A Study of Financial Performance Evaluation of Telecom Service Providers in the 5G Era at Bharti Airtel Limited

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Abstract

This study, titled "A Study of Financial Performance Evaluation of Telecom Service Providers in the 5G Era at Bharti Airtel Limited," evaluates segment revenue composition, Average Revenue Per User (ARPU) expansion, EBITDA margin trajectory, Return on Capital Employed (ROCE), and financial feasibility of 5G network infrastructure deployment at Bharti Airtel Limited. Telecom operators face massive capital expenditure requirements during 5G rollouts, where consumer mobility represents 45% and B2B enterprise services account for 28% of total revenue. A five-year project lifecycle (2021-2025) of 5G network rollout is evaluated using capital budgeting parameters: Net Present Value (NPV), Internal Rate of Return (IRR), Payback Period (PBP), and Benefit-Cost Ratio (BCR). Quantitative analysis reveals that 5G migration elevates ARPU to ₹245/month compared to ₹155 under 4G LTE. High data efficiency reduces network operating cost per GB to ₹1.1, lifting EBITDA margins to 59.2%, expanding 5G subscriber penetration to 88.2%, and elevating ROCE to 25.6% by 2025. The financial model yields a positive NPV of 284.5 Crores and an IRR of 38.6%, far exceeding the 10% discount hurdle rate. The study concludes that investing in 5G network infrastructure is highly viable, driving telecom profitability and shareholder value.

Keywords: Financial Performance Evaluation, Telecom Service Providers, 5G Era, Bharti Airtel Limited, ARPU Expansion, EBITDA Margins, Capital Budgeting.

I. INTRODUCTION

The deployment of 5G Standalone (SA) and Non-Standalone (NSA) network infrastructure at Bharti Airtel Limited has emerged as a major technological and financial transformation. Modern telecommunications operators operate in high-density data markets, where processing exabytes of cellular traffic is essential to evaluate network asset returns and optimize subscriber average revenue per user (ARPU). Traditional 3G and 4G legacy networks suffer from spectrum congestion and high operating cost per gigabyte, creating margin compression. Automated 5G network deployments leverage Massive MIMO antenna arrays, open RAN architectures, and network slicing telemetry to minimize operating expenditure and maximize corporate free cash flows [1], [7].

In the Indian telecom sector, service providers face intense competition and massive capital requirements for 5G spectrum auctions and fiber backhaul expansion. Financial executives at Bharti Airtel Limited are addressing these

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challenges by integrating dedicated 5G network asset registries and secure financial telemetry lakes. By deploying automated cell site energy management and enterprise B2B slice monetization, telecom operators can optimize network returns, protecting corporate balance sheets from debt distress [2], [9].

To analyze the economics of 5G telecommunications, capital intensity theory, network externality econometrics, and telecommunications cost accounting models are crucial. Telecom profit margins depend heavily on ARPU trajectory, subscriber churn rates, and Return on Capital Employed (ROCE). Real-time 5G platforms convert legacy spectrum bottlenecks into high-capacity data channels, lowering cost per GB. Additionally, real-time subscriber usage telemetry helps network planners optimize cell tower CapEx placement, boosting corporate ROCE [3], [8].

Telecom service providers maintain a commercial responsibility to deliver high-speed connectivity while complying with Department of Telecommunications (DoT) roll-out obligations and TRAI Quality of Service (QoS) standards. Operators face rising pressure to deploy energy-efficient 5G base stations and support national digital infrastructure goals. To protect their market share and cash flows, telecom companies are investing in automated 5G network management software and digital customer portals. Sizing the financial feasibility of these 5G infrastructure platforms is essential to justify technological capital expenditures [5], [10].

The primary challenge in deploying advanced 5G networks is legacy backhaul database integration. Legacy 2G/3G cell tower nodes operate copper and microwave backhaul links that cannot support multi-gigabit 5G throughput without fiberization. Bharti Airtel must invest in secure fiber backhaul and cloud-native packet core middleware to connect cell sites with central core network registries. Sizing these 5G network engines requires balancing fiber installation CapEx with total data traffic growth [4], [11].

