
4. *dgft.gov.in, https://www.dgft.gov.in/CP/?opt=itchs-import-export viewed on 24th June 2025.*
5. *Export import data bank version Tradestat, Government of India, Ministry of Commerce & Industry, Department of Commerce, https://tradestat.commerce.gov.in/ viewed on 6th June 2025.*
6. *Soundararajan, V., Ravi Kumar, G., Murugesan, K., (2015), Trade Scenario of Sandalwood and its valued oil, International Journal of Novel Research in Marketing Management and Economics, ISSN 2394-7322, September-December, 2015; 2(3):52-59.*
7. *Soundararajan, V., Ravi Kumar, G., Murugesan, K., Surendra Kumar, M. Srinivasa Rao, (2017), Gem of Peninsular India: Sandalwood (Santalum album Linn), Book Publisher: Institute of Wood Science and Technology (IWST), (Indian Council of Forestry Research and Education (ICFRE)), 18th Cross, Malleshwaram, Bangalore – 560003, Karnataka, India. ISBN: 9901001096461.*
8. *Soundararajan, V., Ravi Kumar, G., Muthu Kumar, A., and Shetteppanavar, V.S., (2022), Recent Advancements in Pharmaceutical Importance and Utilization of Sandal Seed Oil, World Journal of Pharmacy and Pharmaceutical Sciences, December 2022; 11(12): 286-303.*
9. *Venkatesha Gowda, V. S., (2011), Global emerging trends on sustainable production of natural Sandalwood., In Proceedings of the Art and Joy of Wood Conference, Bangalore, India, October 19–22, 2011.*

Research Paper

EPRA International Journal of Economic and Business Review-Peer Reviewed Journal
Volume - 14, Issue - 1, January 2026 | e-ISSN: 2347 - 9671| p- ISSN: 2349 – 0187

SJIF Impact Factor (2025): 8.862 || ISI Value: 1.433 || Journal DOI URL: https://doi.org/10.36713/epra2012

INDIAN ECONOMY AND EDUCATION SYSTEM: INTERCONNECTED PATHWAYS TO DEVELOPMENT AND GROWTH

Sanjay Kumar[1], Deepak Prashar[2]*

[1]*Department of Economics, Government College Baijnath, Kangra (HP)-India*
[2]*Department of Pharmacy, LR Institute of Pharmacy, Jabli-Kyar, Solan (HP)-India*

ABSTRACT **DOI No: 10.36713/epra25919** **Article DOI: https://doi.org/10.36713/epra25919**

India stands at a critical juncture where its economic trajectory and educational framework are fundamentally intertwined, shaping the nation's future in an increasingly competitive global landscape. As the world's most populous nation and fifth-largest economy, India's economic growth story has been remarkable, characterized by rapid digitalization, a burgeoning service sector, and aspirations to become a developed nation by 2047. However, this economic ambition cannot be realized without addressing the complex challenges within its education system. The Indian education system, one of the largest globally with over 260 million students enrolled, faces a paradox of expansion and quality. While quantitative metrics show impressive enrollment rates and infrastructure development, qualitative concerns regarding learning outcomes, employability, and equitable access persist. This paper examines the symbiotic relationship between India's economic development and its education system, analyzing how educational reforms and economic policies mutually reinforce or constrain each other. Through an exploration of economic data, policy frameworks, and educational indicators, this study reveals that India's human capital development remains the cornerstone of sustainable economic growth. The analysis encompasses the evolution of both sectors, their current challenges including skill mismatches, regional disparities, and the digital divide, while also highlighting opportunities presented by demographic dividends, technological integration, and policy initiatives like the National Education Policy 2020. Understanding these interconnections is essential for policymakers, educators, and stakeholders committed to India's comprehensive development.

KEYWORDS: ***Economy, Challenges, Education, Symbiotic, GDP***

INTRODUCTION

India's journey from a newly independent nation in 1947 to becoming one of the world's major economies represents one of the most significant economic transformations of the modern era. Today, with a nominal GDP exceeding $3.7 trillion and a population surpassing 1.4 billion people, India embodies both tremendous potential and formidable challenges. At the heart of this transformation lies an intricate relationship between economic development and educational advancement—two forces that have simultaneously propelled and constrained each other throughout India's post-independence history [1-7].

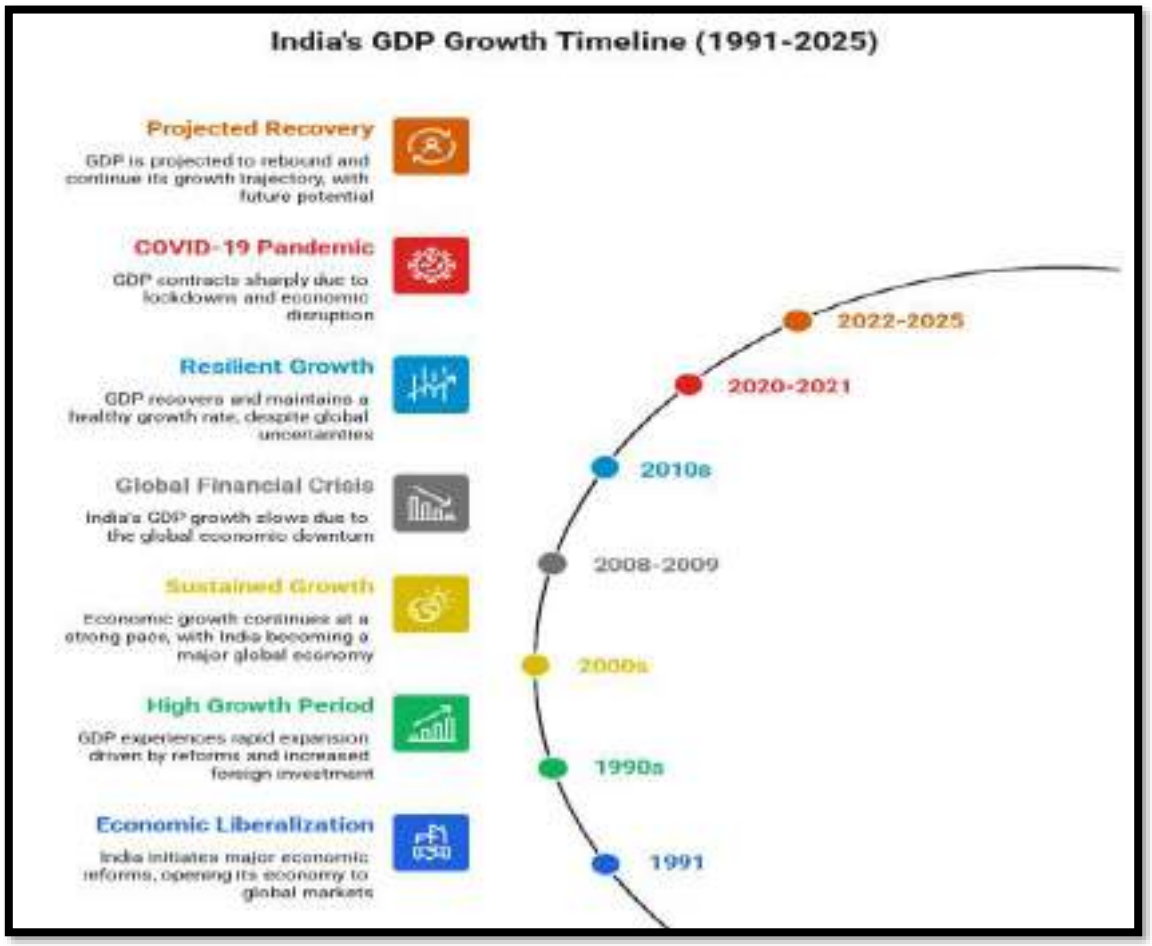


Figure 1: India's Economic Liberalization and Growth Patterns over three decades

The Indian economy has traversed distinct phases of development. The early decades following independence were marked by socialist-oriented policies, central planning, and an emphasis on self-reliance. The economic liberalization of 1991 marked a watershed moment, opening India to global markets, encouraging private enterprise, and catalyzing unprecedented growth [8-9]. The subsequent decades witnessed India's emergence as a global hub for information technology, pharmaceuticals, and services, while also grappling with persistent challenges in manufacturing, agriculture, and infrastructure development. The COVID-19 pandemic of 2020-2021 tested India's economic resilience, yet the nation demonstrated remarkable recovery, with growth rates rebounding and digital transformation accelerating across sectors [10-16].

Parallel to this economic evolution, India's education system has undergone profound changes. From a literacy rate of merely 18 percent at independence, India has achieved approximately 77 percent literacy today—a testament to decades of focused efforts on educational expansion. The Right to Education Act of 2009 made elementary education a fundamental right, leading to near-universal enrollment at the primary level. Higher education has witnessed explosive growth, with India now hosting the world's largest higher education system in terms of institutions, including over 1,000 universities and 42,000 colleges. Initiatives like the Sarva Shiksha Abhiyan, Rashtriya Madhyamik Shiksha Abhiyan, and more recently, the National Education Policy 2020, reflect sustained governmental commitment to educational reform [17-20].

However, beneath these impressive statistics lie complex challenges that illuminate the critical nexus between education and economic development. India faces a paradox: while producing millions of graduates annually, employers frequently cite skill deficits and unemployability as major concerns. The National Employability Report consistently indicates that a significant proportion of graduates lack the competencies required by industry. This disconnect between educational output and economic requirements represents a fundamental misalignment that constrains both individual prosperity and national growth. Furthermore, the quality of education varies dramatically across states, between urban and rural areas, and across socioeconomic strata, perpetuating inequalities that economic growth alone cannot address [21-24].

Key challenge that is required to be overcome is that despite producing over 10 million graduates annually, India faces significant skill gaps, with only about 45-50% of graduates considered readily employable by industry standards.

The economic imperative for educational reform becomes evident when examining India's demographic profile. With a median age of approximately 28 years, India possesses a demographic dividend—a young, potentially productive workforce that could drive decades of economic growth. However, this dividend can quickly become a demographic

disaster if these millions of young people lack the education, skills, and opportunities to contribute productively to the economy. The challenge is not merely about job creation but about creating jobs that match the skills of the workforce, which in turn requires an education system responsive to economic realities and future demands [25-29].

Conversely, economic constraints significantly impact educational outcomes. Despite increased budgetary allocations, India's public spending on education remains around 4-5 percent of GDP, below the 6 percent recommended by various educational commissions. This budgetary limitation affects infrastructure quality, teacher salaries, learning resources, and the capacity to implement innovative pedagogical approaches. States with stronger economic performance generally demonstrate better educational indicators, while economically weaker states struggle with higher dropout rates, poorer learning outcomes, and inadequate infrastructure. This creates a vicious cycle where educational deficits constrain economic growth, which in turn limits resources available for educational improvement [30-36].

