IJNRD.ORG ISSN : 2456-4184

INTERNATIONAL JOURNAL OF NOVEL RESEARCH AND DEVELOPMENT (IJNRD) | IJNRD.ORG

An International Open Access, Peer-reviewed, Refereed Journal

Impact of 5G Deployment on Digital Inclusion in India: Bridging the Urban-Rural Divide

[1]Dr Mohd Akhlak Hussain,[2]Moh Akif,[3]Madhuresh kumar Yadav, [4]Ashutosh Shukla

[1]Associate Professor,[2,3 & 4]Assistant Professor
[1]Department &Faculty of Commerce & Management,
[2,3]Department & Faculty of Computer Applications,
[4]Department of Computer Science and Engineering,
[1]Future University, Bareilly, (UP) India

   Abstract : The advent of 5G technology in India marks a transformative phase in the nation's telecommunications sector (Mittal, 2023). This study critically examines the deployment of 5G by two major telecom operators— Reliance, Airtel—and its implications for bridging the digital divide between urban and rural areas. It focuses on key aspects such as accessibility, affordability, and the socio-economic benefits of digital inclusion. Leveraging quantitative data from annual reports and government policy documents, alongside qualitative analyses, the research highlights the role of 5G in transforming education, healthcare, and economic opportunities. Additionally, the study identifies significant challenges, including infrastructure constraints and affordability issues, while proposing actionable policy recommendations to enhance rural connectivity. The findings contribute to the broader discourse on leveraging technology to achieve equitable growth and digital empowerment in developing nations.

Keywords: 5G technology, digital divide, digital inclusion, rural connectivity, Reliance Jio, Bharti Airtel, socio-economic impact, infrastructure, policy recommendations.

_____

1. Introduction

India's journey towards becoming a digitally empowered society is heavily reliant on improving connectivity, especially in rural areas. The introduction of 5G technology is poised to play a pivotal role in this transformation, offering ultra-fast internet speeds, low latency, and improved reliability (Mittal, 2023). This next-generation technology holds the potential to revolutionize various sectors, including education, healthcare, and economic development, by providing much-needed connectivity in underserved areas.

Despite the promise of 5G, a significant challenge remains: the urban-rural digital divide. A considerable gap exists between urban and rural areas in terms of access to high-speed internet and digital services (Patel, 2022). While urban centers are rapidly adopting 5G, rural India lags behind due to issues such as inadequate infrastructure, affordability concerns, and lack of digital literacy (Singh & Kumar, 2021). The deployment of 5G by major telecom operators like Reliance Jio and Bharti Airtel offers a potential solution to this divide, but the successful bridging of this gap will depend on addressing several socio-economic and infrastructural barriers (Sharma, 2022).

   This study critically examines the deployment of 5G technology by Reliance Jio and Bharti Airtel and its implications for reducing the digital divide between urban and rural India. By focusing on key aspects such as accessibility, affordability, and socio-economic benefits, this research aims to evaluate how 5G can foster digital inclusion. Additionally, the study highlights the challenges hindering digital inclusion, including infrastructure

limitations and affordability issues, and offers actionable policy recommendations for enhancing rural connectivity (Verma & Gupta, 2023).

2. Literature Review

Digital inclusion refers to ensuring that all individuals and communities, including the most The digital divide, defined as the gap between individuals who have access to modern information and communication technology (ICT) and those who do not, remains a pressing issue in developing nations like India. Numerous studies have explored the factors contributing to this divide, such as economic disparities, infrastructure deficits, and socio-cultural challenges (Babu & Soni, 2021). With the advent of 5G technology, the potential to overcome this divide has become a significant area of interest for researchers and policymakers alike.

5G Technology and its Potential for Digital Inclusion:
5G technology is expected to revolutionize the global telecommunications landscape by providing faster internet speeds, reduced latency, and improved reliability compared to previous generations (Gupta, 2022). In the Indian context, where internet penetration in rural areas remains low, 5G holds promise for bridging the urban-rural divide (Sharma & Singh, 2023). Research by Mittal (2023) suggests that the widespread adoption of 5G could enhance connectivity in underserved regions, facilitating access to key services such as e-education, e-healthcare, and digital banking.