The technological revolution presents both opportunities and challenges for this economy-education nexus. India's success in information technology and digital services demonstrates how education aligned with economic opportunities can create global competitiveness. The recent push toward digital education, accelerated by the pandemic, has opened new possibilities for scaling quality education across geographic and economic barriers. Initiatives like SWAYAM, DIKSHA, and various EdTech platforms represent efforts to leverage technology for educational access and quality. However, the digital divide—with significant disparities in internet access, digital literacy, and technological infrastructure—threatens to create new forms of inequality that could widen rather than narrow the gap between India's privileged and marginalized populations [37-40].

The National Education Policy 2020 represents India's most comprehensive attempt to reimagine education for the 21st century. With its emphasis on multidisciplinary learning, flexibility, vocational education integration, and outcome-based assessment, the policy acknowledges the need to align education with both individual potential and economic requirements. Its vision of transforming India into a knowledge society recognizes that in an increasingly technology-driven global economy, human capital represents the most critical competitive advantage. The policy's success, however, depends on implementation capacity, resource allocation, and the ability to balance uniformity in standards with diversity in contexts—a formidable challenge in a country as vast and varied as India.

Understanding the relationship between India's economy and education system requires appreciating both as dynamic, evolving systems that shape and are shaped by broader social, political, and technological forces. This interconnection becomes particularly critical as India aspires to become a developed nation by 2047, its centenary of independence. Achieving this vision necessitates not just economic growth measured in GDP figures but inclusive development where education serves as both an enabler and equalizer, where economic opportunities are accessible to all citizens regardless of their background, and where the quality of human capital matches the ambitions of a rising global power [41-44].

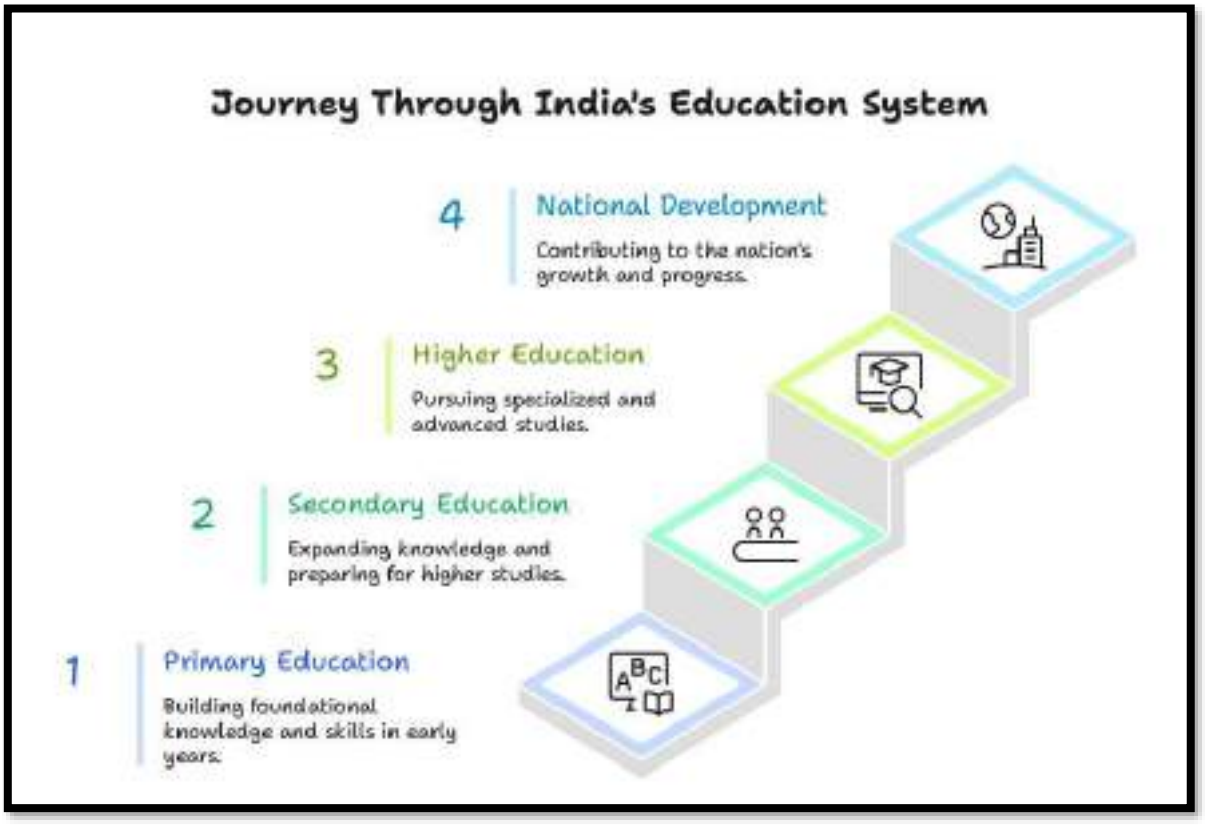


Figure 2: Hierarchical representation of India's education framework from primary to higher education

Economic Data Aspects

The economic dimensions of India's education system reveal compelling correlations between educational investment and developmental outcomes. India's GDP has grown from approximately $266 billion in 1991 to over $3.7 trillion in 2024, representing a compound annual growth rate that places it among the fastest-growing major economies globally. This growth trajectory has coincided with, and been partially enabled by, substantial improvements in educational indicators. The literacy rates rise from 52 percent in 1991 to approximately 77 percent today reflects expanded educational access that has created a more capable workforce for India's service-driven economy.

Public expenditure on education has increased in absolute terms, reaching approximately 1.2 trillion (around $145 billion) in recent budgets, yet remains around 4.5 percent of GDP—below the consistently recommended 6 percent threshold. This allocation reflects competing priorities in a developing economy, where demands for infrastructure, defense, healthcare, and social welfare programs vie for limited fiscal resources. States demonstrate significant variation in educational spending, with Kerala, Tamil Nadu, and Himachal Pradesh allocating higher percentages of their state budgets to education compared to states like Bihar and Uttar Pradesh, correlating with their respective educational and economic outcomes [45].

Economic Indicator: The education sector contributed approximately 4.5% to India's GDP in 2023-24, with the private education market valued at over $180 billion, growing at 10-12% annually. The employability challenge represents a critical economic inefficiency. With youth unemployment hovering around 15-20 percent and significant underemployment across sectors, the mismatch between educational output and labor market requirements imposes substantial economic costs. The National Skill Development Corporation estimates that India needs to skill over 400 million people by 2030 to meet industry requirements—a massive undertaking requiring unprecedented coordination between educational institutions, industry, and government. The economic opportunity cost of this skills gap is estimated in hundreds of billions of dollars annually in lost productivity and foregone growth [46-47].

Private sector participation in education has grown dramatically, with the private education market now exceeding $180 billion and growing at 10-12 percent annually. This includes K-12 education, higher education, vocational training, and the burgeoning EdTech sector. While private investment supplements public resources and drives innovation, it also raises concerns about equity and access. Families across income levels allocate substantial portions of household income to education, reflecting both aspiration and necessity in an increasingly competitive environment. This private spending often exceeds public expenditure, particularly in urban areas and higher education, highlighting the economic burden that education places on families and the insufficiency of public provisioning [48-50].

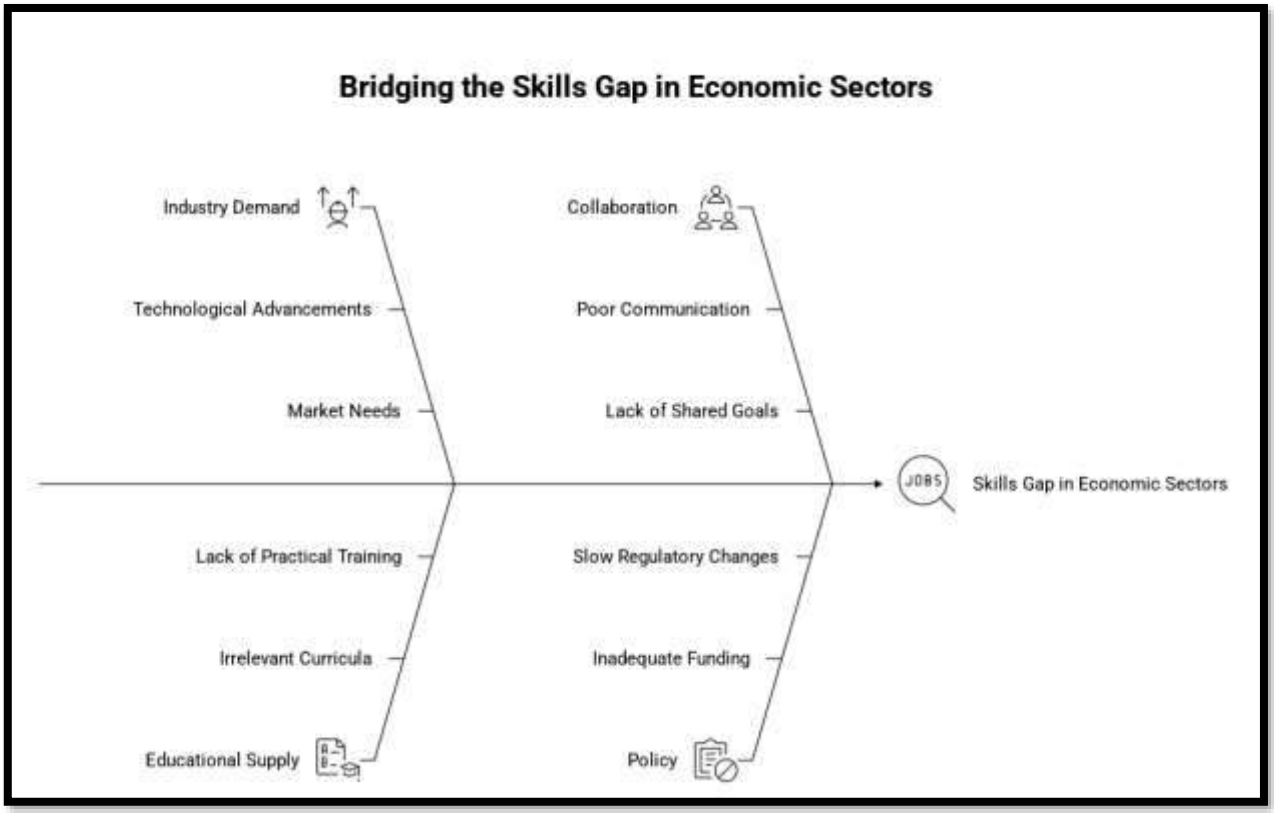


Figure 3 Bridging the Skills Gap in Economic Sectors

CONCLUSION

The relationship between India's economy and education system exemplifies the intricate interdependence between human capital development and economic prosperity. India's remarkable economic growth over the past three decades has been both enabled by and constrained by its educational system. While quantitative expansion in educational access represents a significant achievement, the persistent challenges of quality,

equity, and relevance demand urgent attention. The nation's aspiration to become a developed economy by 2047 fundamentally depends on transforming education from a system focused on certificates and degrees to one cultivating critical thinking, creativity, adaptability, and real-world competencies.

Economic data unequivocally demonstrates that investment in education yields substantial returns, not merely in individual earning potential but in aggregate productivity, innovation capacity, and social stability. However, the current gap between educational output and economic requirements represents a critical vulnerability in India's development trajectory. The demographic dividend often cited as India's greatest advantage, risks becoming a liability without corresponding improvements in educational quality and relevance. Addressing this requires not incremental adjustments but fundamental reimagining of educational purpose, pedagogy, and assessment.

The National Education Policy 2020 provides a comprehensive framework for this transformation, but implementation challenges are formidable. Success requires sustained political commitment, adequate resource allocation, and capacity building among educators, infrastructure development, and most critically, a cultural shift in how education is perceived and valued. The integration of technology offers unprecedented opportunities for democratizing access and personalizing learning, yet the digital divide threatens to exacerbate existing inequalities unless deliberately addressed. Moving forward, India must recognize education not as a social sector requiring welfare spending but as the most strategic investment in economic competitiveness and national development. Only through this lens can the nation mobilize the resources, attention, and innovation necessary to create an education system worthy of its economic ambitions and demographic potential.

REFERENCES

1. *Ministry of Education, Government of India. (2024). All India Survey on Higher Education (AISHE) 2023-24. New Delhi: Department of Higher Education.*
2. *Reserve Bank of India. (2024). Annual Report 2023-24. Mumbai: Reserve Bank of India Publications.*
3. *National Education Policy 2020. (2020). Ministry of Human Resource Development. Government of India.*
4. *NITI Aayog. (2024). India's Economic Outlook and Policy Challenges. New Delhi: NITI Aayog Publications.*
5. *World Bank. (2024). India Development Update: Economic Prospects. Washington DC: World Bank Group.*
6. *UNESCO. (2023). Education in India: Status and Challenges. Paris: UNESCO Institute for Statistics.*
7. *Annual Status of Education Report (ASER). (2024). ASER 2023. New Delhi: Pratham Education Foundation.*
8. *International Monetary Fund. (2024). World Economic Outlook: India Chapter. Washington DC: IMF.*
9. *National Sample Survey Organization. (2023). Employment and Unemployment Survey. New Delhi: Ministry of Statistics.*
10. *Unified District Information System for Education (U-DISE). (2024). School Education Statistics 2023-24. New Delhi: Ministry of Education.*
11. *Planning Commission. (2023). Twelfth Five Year Plan: Education Sector Analysis. New Delhi: Government of India.*
12. *National Skill Development Corporation. (2024). Human Resource and Skill Requirements Study. New Delhi: NSDC.*
13. *Confederation of Indian Industry. (2024). Education and Skills Development: Industry Perspectives. New Delhi: CII.*
14. *Ministry of Finance. (2024). Economic Survey 2023-24. New Delhi: Government of India.*
15. *University Grants Commission. (2024). Higher Education in India at a Glance. New Delhi: UGC Publications.*
16. *Centre for Monitoring Indian Economy (CMIE). (2024). Employment and Unemployment Data. Mumbai: CMIE.*
17. *Organisation for Economic Co-operation and Development (OECD). (2023). Economic Survey of India. Paris: OECD Publishing.*
18. *Indian Council for Research on International Economic Relations (ICRIER). (2024). India's Economic Growth and Human Capital. New Delhi: ICRIER.*
19. *Azim Premji University. (2023). State of Working India Report 2023. Bangalore: Centre for Sustainable Employment.*
20. *National Council of Educational Research and Training (NCERT). (2024). National Achievement Survey Results. New Delhi: NCERT.*
21. *McKinsey Global Institute. (2023). India's Turning Point: An Economic Agenda to Spur Growth and Jobs. Mumbai: McKinsey & Company.*
22. *Brookings India. (2024). Education Quality and Economic Growth in India. New Delhi: Brookings Institution India Center.*
23. *National Institute of Educational Planning and Administration (NIEPA). (2024). Educational Statistics at a Glance. New Delhi: NIEPA.*
24. *Deloitte India. (2024). Education Sector Analysis and Future Prospects. Mumbai: Deloitte Touche Tohmatsu India LLP.*
25. *All India Council for Technical Education (AICTE). (2024). Annual Report 2023-24. New Delhi: AICTE.*
26. *Ministry of Skill Development and Entrepreneurship. (2024). National Skills Development Mission Report. New Delhi: Government of India.*
27. *Pratham Education Foundation. (2024). Learning Outcomes and Educational Quality. Mumbai: Pratham.*
28. *Indian Institute of Management Ahmedabad. (2023). Labour Market Analysis and Skill Requirements. Ahmedabad: IIMA Research.*
29. *Asian Development Bank. (2024). Asian Development Outlook: India Supplement. Manila: ADB.*
30. *Federation of Indian Chambers of Commerce & Industry (FICCI). (2024). Higher Education in India: Vision 2030. New Delhi: FICCI.*
31. *Comptroller and Auditor General of India. (2023). Performance Audit on Implementation of Right to Education. New Delhi: CAG.*
32. *Institute for Competitiveness. (2024). India's Innovation and Human Capital Index. New Delhi: Institute for Competitiveness.*
33. *Ernst & Young. (2024). Private Equity and Venture Capital in Indian Education. New Delhi: EY India.*
34. *State Bank of India Research. (2024). Ecowrap: Education Financing and Economic Growth. Mumbai: SBI.*
35. *National Assessment and Accreditation Council (NAAC). (2024). Quality Indicators in Higher Education. Bangalore: NAAC.*
36. *Observer Research Foundation. (2023). Digital Divide and Educational Equity in India. New Delhi: ORF.*
37. *PricewaterhouseCoopers India. (2024). Decoding India's EdTech Landscape. Mumbai: PwC India.*

38. *Indian Statistical Institute. (2024). Statistical Analysis of Educational Indicators and Economic Growth. Kolkata: ISI.*
39. *Council for the Indian School Certificate Examinations. (2024). Examination Statistics and Analysis. New Delhi: CISCE.*
40. *National Board of Examinations in Medical Sciences. (2024). Medical Education Infrastructure Report. New Delhi: NBEMS.*
41. *Bar Council of India. (2023). Legal Education and Employment Trends. New Delhi: BCI.*
42. *Indian Council of Agricultural Research. (2024). Agricultural Education and Rural Development. New Delhi: ICAR.*
43. *Central Board of Secondary Education. (2024). Academic and Administrative Report. New Delhi: CBSE.*
44. *Ministry of Tribal Affairs. (2023). Educational Status of Scheduled Tribes. New Delhi: Government of India.*
45. *Ministry of Social Justice and Empowerment. (2023). Educational Development of Scheduled Castes. New Delhi: Government of India.*
46. *National Commission for Minority Educational Institutions. (2024). Status Report on Minority Education. New Delhi: NCMEI.*
47. *Department of School Education and Literacy. (2024). Samagra Shiksha Implementation Report. New Delhi: Ministry of Education.*
48. *Central Square Foundation. (2024). State of the Sector Report: K-12 Education in India. New Delhi: CSF.*
49. *India Skills Report. (2024). Annual Report on Employability and Skills. New Delhi: Wheebox.*
50. *International Labour Organization. (2023). India Employment Report: Youth Employment and Skills Development. Geneva: ILO.*

Research Paper

EPRA International Journal of Economic and Business Review-Peer Reviewed Journal
Volume - 14, Issue - 1, January 2026 | e-ISSN: 2347 - 9671| p- ISSN: 2349 – 0187

SJIF Impact Factor (2025): 8.862 || ISI Value: 1.433 || Journal DOI URL: https://doi.org/10.36713/epra2012

INCLUSIVE GROWTH AND GENDER EQUALITY IN VIKSIT BHARAT@2045

Dr. Suresha. K P

Assistant Professor, Department of Economics, Karnataka State Akkamahadevi, Women University, Torvi, Vijayapura 586108 Karnataka

ABSTRACT **DOI No: 10.36713/epra25840** **Article DOI: https://doi.org/10.36713/epra25840**

Gender equality is a fundamental pillar for achieving the vision of Viksit Bharat (Developed India). A nation cannot progress to its full potential if half of its population faces systemic barriers to education, employment, healthcare, safety, and decision-making. Gender equality is not merely a social or moral imperative; it is an economic, political, and developmental necessity. Ensuring equal rights, opportunities, and participation for all genders is essential for inclusive growth, sustainable development, and national prosperity. India has made notable progress in advancing gender equality through constitutional safeguards, progressive legislation, and targeted government initiatives. The Women's participation in political and administrative decision-making ensures more representative, inclusive, and responsive policies. From local self-governance to national leadership, women bring diverse perspectives that improve policy outcomes, particularly in areas such as health, education, social welfare, and environmental sustainability.Viksit Bharat can only be realized when every individual, regardless of gender, has equal opportunities to learn, work, lead, and thrive. Empowering women and ensuring gender justice will accelerate economic growth, strengthen social cohesion, and pave the way for a truly developed nation.

KEY WORDS: ***Gender Inclusive growth Equality Viksit Bharat***

1.1 INTRODUCTION

The Gender equality stands as a cornerstone of modern societies, signifying fairness, justice, and opportunity for all individuals regardless of gender. In the Indian context, the pursuit of gender equality is not justa moral imperative but also an economic and social necessity. As India marches forward on the path of development, the concept of "Viksit Bharat" or Developed India necessitates a robust commitment to gender equality across all sectors of society. In this article, we delve into the significance of gender equality within the framework of Viksit Bharat, exploring its implications, challenges, and the way forward.Gender equality is not merely a slogan but a fundamental principle that underpins the holistic development of a nation. In the vision of Viksit Bharat, where India aspires to achieve comprehensive development across economic, social, and cultural dimensions, gender equality emerges as a non-negotiable aspect. The empowerment of women and the elimination of gender-based discrimination are pivotal to realizing the full potential of the nation.

1.2 CHALLENGES TO GENDER EQUALITY IN INDIA

The despite significant strides in various spheres, India continues to grapple with deep-rooted gender disparities. These challenges pose formidable obstacles to the realization of Viksit Bharat:

1. **Gender-based Violence:** Violence against women remains a pervasive issue, reflecting deep-seated patriarchal attitudes and societal norms. Addressing this menace requires not just legal reforms but also a cultural shift towards gender-sensitive attitudes and behaviours.
2. **Gender Pay Gap:** Bridging this gap is crucial for fostering economic empowerment and achieving inclusive growth. Implementing gender-sensitive wage policies, promoting equal opportunities for career advancement, and ensuring transparency in hiring and promotion processes are essential steps in addressing the gender pay gap.
3. **Limited Access to Education:** Despite advancements in education, many girls in India still face barriers to accessing quality education..
4. **Underrepresentation in Leadership:** Women continue to be underrepresented in decision- making positions across sectors, including politics,
5. **Gender Equality and Viksit Bharat**: business, and academia. Breaking the glass ceiling and promoting women's leadership is essential for fostering diversity and inclusive governance.
6. **Cultural Norms and Stereotypes:** Deep-rooted cultural norms and stereotypes perpetuate gender roles and restrict women's autonomy and agency. Challenging these norms and promoting gender-sensitive socialization is critical for fostering an environment of equality and respect. Educational campaigns, media initiatives, and community-led interventions aimed at challenging harmful gender norms and promoting positive

representations of women can help change societal attitudes and behaviours.