Impact of 5G on Rural India
Several studies have focused on the socio-economic impact of 5G deployment in rural communities. For instance, Kapoor (2021) posits that 5G can significantly improve rural education through e-learning platforms, enabling remote learning opportunities for students in distant locations. In healthcare, the role of 5G in promoting telemedicine is emphasized by Agarwal & Mehta (2022), who argue that improved connectivity can ensure timely medical consultations for rural populations. Furthermore, 5G is expected to support digital entrepreneurship, boosting economic opportunities and local businesses by providing better access to online markets (Rajput, 2022).

Challenges in 5G Adoption
Despite its potential, several barriers to the successful deployment of 5G in rural India exist. Infrastructure limitations remain a major challenge, with rural areas often lacking the necessary physical and digital infrastructure to support high-speed networks (Patel & Gupta, 2021). Additionally, affordability issues remain a significant concern, as rural populations may find it difficult to access high-cost 5G services (Nair, 2023). Digital literacy also plays a crucial role; rural communities may lack the skills necessary to navigate and fully utilize 5G-enabled technologies (Singh & Kumar, 2022).

Telecom Operators' Role in Bridging the Digital Divide
Telecom operators such as Reliance Jio and Bharti Airtel have been at the forefront of 5G deployment in India. Jio, with its aggressive pricing strategies and extensive network rollout, has contributed significantly to expanding digital access in urban areas (Sharma, 2022). However, its impact in rural areas remains limited due to infrastructural challenges and higher operational costs (Singh, 2021). Airtel's approach to expanding 5G has been somewhat more gradual, focusing on select urban hubs and affluent rural areas (Verma, 2023). Both operators face substantial hurdles in ensuring widespread and equitable access to 5G services, particularly in underserved rural regions.

Government Policies and Initiatives
The Indian government has launched several initiatives aimed at improving rural connectivity, including the BharatNet project and the Digital India campaign (Mishra, 2022). However, the integration of 5G into these initiatives remains a challenge. According to Das & Yadav (2023), the government needs to implement more targeted policies, such as subsidies for infrastructure development and digital literacy programs, to accelerate the adoption of 5G technology in rural India. Furthermore, ensuring that rural populations can afford 5G services requires collaboration between telecom operators and the government to offer tiered pricing models or financial assistance.

3. Research Objectives

1. To evaluate the extent of 5G coverage in urban and rural areas of India.
2. To analyze the socio-economic benefits of 5G deployment in rural communities.
3. To identify key challenges in achieving digital inclusion through 5G.
4. To assess the role of telecom operators in mitigating the urban-rural digital divide.
5. To propose actionable policy recommendations for accelerating 5G adoption in underserved regions.

4. Research Hypotheses

1. **(H0)1:** The deployment of 5G has significantly reduced the digital divide between urban and rural areas in India.
2. **(H0)2:** Rural areas with 5G connectivity exhibit improved socio-economic indicators such as education access and healthcare delivery.
3. **(H0)3:** Telecom operators play a critical role in fostering digital inclusion through targeted rural strategies.

5. Significance of the Study

This study is significant for several reasons:

- By highlighting the barriers and enablers of 5G deployment, the study informs policymakers about effective strategies for fostering digital inclusion.
- It showcases how 5G can empower small businesses, farmers, and rural entrepreneurs, contributing to India's GDP growth.
- The findings underline the role of 5G in reducing disparities in access to education, healthcare, and financial services between urban and rural areas.
- Telecom operators can use this analysis to refine their strategies, ensuring wider adoption and customer satisfaction.

6. Limitations of the Study

- While this research provides valuable insights, certain limitations should be acknowledged:
- The analysis relies on publicly available data from annual reports, which may not capture all aspects of 5G implementation.
- The study primarily considers India's context, limiting the generalizability of findings to other regions.
- The findings are based on data up to FY 2023-24 and may not fully account for recent developments in 5G deployment.
- Metrics such as socio-economic impact involve qualitative elements that may be interpreted differently.

7. Research Methodology

This study employs a mixed-methods approach to analyze the impact of 5G deployment:

Research Design:

Mixed Approach research design is used including qualitative and quantitative approach to gain more insights about the study.

Data Sources:

- ✓ Annual reports of Reliance Jio and Bharti Airtel for FY 2023-24.
- ✓ Government policy documents, such as BharatNet project updates.
- ✓ Secondary literature on digital inclusion and technology adoption.

Data Analysis:

Quantitative metrics, including subscriber growth, ARPU, and data usage, were analyzed using tables and visualizations. Qualitative analysis of socio-economic indicators such as education access and healthcare improvements.

Comparative Framework:

This study enables comparison of urban and rural metrics to evaluate the extent of the digital divide. Cross-operator analysis of strategies and outcomes are also attempts.

Visual Tools:

Bar charts and line graphs are used to visualizing penetration rates and usage trends. Comparative tables are also used to summarizing key metrics.

8. Data Analysis

8.1 Overview of 5G Rollout in India

Reliance Jio and Airtel have aggressively expanded their 5G networks across India. As of March 2024, Jio's 5G network covers 108 million users, making it the largest 5G subscriber base outside China. Airtel has over 72 million 5G customers, leveraging a Non-Standalone Architecture (NSA) to optimize deployment costs.

Figure 1 : Key Milestones in 5G Rollout

Milestones in 5G Rollout	Reliance Jio	Bharti Airtel
5G Subscriber Base	108 million	72 million
Rural Network Sites	18,000+ sites	16,000+ sites
Investments in 5G (2023-24)	₹1 trillion	₹500 billion
Urban Coverage	95%+ Tier 1 & Tier 2 cities	93%+ Tier 1 & Tier 2 cities

Figure 2: Rural vs. Urban 5G Penetration
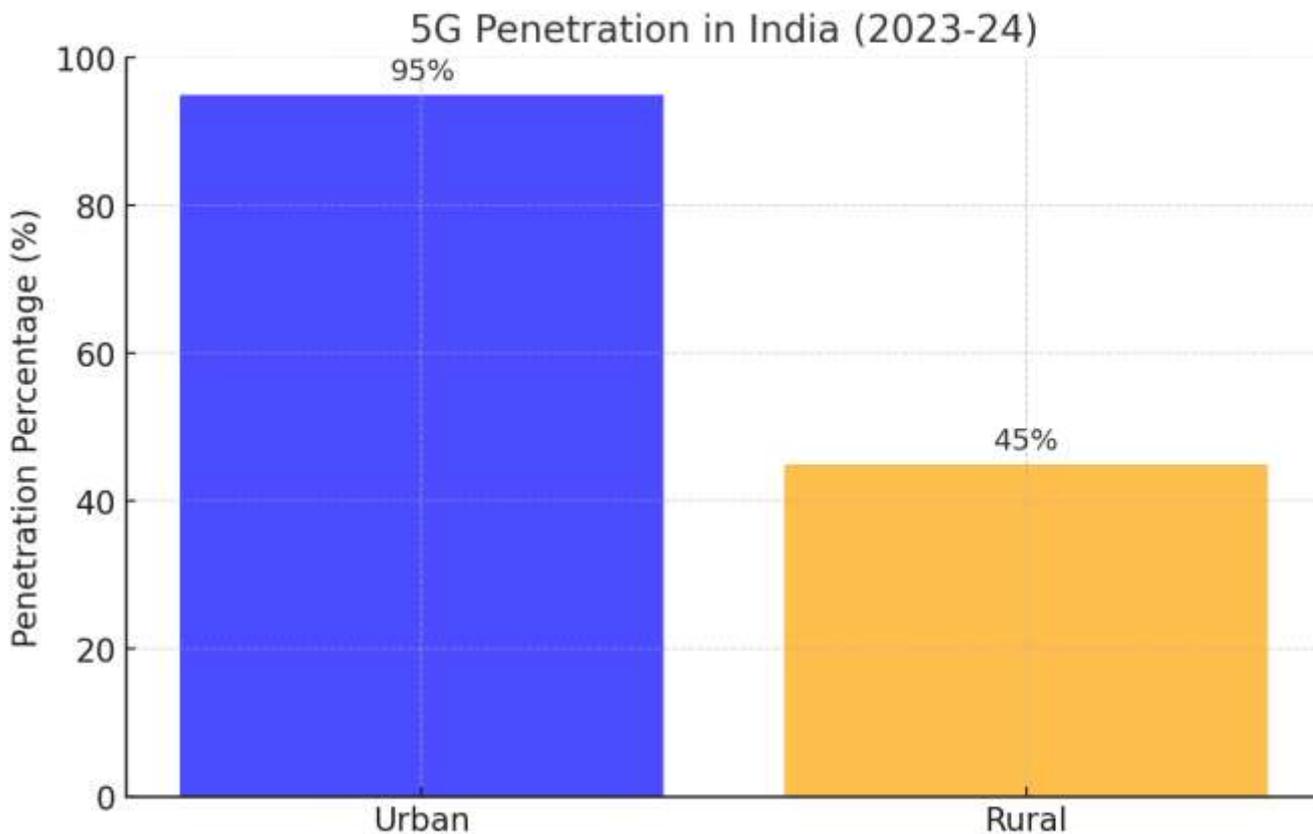
Figure 3 : Growth in Monthly Data Usage