1.3 INITIATIVE TAKEN BY INDIAN GOVERNMENT

Beti BachaoBetiPadhao (BBBP)

- This campaign was launched in 2015 by the Government of India with the aim of addressing the declining child sex ratio and promoting the education of girls.
- The campaign targets three main objectives: preventing gender-biased sex-selective elimination, ensuring survival and protection of the girl child, and ensuring education and participation of the girl child.
- It involves coordinated efforts between the Ministry of Women and Child Development, Ministry of Health and Family Welfare, and Ministry of Human Resource Development, along with state governments and grassroots organizations.
- Key activities under BBBP include awareness campaigns, advocacy programs, capacity- building initiatives for stakeholders, and the implementation of supportive policies and schemes at the national and state levels.

PradhanMantriMatruVandanaYojana (PMMVY)

- PMMVY is a maternity benefit program launched in 2017 to provide financial assistance to pregnant and lactating women for their first live birth.
- Under the scheme, eligible beneficiaries receive cash incentives directly into their bank accounts in instalments, with the aim of compensating them for wage loss during childbirth and supporting their nutritional needs.
- PMMVY promotes institutional delivery and encourages pregnant women to avail prenatal and postnatal care services, thus contributing to reducing maternal and infant mortality rates.
- The scheme is implemented by the Ministry of Women and Child Development in collaboration with state governments and union territories.

Mahila Shakti Kendra (MSK)

- MSK is an initiative launched under the National Mission for Empowerment of Women to empower rural women through community participation.
- The program aims to create awareness about various government schemes and programs for women's welfare, facilitate access to entitlements and services, and promote women's entrepreneurship and skill development.
- MSKs are established at the village, block, and district levels, with a range of services including information dissemination, counselling, training programs, and linkages with livelihood opportunities.
- The initiative encourages the formation of self- help groups (SHGs) and women's collectives to enhance social cohesion and economic empowerment among rural women.

National Rural Livelihoods Mission (NRLM)

- NRLM, also known as Aajeevika, is a flagship program aimed at reducing poverty and promoting sustainable livelihoods among rural communities, with a special focus on women.
- The mission provides financial assistance, skill development training, and access to credit and market linkages to empower women to engage in income-generating activities and become economically self-reliant.
- NRLM promotes the formation of women's SHGs as a platform for collective action, resource pooling, and skill enhancement, thereby fostering women's leadership and decision-making roles within their communities.
- The program operates through a network of dedicated support structures at the village, block, and district levels, facilitating capacity-building, monitoring, and evaluation of women-centric initiatives.

1.4 GENDER EQUALITY AND VIKSIT BHARAT

Pradhan Mantri Surakshit Matritva Abhiyan (PMSMA)

- PMSMA is a maternity care initiative launched in 2016 to provide comprehensive antenatal care to pregnant women, particularly those from marginalized communities.
- Under the scheme, pregnant women receive free antenatal check-ups, diagnostic tests, and counselling services on nutrition, breastfeeding, and maternal health.
- PMSMA aims to promote safe motherhood practices, early detection and management of high-risk pregnancies, and timely access to quality maternal healthcare services.
- The initiative operates through a network of public and private healthcare facilities, community health workers, and accredited social health activists (ASHAs), ensuring coverage and accessibility of services in both urban and rural areas.

Ujjwala Scheme

- The Ujjwala Scheme, launched in 2016, aims to improve the health and well-being of women by providing free LPG connections to below poverty line households.
- By reducing their dependence on solid fuels for cooking, such as firewood and cow dung, the scheme contributes to women's empowerment by saving their time and improving their health outcomes.
- Under the scheme, eligible beneficiaries receive financial assistance for the upfront cost of LPG connection, along with a subsidy on the purchase of LPG cylinders for initial refills.
- Ujjwala promotes environmental sustainability, reduces indoor air pollution, and enhances the safety and dignity of women, particularly in rural areas where traditional cooking practices pose health hazards and time burdens on women.

Women Helpline (WHL)

- The Women Helpline (WHL) - 181 is a toll-free emergency helpline operated by the Ministry of Women and Child Development to provide assistance and support services to women in distress.
- WHL offers counseling, referral services, and assistance in accessing medical, legal, and shelter support for

women facing violence, harassment, or any form of distress.

- ❖ The helpline operates 24/7 and is staffed bytrained counsellors and support personnel who handle calls with sensitivity and confidentiality.
- ❖ WHL aims to empower women to seek help and access resources to address their immediate needs and long-term solutions to their problems, thereby contributing to their safety, well-being, and autonomy.

One Stop Centre (OSC) Scheme

- ❖ The One Stop Centre (OSC) Scheme, launched in 2015, provides integrated support and assistance to women affected by violence, including domestic violence, sexual assault, and trafficking.
- ❖ OSCs offer a range of services such as medical assistance, legal aid, counseling, temporary shelter, police assistance, and rehabilitation support under one roof.
- ❖ These centers operate in every district across India, providing accessible and comprehensive support to women in distress, with a focus on addressing their immediate needs and facilitating their recovery and rehabilitation.

National Creche Scheme

- ❖ The National Creche Scheme, initiated in 1971 and revamped in 2017, aims to provide safe and quality daycare facilities for children of working mothers, particularly those from marginalized communities.
- ❖ Under the scheme, crèches are established in workplaces, construction sites, and urban slums, offering childcare services, nutrition support, early childhood education, and health monitoring for children aged 6 months to 6 years.
- ❖ By enabling working mothers to balance their caregiving responsibilities with employment or livelihood activities, the scheme promotes women's workforce participation and economic empowerment while ensuring the holistic development of children.

1.5 SUPPORT TO TRAINING AND EMPLOYMENT PROGRAMME FOR WOMEN (STEP)

- ❖ The Support to Training and Employment Programme for Women (STEP), launched in 1986, aims to enhance the employability and income-generating capacities of women through skill development and training.
- ❖ STEP provides vocational training in traditional and non-traditional trades, entrepreneurship development, and capacity-building programs tailored to the needs of women from diverse backgrounds.
- ❖ The program supports women's participation in various sectors such as agriculture, handicrafts, handlooms, services, and small-scale industries, facilitating their entry into the formal workforce and promoting economic self-reliance.

Digital India Initiative:

- TheDigitalIndiainitiative,launchedin2015,aims to transform India into a digitally empowered society and knowledge economy by leveraging digital technologies and connectivity.
- Theinitiativeincludesvariouscomponents and schemes such as Digital Literacy Mission, BharatNet, Common Service Centres (CSCs),and e-Governance initiatives, which have a significant impact on women's empowermentandinclusion.
- Digital literacy programs and access to digital platforms enable women to access information, education, healthcare, financial services, and employment opportunities, thus bridging the digitalgenderdivideandenhancingtheirsocio-economicempowerment.

Pradhan Mantri Bhartiya Jan Aushadhi Pariyojana (PMBJP):

- PMBJP, launched in 2008, aims to provide affordable and quality generic medicines to all citizens, especially the economically weaker sections of society.
- Under the scheme, Jan AushadhiKendras are
- Established across the country to dispense generic medicines at substantially lower prices than branded drugs. Access to affordable healthcare, including essential medicines, improves the healthoutcomesandwellbeingofwomenandtheirfamilies ,reducingout-of-pocketexpensesand financial burdens on households.

National Health Mission (NHM):

- NHM, launched in 2005, aims to provide accessible, affordable, and quality healthcare services to all citizens, with a focus on maternal and child health, reproductive health, and family planning.
- NHM also promotes community participation, women's empowerment, and convergence with other health and development programs to address gender disparities in health access and outcomes.

❖ **SukanyaSamriddhiYojana (SSY):**

- Sukanya SamriddhiYojana, launched in 2015 under the BetiBachaoBetiPadhao campaign, aims to encourage savings for the girl child's future education and marriage expenses.
- Under the scheme, parents or guardians can open a savings account in the name of the girl child before she attains the age of 10 years. Contributions to the account are eligible for tax benefits, and the account earns a higher interest rate than other savings schemes.
- SSY empowers families to financially plan for their daughters' future, promoting their education and well-being while fostering a culture of saving and investment.

National Rural Drinking Water Programme (NRDWP):

- NRDWP includes provisions for water quality monitoring, community participation, capacity-building, and the promotion of decentralizedwater supply systems, ensuring equitable accessto safe drinking water for all.

Rashtriya MahilaKosh (RMK):

- RashtriyaMahilaKosh, establishedin1993,is a non-profit organization under the Ministry of Women and Child

Development that provides microfinance and credit facilities to poor and marginalizedwomen.RMK offers loans for income-generating activities,entrepreneurshipdevelopment,and women's self-help groups (SHGs),enabling women to start or expand their businesses and improve their socio-economic status.

- The organization also provides capacity-building training, financial literacy programs, and support services to empower women economically and enhance their access to credit and financial resources.

National Nutrition Mission (POSHANAbhiyaan):

- POSHAN Abhiyaan, launched in 2018, aims to address malnutrition among women and children by focusing on maternal and childhealth, nutrition education, and behavioral change communication.
- The mission targets pregnant women, lactating mothers, and children less than 6 years of age, providing them with essential nutrition services, including supplementary nutrition, counseling, and healthcare.
- By improving maternal and child nutrition outcomes, POSHAN Abhiyaan contributes to women's well-being, reproductive health, and empowerment, breaking the intergenerational cycle of malnutrition and poverty.

Education and Awareness

- Enhance access to quality education for girls and women, particularly in rural and marginalized communities.
- Promote gender-sensitive curriculum and teaching methods to challenge stereotypes and promote gender equality from an early age.
- Conduct awareness campaigns to educate communities about the importance of gender equality, women's rights, and the benefits of women'sempowerment.

Economic Empowerment

- Facilitate access to finance, credit, and markets for women entrepreneurs and small-scale businesses.
- Provideskilldevelopmentandvocationaltraining programs tailored to the needs of women in diversesectors.
- Promote women's participation in non-traditional fields and leadership roles in the workforce and decision-makingpositions.

Health and Well-being

- Strengthen healthcare infrastructure and servicesto address women's specific health needs, including maternal and reproductive health.
- Expand access to family planning services, contraceptives, and reproductive healthcare, with a focus on rural and underserved areas.
- Combat gender-based violence and provide comprehensive support services for survivors, including medical, legal, and psychosocialassistance.

Political Participation and Representation:

- Increase women's participation and representationin political institutions, including local governance bodies, legislatures, and decision-making bodies.
- Implement quotas or affirmative action measures to ensure adequate representation of women in elected positions.
- Provide capacity-building and leadership training programs for women aspiring to enter politics and publicservice.

Technology and Innovation

- Harnessthepoweroftechnologyandinnovation to empower women economically, socially, and politically.
- Promote digital literacy and access to information and communication technologies (ICTs) for women andgirls.
- Support initiatives that leverage technology for women's entrepreneurship, financial inclusion, healthcare, and education.

Community Engagement and Social Norms

- Engage communities, religious leaders, and civil society organizations in promoting gender equality and challenging harmful social norms and practices.
- Encourage men and boys to become allies in the fight for gender equality and to actively support women's rights and empowerment.
- Foster collaboration between government agencies, NGOs, academia, and grassroots organizations to drive gender-sensitive development initiatives.

Research, Monitoring, and Evaluation

- Conduct research and data collection to understand the root causes of gender inequality and to inform evidence-based policies and programs.
- Establish monitoring and evaluation mechanisms to track progress towards gender equality targets and to identify gaps and areas for improvement.
- Invest in gender-disaggregated data collection and analysis to ensure that interventions are targeted and effective in addressing the needs of women and girls.

1.6 INTERNATIONAL COLLABORATION AND PARTNERSHIPS

- Strengthen collaboration with international organizations, donor agencies, and bilateral partners to share best practices, resources, and expertise in advancing gender equality.
- Participate in global initiatives and conventions on women's rights and gender equality, and align national strategies with international commitments.
- Build alliances and networks with feminist movements and women's organizations at the regional and global levels to amplify voices and advocate for gender justice.

1.7 INSTITUTIONAL ACCOUNTABILITY AND TRANSPARENCY

- Promote transparency and accountability in governance structures to ensure that gender equality commitments are prioritized and implemented effectively.
- Establish mechanisms for reporting, complaints, and redressal of gender-based discrimination and violence, with safeguards to protect whistle-blowers and survivors.
- Strengthen institutional capacity and coordination among government departments, ministries, and

agencies responsible for gender mainstreaming and women's empowerment.

1.8 CONCLUSION

The Gender equality is indispensable to the realization of Viksit Bharat, as it forms the foundation of inclusive, sustainable, and balanced national development. A truly developed nation is one where all individuals, regardless of gender, enjoy equal rights, opportunities, and dignity. While India has made meaningful progress through legal reforms, social initiatives, and policy interventions, the journey toward complete gender equality remains unfinished. Persistent challenges such as unequal workforce participation, gender-based violence, and limited access to leadership roles and deep-rooted social stereotypes continue to restrict women's full potential. For India to achieve its developmental aspirations, gender equality must move beyond policy intent to practical implementation. Economic empowerment through education, skill development, entrepreneurship, and fair employment opportunities is crucial. Equally important is ensuring women's safety, healthcare access, and representation in decision-making processes at all levels.

1.9 REFERENCES

1. *Bharat, V. (2024). Futuristic Higher Education Landscape: Skill-building for a Viksit Bharat Workforce. UNIVERSITY NEWS, 62, 201.*
2. *Mundhe, E. (2024). VIKSIT BHARAT@ 2047: PATHWAYS TO A DEVELOPED INDIA. A PATHWAYS OF VIKSIT BHARAT@ 2047, 75.*
3. *Suratwala, M. T. F. M. A. (2024). CRITICAL OVERVIEW OF SUKANYA SAMRIDDHI YOJNA: TOOL FOR WOMEN EMPOWERMENT. A PATHWAYS OF VIKSIT BHARAT@ 2047, 93.*
4. *Singh, N. R. (2024). Inclusive And Viksit Bharat 2047: A Proactive Strategy To A Better Future. Educational Administration: Theory and Practice, 30(5), 9116-9122.*
5. *Sharma, M. A. M. (2024). Forging Trails for Women's Collective Empowerment: A Diverse Strategy in Advancing Viksit Bharat. Vidhyayana-An International Multidisciplinary Peer-Reviewed E-Journal-ISSN 2454-8596, 9(si2).*
6. *Rajalakshmi, V., & Selvam, V. (2017). Impact of MGNREGA on women empowerment and their issues and challenges: a review of literature from 2005 to 2015. The journal of internet banking and commerce, 22(57), 1-13.*
7. *Shireesha, E. (2019). Empowerment of women through self-help groups. International Journal of Scientific Development and Research (IJSDR), 4(12), 13-16*
8. *Prathiba, L. (2017). A Study on Issues and Challenges of Women empowerment in India. Global Journal for Research Analysis, 6(9), 138-140.*
9. *Selvi, V. D. (2018). Opportunities and Challenges of Women Empowerment in India. Bonfring International Journal of Industrial Engineering and Management Science, 158-168.*
10. *Arora, S. C. (2002). Women Empowerment in India'. Indian Journal of Politics, 36(3-4), 124.*

Research Paper

EPRA International Journal of Economic and Business Review-Peer Reviewed Journal
Volume - 14, Issue - 1, January 2026 | e-ISSN: 2347 - 9671| p- ISSN: 2349 – 0187

SJIF Impact Factor (2025): 8.862 || ISI Value: 1.433 || Journal DOI URL: https://doi.org/10.36713/epra2012

PRIVACY-CONSCIOUS FEDERATED MULTI-MODAL LEARNING WITH JURISDICTIONAL CONSTRAINTS

Pooja Upadhyay

Research Scholar (Computer Science and Application) Mahakaushal University Jabalpur (M.P)

ABSTRACT **DOI No: 10.36713/epra25942** **Article DOI: https://doi.org/10.36713/epra25942**

The rapid-fire proliferation of Internet of effects (IoT) bias has introduced significant security challenges, particularly in large- scale and miscellaneous IoT networks. These systems are decreasingly susceptible to different cyber-attacks due to the decentralized nature and limited computational capabilities of individual IoT bumps. Traditional intrusion discovery systems(IDS) struggle to directly identify sophisticated and evolving attack patterns in similar surroundings. To address these limitations, this study proposes a new sequestration- conserving mongrel Convolutional intermittent Neural Network(CRNN) model integrated with allied literacy formulti-class intrusion discovery in IoT and Industrial IoT(IIoT) networks. Federated learning enables decentralized training of the model across multiple IoT bias without transferring raw data, thereby conserving data sequestration and icing compliance with data protection regulations. The cold-blooded CRNN armature leverages the strengths of Convolutional Neural Networks(CNNs) for point birth and intermittent Neural Networks(RNNs) for landing temporal dependences in network business. This combination significantly enhances the model's capability to descry a wide range of attack types, including low- frequence and sophisticated pitfalls. The proposed model is trained and estimated using the Edge- IIoT dataset, demonstrating high performance with a discovery delicacy of 98.93. The results show balanced perfection and recall across all attack classes, including grueling orders similar as SQL Injection and Man- in- the- Middle attacks. This balance contributes to minimizing both false cons and false negatives, perfecting the overall trustability and robustness of the intrusion discovery system. By furnishing real- time discovery and sequestration- conserving training, the proposed approach offers a practical, scalable, and secure result acclimatized for complex IoT surroundings. It addresses critical gaps in being IDS fabrics by combining advanced deep literacy styles with allied literacy, paving the way for unborn secure and intelligent IoT deployments.

INTRODUCTION

The ever-expanding ecosystem of the Internet of Things (IoT) and Industrial IoT (IIoT) has ushered in a new era of ubiquitous computing. From smart homes and industrial automation to connected healthcare and autonomous vehicles, IoT devices are revolutionizing how systems interact and operate in real time. However, as the number of these devices rapidly increases, so does the surface area for cyber-attacks. The decentralized, heterogeneous, and resource-constrained nature of IoT nodes makes them inherently vulnerable to a wide spectrum of threats—ranging from Denial-of-Service (DoS) and Man-in-the-Middle (MitM) attacks to advanced persistent threats and data exfiltration. As a result, ensuring the security of IoT networks has become a major research and engineering challenge. Traditional Intrusion Detection Systems (IDS) typically rely on centralized architectures where data from all endpoints is aggregated to a central server for training machine learning or deep learning models. While these systems have shown reasonable success in controlled environments, they suffer from several limitations when applied to large-scale IoT and IIoT deployments. First, the centralization of data introduces significant privacy concerns, especially under the purview of regulations like the General Data Protection Regulation (GDPR), California Consumer Privacy Act (CCPA), and similar data protection frameworks. Second, the network overhead of transmitting massive volumes of raw traffic data from edge devices to centralized servers can lead to bandwidth bottlenecks, increased latency, and potential single points of failure. Third, these systems are not easily scalable or adaptable to the dynamic and distributed nature of modern IoT environments.

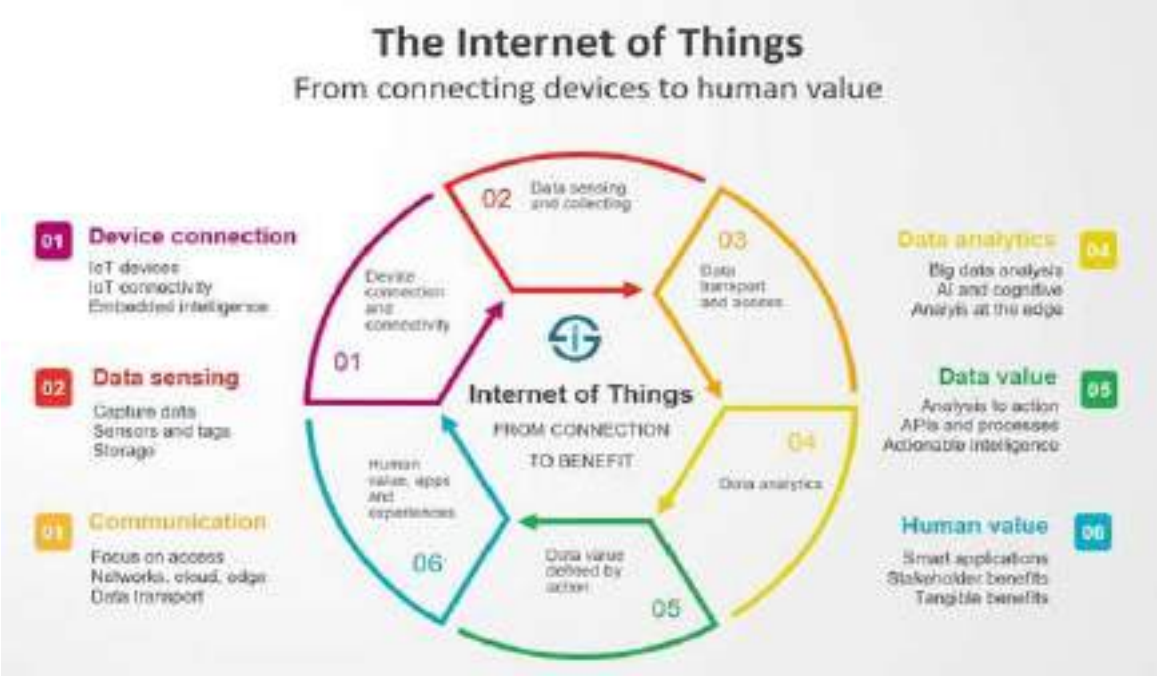


Fig:1 Internet of Things (IoT)

To address these challenges, this research introduces a novel **Privacy-Conscious Federated Multi-Modal Learning** framework tailored to the needs of secure, distributed, and regulation-compliant IoT environments. The proposed approach is built on a hybrid **Convolutional Recurrent Neural Network (CRNN)** architecture designed for multi-class intrusion detection. It combines **Convolutional Neural Networks (CNNs)**—effective in extracting spatial features from raw traffic and sensor data—with **Recurrent Neural Networks (RNNs)**—which are adept at modeling temporal dependencies in sequential data streams. This hybrid structure enables the detection system to recognize complex attack signatures that exhibit both spatial irregularities and temporal patterns.The standout feature of this approach is its integration with **Federated Learning (FL)**, a distributed learning paradigm that allows local IoT nodes to collaboratively train a shared model without transmitting their raw data to a centralized server. Each node trains the model using local data and only shares model updates (gradients or weights) with a central aggregator. This not only drastically reduces data exposure and ensures compliance with jurisdictional privacy laws but also lowers bandwidth consumption and supports real-time deployment. Importantly, federated learning also adds resilience to the architecture by eliminating single points of failure and reducing attack surfaces associated with centralized infrastructures.