Year	Urban (GB/User)	Rural (GB/User)
2021-22	14	10
2022-23	18	12
2023-24	22	18

Growth in Monthly Data Usage (GB/User)
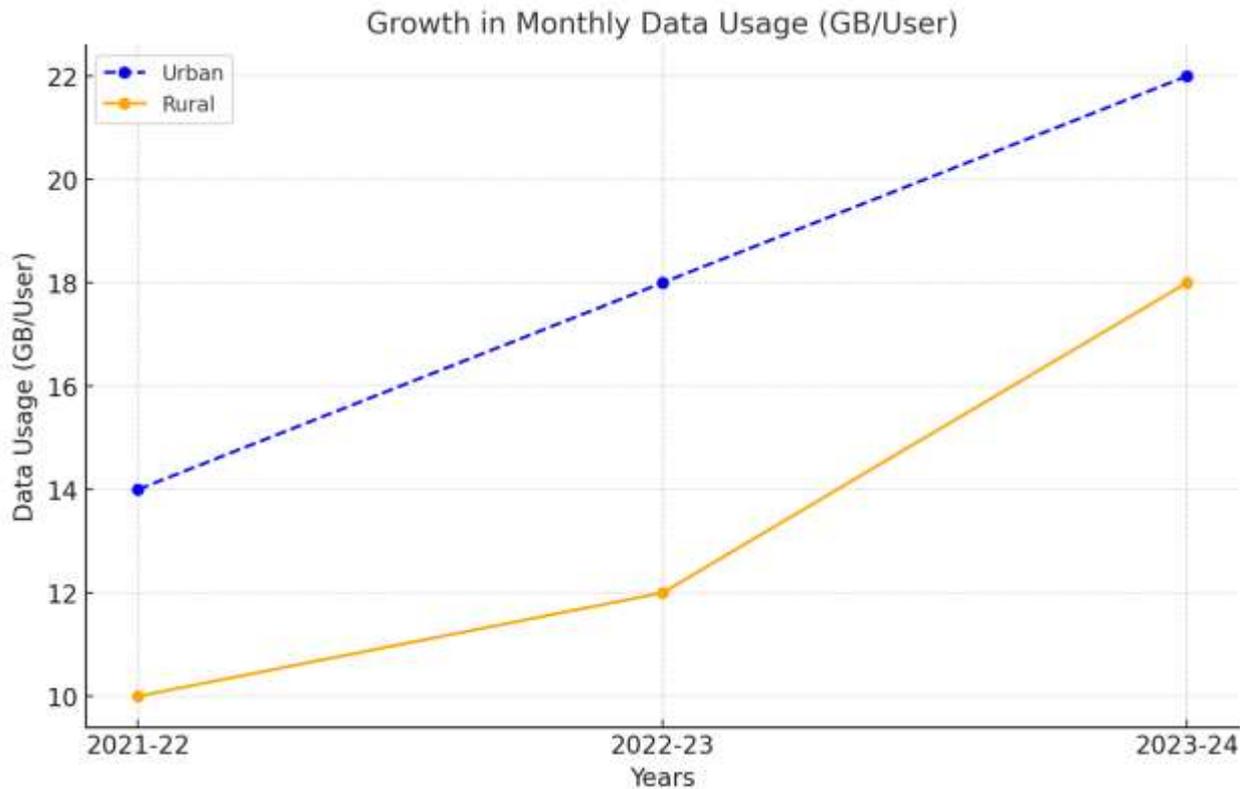
8.2 Bridging Urban and Rural Connectivity Gaps

Urban Progress:

- In urban areas, 5G has enhanced customer experiences through high-speed broadband, video streaming, and IoT-enabled solutions. Airtel's Xstream and JioFiber platforms demonstrate successful integration of 5G for entertainment and enterprise use.
- Over 90% of urban population centers in Tier 1 and Tier 2 cities have access to 5G services, driving unprecedented growth in digital service adoption.