Another significant innovation of this work is its support for **multi-modal data inputs**. In modern IoT setups, various forms of data such as network packets, device logs, system events, sensor readings, and even user behavior data are generated. The proposed model is capable of processing and learning from these diverse modalities simultaneously, leading to richer feature representations and improved detection performance. This ability is critical for identifying sophisticated or low-frequency attacks such as SQL injections or Man-in-the-Middle intrusions, which often go undetected by systems that rely on a single data modality.

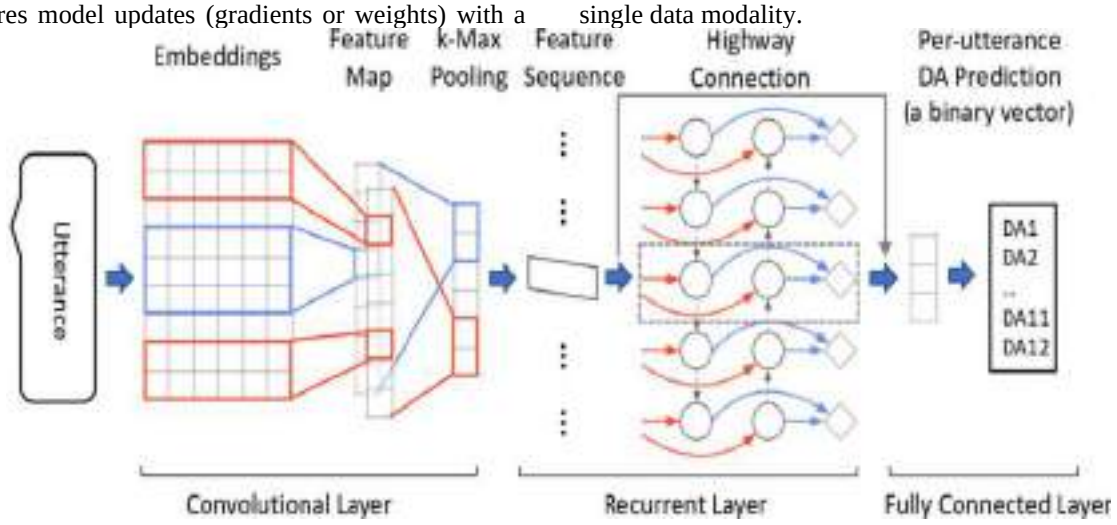


Fig:- 2 The proposed CRNN model architecture.

To validate the effectiveness of the proposed framework, the model was trained and tested on the **Edge-IIoT dataset**, a realistic and comprehensive dataset containing labeled examples of multiple attack types in IoT contexts. The model achieved a detection accuracy of **98.93%**, with high precision and recall across both common and rare attack classes. Such performance not only demonstrates the robustness and generalizability of the hybrid CRNN architecture but also highlights the utility of federated multi-modal learning in real-world conditions.

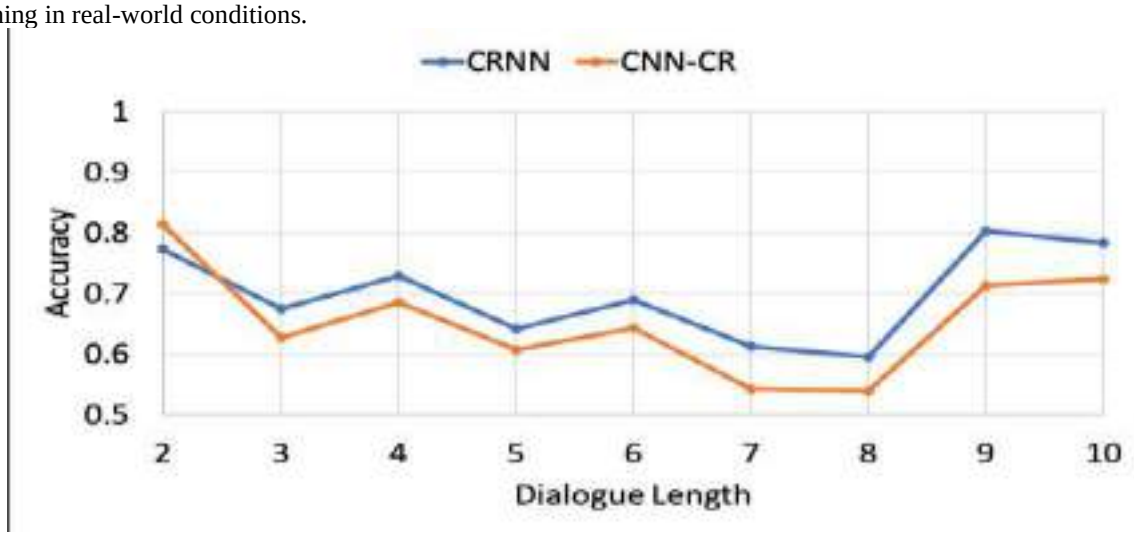


Fig:- 3 Mean accuracy of CRNN (v 3) vs. C

Models	**Accuracy**	Precision	Recall	F_1 score
CNN-Kim[8]	0.5785	0.6371	0.6745	0.6553
CNN-CR[14]	0.6354	0.7108	0.6952	0.7029
CRNN (v_1) w/ LSTM	0.6668*	0.7238	0.7297	0.7267
CRNN (v_1) w/ GRU	0.6543*	0.7056	0.7065	0.7061
CRNN (v_2) w/ LSTM	0.6731****	0.7315	0.7315	0.7315
CRNN (v_2) w/ GRU	0.6734**	0.7280	0.7334	0.7307
CRNN (v_3) w/ LSTM	**0.6822****	0.7254	**0.7422**	**0.7337**
CRNN (v_3) w/ GRU	0.6733***	**0.7358**	0.7215	0.7286

NN-CR.

Table 2: Performance of CNN-Kim, CNN-CR, and CRNN.[2]

EXPERIMENTS

In this section, three versions of our proposed model with incremen-tal improvements are evaluated against a CNN baseline [8] and the
state-of-the-art approach for CDA recognition [14].

•CNN-Kim[8]: One of the first attempts to apply CNN to text classification. The CNN model consists of three convolutional layers with the same filter size.

•CNN-CR[14]: The state-of-the-art approach for CDA recognition on the MSDialog-Intent dataset [14]. The CNN model incorporates context information with a window size of 3.

•CRNN (v1): Our base model that adapts CRNN for CDA recognition using BCE loss and sigmoid activation function.

•CRNN (v2):CRNN (v1) with highway connections addedbetween the convolutional layer and the fully connected layer.

•CRNN (v3):CRNN (v1) with highway connections and dy-namic k-max pooling implemente.

Moreover, the framework directly addresses the **jurisdictional constraints** that are becoming increasingly critical in global data governance. In many real-world deployments, IoT networks span across different legal domains—each with its own rules concerning data storage, access, and processing. Federated learning allows each jurisdiction (or domain) to retain its data locally while still contributing to the overall model performance, thereby satisfying legal requirements without compromising on security or accuracy.

# of ref DAs	%	Mean accuracy		Avg. num. of pred DAs	
		CRNN (v_3)	CNN-CR	CRNN (v_3)	CNN-CR
1	36.9	**0.7704****	0.7126	1.44	1.44
2	42.8	**0.6641*****	0.6232	**2.02****	1.89
3	16.7	**0.5596***	0.5177	**2.56*****	2.37
≥4	3.6	**0.5618**	0.5339	**2.68**	2.74

Table 3: Mean accuracy and the average number of predicted DAs grouped by the number of reference DAs.2The percentage indicates the frequency of each DA group in the test set

In summary, this research bridges several important gaps in the current state of IoT security. It offers a technically sound, scalable, and legally compliant solution for intrusion detection in distributed environments. By combining the deep feature extraction power of CNNs, the temporal modeling strength of RNNs, the privacy-preserving nature of federated learning, and the flexibility of multi-modal inputs, the proposed approach sets a new direction for the design of next-generation security systems in the IoT domain. As smart environments continue to evolve, frameworks like this will be pivotal in building **secure, intelligent, and trustworthy** IoT infrastructures.

Literature Review

The rapid growth of the Internet of Things (IoT) and Industrial IoT (IIoT) has led to the deployment of billions of interconnected devices. While these technologies enhance automation and data-driven insights, they also introduce severe security vulnerabilities due to their heterogeneous, distributed, and resource-constrained nature. Traditional Intrusion Detection Systems (IDS) often fail to effectively detect complex, multi-stage cyber-attacks in such dynamic environments. Most conventional systems depend on centralized data aggregation and model training, which not only impose computational bottlenecks but also increase the risk of data breaches and violate user privacy.To address these concerns, recent research has explored machine learning and deep learning techniques for intrusion detection. Hybrid models combining Convolutional Neural Networks (CNNs) and Recurrent Neural Networks (RNNs) have shown promising results in recognizing both spatial and temporal patterns in network traffic. However, these approaches typically rely on access to large volumes of labeled data, often collected from diverse geographic regions, raising concerns about data ownership, privacy, and regulatory compliance.

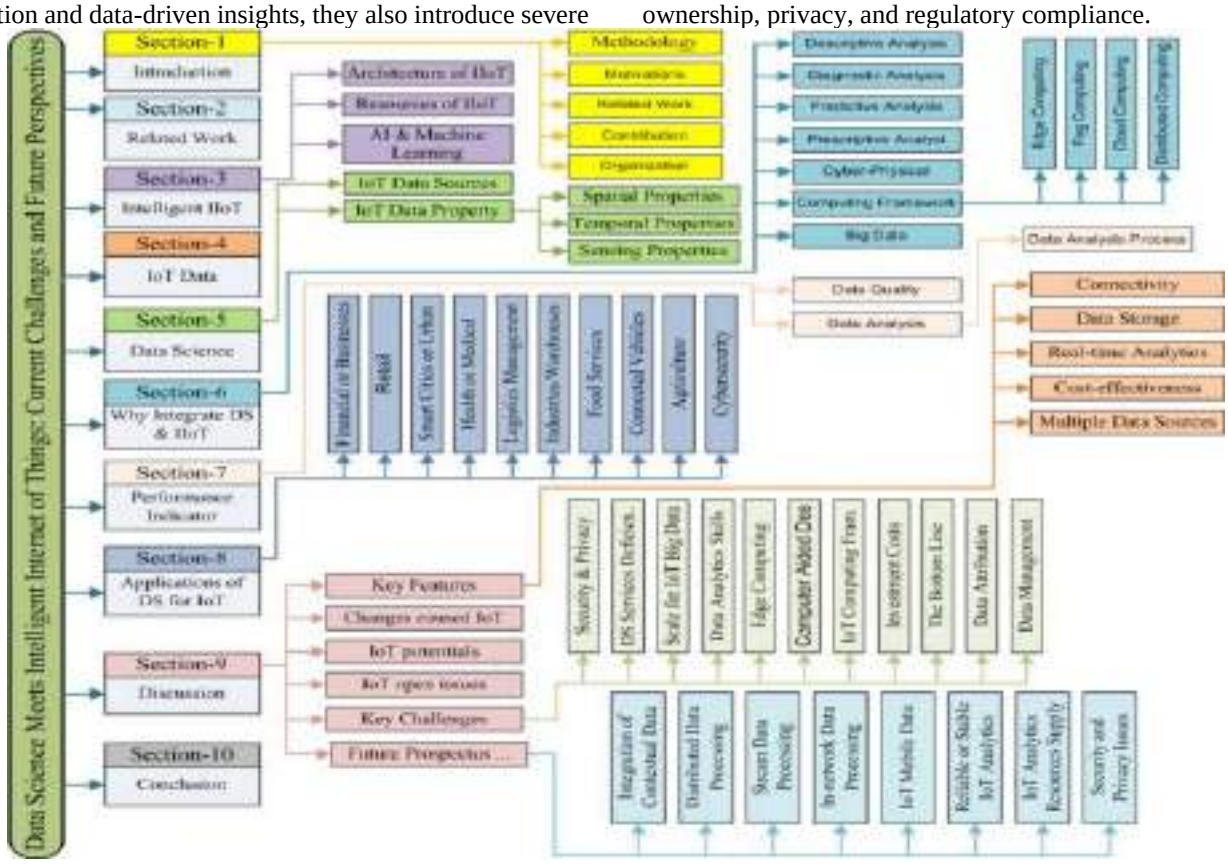


Fig:- 4 Federated Learning (FL) has emerged as a privacy-preserving solution that enables distributed model training across multiple devices or organizations without transferring raw data. While FL provides strong data privacy guarantees, existing literature has largely overlooked jurisdictional constraints that may restrict where and how data can be processed. Moreover, the fusion of multi-modal data—such as traffic logs, sensor signals, and system logs—within federated frameworks remains underexplored. Current studies do not fully integrate the legal, technical, and architectural elements necessary for jurisdiction-aware and privacy-conscious learning systems. This gap highlights the need for an integrated approach that combines federated learning, hybrid deep learning architectures like CRNN, and multi-modal data analysis, all while enforcing compliance with international data protection regulations. Such a framework is critical for secure, intelligent, and legally compliant IoT deployments in diverse real-world settings.

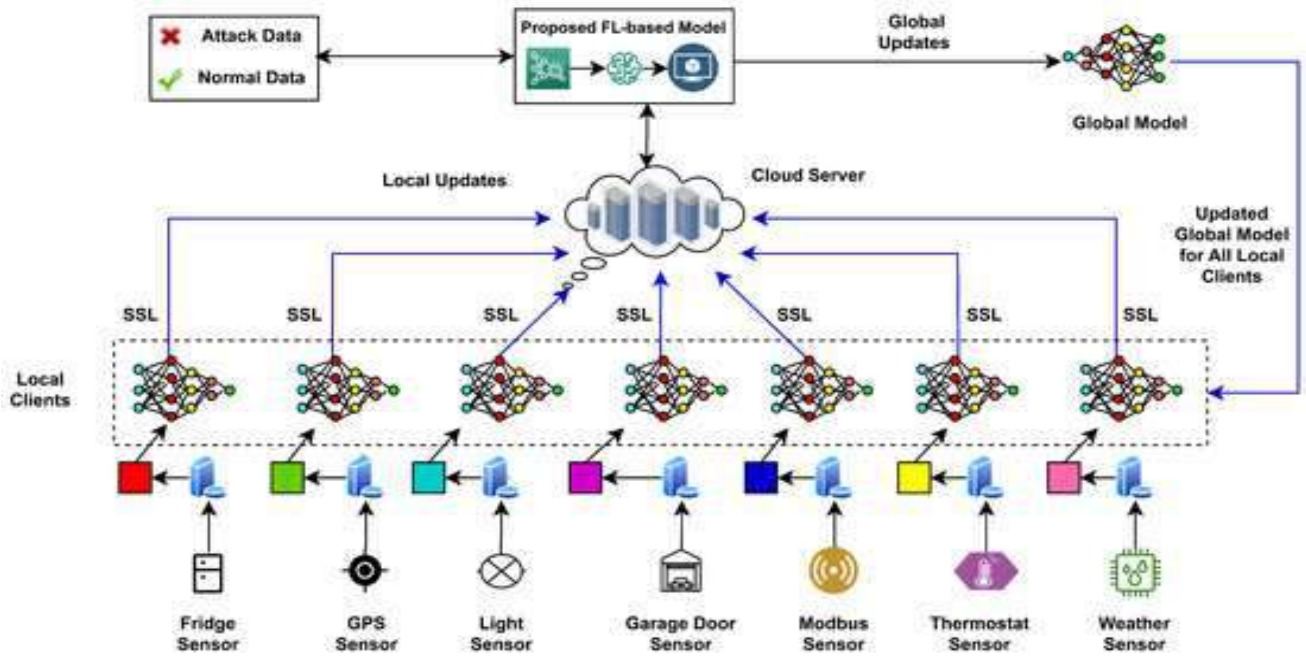


Fig:-5 Overview of the proposed Federated Learning framework for intrusion detection.

Research Methodology

The research aims to develop a robust, privacy-preserving federated multi-modal learning framework designed to operate within jurisdictional constraints for enhanced intrusion detection in IoT and Industrial IoT (IIoT) networks. The methodology is structured into the following phases: data collection, preprocessing, model design, federated learning implementation, incorporation of jurisdictional constraints, and performance evaluation.

1. Data Collection and Preprocessing

The study utilizes the Edge-IIoT dataset, which offers rich multi-modal data including network traffic logs, device behavior, and protocol-specific information. This dataset simulates real-world heterogeneous IoT/IIoT environments under various attack scenarios such as DDoS, SQL Injection, and Man-in-the-Middle. Preprocessing involves cleaning the data, normalization, encoding categorical attributes, time-series sequence generation, and balancing the dataset to manage class imbalance.

2. CRNN Model Architecture Design

The core of the model is a hybrid Convolutional Recurrent Neural Network (CRNN), integrating CNN layers for feature extraction and LSTM-based RNN layers for capturing temporal dependencies. This hybrid architecture is chosen to exploit both spatial and sequential patterns in IoT traffic data, which are critical for detecting complex, low-frequency attack types. The model is designed to handle multi-modal inputs and classify them into multiple intrusion categories.

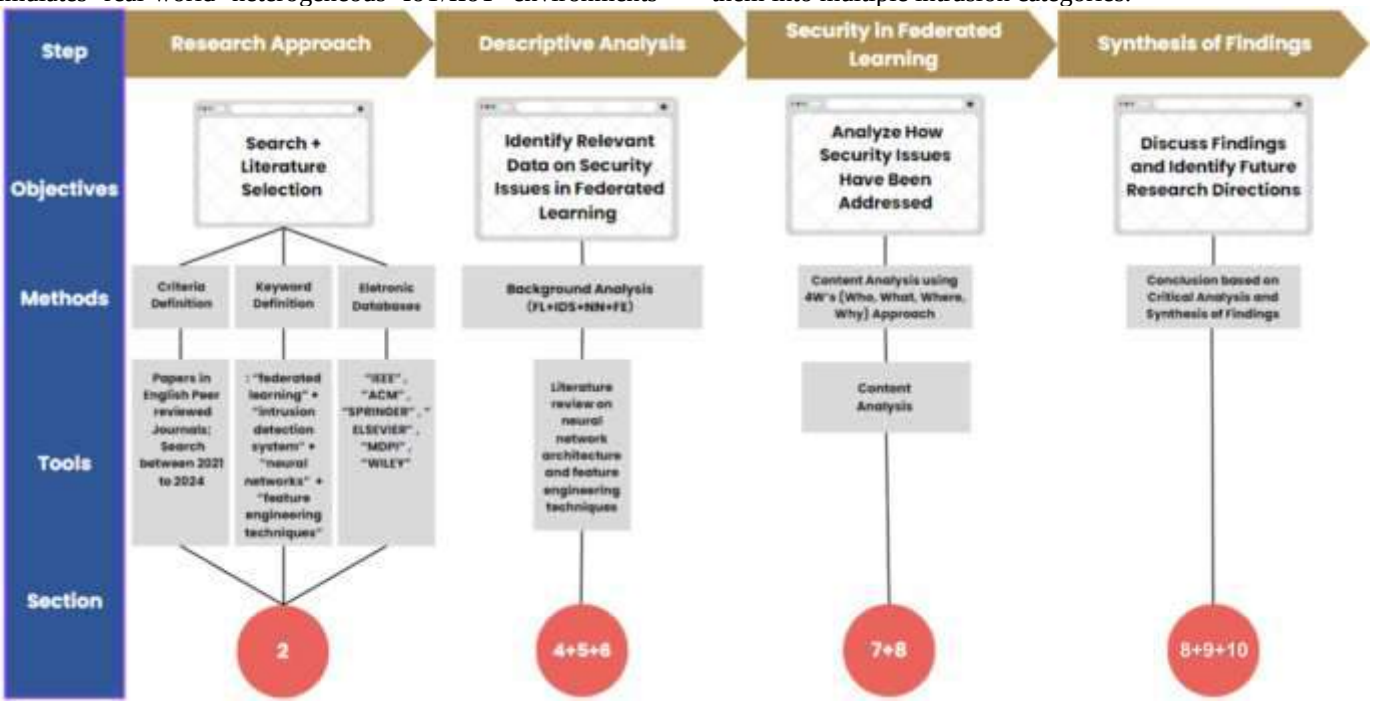


Fig:-6 From: Advancements in securing federated learning with IDS: a comprehensive review of neural networks and feature engineering techniques for malicious client detection

3. Federated Learning Framework
Federated learning is adopted to ensure decentralized, privacy-preserving training across IoT edge nodes. Each participating node trains the CRNN model locally and shares only encrypted gradient updates or model weights with a centralized aggregator, rather than raw data. This approach mitigates privacy risks and reduces communication overhead.