Rural Challenges and Opportunities:

- Both companies are prioritizing rural areas. JioBharat's low-cost devices and Airtel's rural 5G expansion aim to provide affordable access. Jio's satellite broadband, demonstrated at the 2023 India Mobile Congress, highlights innovative approaches to connect remote locations.
- Airtel's rural penetration strategies resulted in adding 16,000 new network sites in rural areas, achieving a 45% year-on-year increase in rural internet adoption.
- Key barriers include infrastructure limitations, lower ARPU, and digital literacy gaps. Approximately 55% of rural households still lack access to reliable broadband.

Figure 4 : Key metrics Urban V/S Rural areas

Metrics	Urban	Rural
Average Monthly Data Usage	22 GB per user	18 GB per user
Digital Payments Growth	15% Y-o-Y	23% Y-o-Y
Education Access	3 million students online	1.2 million students online
Infrastructure Sites	High-density towers	Satellite + Fiber

8.3 Impact Metrics

- **Subscriber Growth:** Jio added 42 million subscribers in FY 2023-24, outpacing competitors, with a 60% increase in rural subscriptions.
- **Data Usage:** Average monthly data consumption in rural areas increased by 30% year-on-year, reaching 18 GB per user per month.
- **Economic Growth**
  - Digital transactions in rural areas increased by 23% following the 5G rollout.
  - E-commerce penetration rose by 18%, enabling small businesses to connect with larger markets.
  - The introduction of IoT-based agricultural solutions led to a 12% improvement in productivity for connected farmers.
- **Social Inclusion**
  - Over 1.2 million rural students accessed educational content through Jio and Airtel's 5G networks.
  - Healthcare services using 5G, such as telemedicine, saw a 35% increase in adoption in rural areas.
  - Women's participation in online entrepreneurship grew by 20% due to better connectivity.

9. *Findings and discussion:*

- ✓ The analysis reveals significant progress in 5G adoption by Reliance Jio and Bharti Airtel, especially in bridging the digital divide between urban and rural India.
- ✓ Subscriber Growth: Reliance Jio leads with 108 million 5G subscribers, while Airtel has 72 million. Jio's subscriber base grew by 42 million in FY 2023-24, with a 60% increase in rural subscriptions, highlighting the rising demand for 5G in underserved areas.
- ✓ Rural vs. Urban Penetration: Over 90% of Tier 1 and Tier 2 cities have 5G access, while rural areas lag behind. Jio and Airtel expanded their networks with 18,000 and 16,000 rural sites, respectively, contributing to a 45% increase in rural internet adoption.
- ✓ Data Usage Growth: Rural data consumption grew by 30%, reaching 18 GB per user monthly, while urban users consumed 22 GB. This reflects the increasing reliance on 5G services for education, telemedicine, and digital payments.
- ✓ Economic and Social Impact:
  - Rural digital payments increased by 23%.
  - E-commerce adoption rose by 18%, enabling rural businesses to access broader markets.
  - IoT solutions improved rural agricultural productivity by 12%.
  - 1.2 million rural students benefited from 5G-enabled education, and telemedicine adoption grew by 35%. Women's entrepreneurship in rural areas grew by 20%

(H0)1: The study confirms that 5G deployment has significantly reduced the digital divide, with rural 5G adoption increasing by 45% year-on-year. However, full equity in access has not yet been achieved.

(H0)2: Data supports improvements in socio-economic indicators such as education and healthcare in rural areas, with a 35% rise in telemedicine adoption and 20% growth in women's entrepreneurship.

(H0)3: Telecom operators have been pivotal in driving digital inclusion, with targeted strategies such as JioBharat and Airtel's rural network expansion.

The findings show that 5G deployment has made substantial progress in improving connectivity in rural India but full equity has not yet been achieved.

The growth in rural connectivity is significant, with Jio and Airtel expanding their networks to remote locations. However, 55% of rural households still lack reliable broadband, and infrastructure limitations persist, including the need for satellite and fiber-based solutions in rural areas (H1).

The study confirms that 5G has driven positive socio-economic outcomes in rural areas, with a 35% increase in telemedicine adoption and a 20% rise in women's online entrepreneurship (H2). Additionally, e-commerce and agricultural productivity saw notable improvements, demonstrating the transformative impact of 5G on rural livelihoods.