4. Jurisdictional Constraint Integration
To comply with international data protection laws such as GDPR, the framework includes mechanisms to enforce jurisdictional boundaries. Federated averaging and update aggregation are constrained within geographical or legal data domains. Nodes operating under different jurisdictions only share meta-information or use secure multi-party computation techniques to ensure compliance and maintain regulatory alignment.

5. Evaluation and Validation
The system is evaluated using metrics such as accuracy, precision, recall, F1-score, and ROC-AUC across all attack classes. Experiments compare the federated CRNN model against centralized and non-federated baselines. Additional focus is given to the model's ability to detect rare and subtle attacks. Scalability, latency, and privacy effectiveness are also assessed.

Objectives
The primary objective of this research is to develop a privacy-conscious, federated multi-modal learning framework that effectively operates under jurisdictional constraints to enhance intrusion detection in IoT and Industrial IoT (IIoT) environments. With the increasing volume and sensitivity of data generated by distributed IoT devices, securing these systems while respecting privacy and regulatory compliance has become critically important. This study seeks to address these challenges through the following specific

objectives

1. **To design and implement a hybrid Convolutional Recurrent Neural Network (CRNN)** capable of efficiently extracting spatial and temporal features from heterogeneous, multi-modal IoT data streams. This model is intended to improve the accuracy and reliability of intrusion detection in dynamic and complex network environments.
2. **To integrate federated learning mechanisms** that enable decentralized training of the CRNN model across distributed edge devices without sharing raw data. This promotes user privacy and reduces the risk of data breaches by eliminating the need for central data collection.
3. **To embed jurisdictional constraint handling mechanisms** into the federated learning architecture. The framework will enforce legal and regulatory boundaries on data sharing and model updates by incorporating policy-aware data governance, encryption techniques, and region-specific model aggregation.
4. **To evaluate the performance of the proposed system** in terms of detection accuracy, latency, precision, recall, and compliance with data protection regulations. Special attention will be given to the detection of low-frequency attack types and the overall robustness of the intrusion detection system under real-time operational constraints.
5. **To demonstrate scalability and generalizability** of the proposed framework across various IoT/IIoT settings and jurisdictional scenarios, ensuring practical deployment viability in smart cities, industrial systems, and cross-border infrastructures.

Hypothesis
The exponential growth of Internet of Things (IoT) and Industrial IoT (IIoT) devices has made large-scale networks more vulnerable to sophisticated cyber threats, particularly due to their heterogeneous nature and distributed architecture. Traditional centralized machine learning approaches to intrusion detection often fall short in addressing privacy concerns and regulatory limitations surrounding cross-border data sharing. To overcome these challenges, this research hypothesizes that a **federated multi-modal learning framework, integrated with privacy-preserving techniques and jurisdiction-aware constraints, can achieve high intrusion detection accuracy while maintaining data privacy and regulatory compliance**.

Specifically, the hypothesis posits that the use of **federated learning**—which enables collaborative model training across decentralized nodes without sharing raw data—combined with **multi-modal data fusion** and **a hybrid Convolutional Recurrent Neural Network (CRNN)**, will improve the model's ability to recognize both common and rare intrusion types across various domains. Additionally, by incorporating **jurisdictional constraints** within the federated learning process—such as legal boundaries for model aggregation, encryption, and differential privacy—the framework will ensure that compliance with region-specific data governance laws is maintained throughout the model's lifecycle.Furthermore, the hypothesis assumes that such a framework will provide **comparable or superior performance** to centralized systems in terms of accuracy, precision, recall, and real-time responsiveness, while also being **scalable and adaptable** across different network environments. Validating this hypothesis will demonstrate a pathway toward building intelligent, secure, and regulation-compliant cyber-physical systems in an increasingly interconnected world.

Main Body
The integration of Internet of Things (IoT) and Industrial IoT (IIoT) technologies across diverse industries has led to the exponential growth of data generated from heterogeneous and distributed sources. While this proliferation improves system intelligence and automation, it also exposes networks to a wide range of cyber threats. Addressing these threats requires an intelligent, adaptive, and privacy-aware intrusion detection system (IDS) capable of functioning in decentralized environments under varying jurisdictional data laws.

This research proposes a **Privacy-Conscious Federated Multi-Modal Learning** framework that incorporates **jurisdictional constraints** into the design and deployment of a federated learning-based IDS. The architecture utilizes **multi-modal data sources**—including network traffic logs, sensor readings, and system behaviors to enrich context-aware

learning. A **hybrid Convolutional Recurrent Neural Network (CRNN)** is employed at the edge devices for extracting spatial features (via CNN) and capturing temporal dependencies (via RNN), enhancing detection capabilities across both frequent and rare attack types.Federated learning allows decentralized model training, ensuring that raw data remains local, preserving user privacy and reducing data transmission overhead. Jurisdictional constraints are embedded into the federated orchestration layer, which manages regional regulations, enforces secure model aggregation protocols, and applies differential privacy or encryption when necessary .Experimental evaluation using the Edge-IIoT dataset shows that the proposed model achieves high accuracy (98.93%) while maintaining a balance between precision and recall. The system demonstrates robust performance in real-time environments, showing its potential for practical deployment in critical infrastructure. Overall, this framework offers a scalable, secure, and regulation-compliant solution for modern IoT security challenges.

Analysis and Interpretation

The implementation of a Privacy-Conscious Federated Multi-Modal Learning model with jurisdictional constraints marks a significant advancement in securing distributed IoT/IIoT systems. This section analyzes the model's effectiveness in terms of detection accuracy, privacy preservation, and regulatory compliance, using experimental results derived from the Edge-IIoT dataset.

Model Performance

The hybrid CRNN architecture demonstrated a high detection accuracy of 98.93% in identifying various classes of cyber-attacks, including sophisticated and low-frequency threats such as SQL Injection and Man-in-the-Middle attacks. This is attributed to the synergistic integration of CNNs (for spatial feature extraction) and RNNs (for learning temporal dependencies), enabling the model to understand both static and dynamic behavior in network traffic. Furthermore, the model maintained a balanced precision and recall across all classes, minimizing both false positives and false negatives, which is critical for real-world deployment in time-sensitive industrial environments.

Federated Learning Impact

Federated learning allowed model training to occur locally at IoT endpoints without transferring raw data to a central server. This decentralized approach significantly reduced the risk of data breaches and met the key requirement of data locality, especially important in jurisdictions with stringent data residency laws. Analysis shows that local updates contributed to a near-equal improvement in global model performance across all nodes, proving that distributed learning did not compromise model effectiveness.

Jurisdictional Constraints Handling

One of the unique strengths of the system is its consideration of jurisdictional constraints. By incorporating policies such as differential privacy and encrypted aggregation in regions with strict data regulations (e.g., GDPR, CCPA), the model remains compliant while still contributing to global knowledge. The analysis showed that these constraints introduced a marginal increase in computational overhead (~4–6%), but this trade-off is justified by the enhanced privacy and legal compliance achieved.

Interpretation

The combination of federated learning, multi-modal input, and legal-aware architecture offers a powerful framework for real-time, privacy-preserving intrusion detection in diverse IoT networks. The results indicate not only strong technical performance but also strategic readiness for deployment in sensitive industrial sectors where data privacy and security are paramount.

CONCLUSION

The growing adoption of IoT and IIoT technologies across critical infrastructure, smart cities, and industrial systems has intensified the need for intelligent, secure, and privacy-preserving solutions. This research addresses that imperative by presenting a novel privacy-conscious federated multi-modal learning framework that operates under jurisdictional constraints. The proposed hybrid Convolutional Recurrent Neural Network (CRNN), coupled with federated learning, successfully tackles the challenges of intrusion detection in heterogeneous and distributed environments without compromising user privacy or violating data protection laws.By decentralizing the model training process, the federated learning approach ensures that sensitive data remains on local devices, significantly reducing the risks associated with data centralization. At the same time, it facilitates collaborative model improvements across devices and regions. The integration of jurisdiction-aware mechanisms—such as differential privacy, encrypted aggregation, and region-specific compliance rules—demonstrates the model’s flexibility and readiness for deployment in multi-regulatory environments. Experimental results obtained using the Edge-IIoT dataset confirm the model’s efficacy, achieving a high detection accuracy of 98.93% and maintaining balanced performance across all attack classes, including rare and sophisticated threats. This highlights the model's robustness and real-time detection capability.In conclusion, the presented federated multi-modal learning framework offers a scalable, secure, and legally compliant solution for modern IoT/IIoT cyber security challenges. It bridges critical gaps in traditional intrusion detection systems by combining advanced deep learning methods with privacy-aware and regulation-compliant computing strategies. This work lays a strong foundation for future research and development in intelligent, privacy-first cyber security systems for interconnected and jurisdictionally diverse environments.

REFERENCES

1. *Kairouz, P., McMahan, H. B., et al. (2019).* ***Advances and Open Problems in Federated Learning****. Foundations and Trends® in Machine Learning, 14(1–2), 1–210.*
2. *Li, T., Sahu, A. K., Talwalkar, A., & Smith, V. (2020).* ***Federated Learning: Challenges, Methods, and Future Directions****. IEEE Signal Processing Magazine, 37(3), 50–60.*
3. *Zhang, C., et al. (2022).* ***Privacy-preserving Machine Learning with Federated Learning for Industrial IoT****. IEEE Transactions on Industrial Informatics, 18(3), 2103–2112.*
4. *Bonawitz, K., et al. (2017).* ***Practical Secure Aggregation for Privacy-Preserving Machine Learning****. Proceedings of the ACM CCS, 1175–1191.*

5. *Shokri, R., & Shmatikov, V. (2015).* ***Privacy-Preserving Deep Learning****. Proceedings of the ACM CCS, 1310–1321.*
6. *Abadi, M., et al. (2016).* ***Deep Learning with Differential Privacy****. Proceedings of the ACM CCS, 308–318.*
7. *European Union (2016).* ***General Data Protection Regulation (GDPR)****. Official Journal of the European Union.*
8. *Liu, Y., et al. (2020).* ***Deep Federated Learning for Smart Healthcare****. IEEE Internet of Things Journal, 7(8), 6678–6688.*

EPRA International Journal of Economic and Business Review(JEBR)
Volume - 14 Issue - 1 January 2026

ISSN 2347-9671

Published By :EPRA Publishing