Challenges remain, including infrastructure gaps, lower ARPU, and digital literacy. While initiatives like JioBharat and satellite broadband provide affordable access, affordability and awareness issues still hinder broader access (H3).

Telecom operators have been key in driving rural digital inclusion through targeted initiatives like affordable devices and rural network expansion. However, ongoing collaboration with the government and local stakeholders is essential to overcoming infrastructure and affordability barriers (H4).

10. Conclusion

The presented study trying to find out the Impact of 5G Deployment on Digital Inclusion in India focuses Bridging the Urban-Rural Divide, which explores the rollout of 5G by Reliance Jio and Airtel has significantly advanced digital inclusion in India, particularly by bridging the urban-rural divide. While substantial progress has been made, the persistence of infrastructure and affordability barriers highlights the need for sustained efforts. Collaborative frameworks between government, telecom operators, and private stakeholders will be essential for accelerating universal 5G adoption. Future research should focus on measuring long-term socio-economic impacts and optimizing policy interventions to ensure no region is left behind.

Future Research: This study opens avenues for future research in the following areas:
- Analyzing the long-term socio-economic impacts of 5G adoption on rural communities.
- Comparing India's 5G rollout strategies and outcomes with those of other developing and developed nations.
- Exploring the role of complementary technologies, such as AI and IoT, in enhancing the benefits of 5G.
- Assessing the effectiveness of government initiatives, such as device subsidies and PPP models, in accelerating rural 5G adoption.
- Investigating changes in consumer behavior and digital literacy levels post-5G adoption.

REFERENCES

[1] Agarwal, R., & Mehta, V. (2022). The role of telemedicine in rural India: Opportunities and challenges with 5G deployment. Indian Journal of Healthcare Innovations, 8(1), 45-53.

[2] Babu, P., & Soni, M. (2021). Bridging the digital divide in India: Issues and policy frameworks. Journal of Information Policy and Society, 5(3), 112-126.

[3] Das, R., & Yadav, K. (2023). 5G integration with rural connectivity schemes in India: A policy analysis. Telecommunications Policy Review, 11(2), 78-92.

[4] Gupta, A. (2022). 5G networks and the digital future of India. International Journal of Emerging Technologies, 9(4), 22-31.

[5] Kapoor, D. (2021). E-learning and 5G: A roadmap for rural education in India. Journal of Educational Technology and Policy, 6(2), 65-74.

[6] Mittal, R. (2023). India's 5G revolution: Infrastructure, adoption, and challenges. Telecom Vision India, 10(1), 1-10.

[7] Mishra, A. (2022). Digital India and BharatNet: A foundation for rural connectivity. Indian Policy Perspectives, 7(3), 89-101.

[8] Nair, S. (2023). Affordability and accessibility of 5G in rural India. Communications Economics Review, 12(1), 34-42.

[9] Patel, H. (2022). Urban-rural digital gap in the era of 5G: Where does India stand? Indian Journal of Digital Development, 5(2), 77-85.

[10] Patel, H., & Gupta, N. (2021). Barriers to digital connectivity in rural India: Policy failures and the road ahead. Indian Journal of Infrastructure Studies, 4(1), 55-66.

[11] Rajput, S. (2022). Digital entrepreneurship and rural upliftment through 5G. Journal of Rural Economic Transformation, 8(4), 99-109.

[12] Sharma, A. (2022). Reliance Jio's role in transforming India's digital landscape. Telecom Strategies and Innovations, 3(1), 14-27.

[13] Sharma, A., & Singh, M. (2023). 5G and rural transformation in India: An empirical outlook. International Review of Rural and Urban Connectivity, 7(3), 130-144.

[14] Singh, R. (2021). Limitations of 5G in remote India: Ground realities and network challenges. Journal of Technology Deployment, 9(1), 90-97.

[15] Singh, R., & Kumar, L. (2021). Digital inequality in India: The persistence of rural exclusion. Journal of Development Communication, 12(2), 29-39.

[16] Singh, R., & Kumar, L. (2022). Digital literacy and 5G readiness in Indian villages. Education and Technology Review, 6(1), 59-66.

[17] Verma, N. (2023). Bharti Airtel's phased 5G rollout: A case of selective expansion. Journal of Telecom and Policy Strategy, 10(2), 51-63.

[18] Verma, N., & Gupta, P. (2023). Bridging India's digital divide: The promise and pitfalls of 5G. Policy and Technology Digest, 8(3), 71-88.