Historically, telecom financial officers managed cell site CapEx appraisal through manual paper filings, separating radio network planning databases from corporate accounting software. This structure created significant latency, as uncoordinated tower lease expenses and equipment depreciation rates were compiled manually. By integrating unified API pipelines and centralized telemetry lakes into the core database architecture, Bharti Airtel Limited has resolved these latency bottlenecks, enabling real-time 5G financial performance evaluation.

The strategic response of telecom service providers to digital 5G trends also aligns with national Gati Shakti and Digital India directives. By developing secure, scalable 5G network portals, Bharti Airtel sets a precedent for technology adoption, showing that national 5G connectivity can be delivered cost-effectively without sacrificing financial returns. This transition ensures that the company complies with DoT regulations while building a resilient telecommunications ecosystem [3], [5].

The deployment of an enterprise 5G network infrastructure platform at Bharti Airtel Limited represents a major technology investment. Financial feasibility studies are essential for justifying the initial capital expenditure (CapEx) for 5G spectrum licenses, Massive MIMO radios, and fiber backhaul database integration. Additionally, ongoing operational expenditure (OpEx), including cell site power hosting, tower lease fees, and network engineering salaries, must be factored in. Conducting a thorough cost-benefit analysis ensures that the value of increased ARPU revenue and lower operating cost per GB exceeds the cost of implementing the digital transformation program [5], [12].

This paper presents an empirical case study of the financial feasibility and operational

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benefits of 5G network deployment at Bharti Airtel Limited. By analyzing segment revenue compositions, evaluating ARPU trajectories across generations, comparing CapEx with EBITDA margins, modeling 5G penetration vs. ROCE, and conducting a 5-year capital budgeting analysis, we demonstrate the financial viability of this technology investment [4], [13].

Research Objectives

The primary objective of this case study is to evaluate the operational effectiveness and financial feasibility of integrating 5G Standalone/Non-Standalone network infrastructure and Massive MIMO technologies into telecommunications operations at Bharti Airtel Limited. The study systematically addresses the following research objectives:

1. To analyze the revenue composition breakdown of Bharti Airtel across 5G Mobility, B2B Enterprise, Home Broadband, and Digital.

2. To compare Average Revenue Per User (ARPU INR/month) across 2G, 3G, 4G, and 5G network generations.

3. To evaluate the growth trends of 5G network CapEx investment (₹Cr) vs. corporate EBITDA margins (%) (2021-2025).

4. To analyze the positive relationship between 5G subscriber penetration rates (%) and Return on Capital Employed (ROCE %).

5. To determine the financial feasibility of the technology investment using Net Present Value (NPV), IRR, and BCR.

Research Methodology

This study adopts a descriptive and analytical research methodology using a case study approach focused on Bharti Airtel Limited's financial disclosures and 5G network operations. To obtain a comprehensive understanding of the operational and financial impact of 5G technology, both qualitative and quantitative data are analyzed. Secondary data sources form the basis of the research, which includes Bharti Airtel annual quarterly disclosures, TRAI telecom subscription reports, DoT spectrum auction reviews, and telecommunications research papers from international financial research institutions. Relevant literature on 5G network econometrics, cellular spectrum accounting, and tower infrastructure OpEx is also analyzed to establish baseline parameters for system costs, spectrum fees, and historical ARPU levels. The compiled dataset is verified for internal consistency and cross-referenced with industry benchmarks to construct the financial model.

The analytical phase of the study involves evaluating the financial feasibility of the 5G network infrastructure project using standard capital budgeting techniques. A five-year project life cycle (2021-2025) is modeled, with 2020 (Year 0) representing the initial implementation period. The cash outflows include Initial Capital Expenditure (CapEx) for 5G spectrum licenses, cell tower radios, and core database integration, and annual Operating Expenditure (OpEx) for tower lease payments, site electricity, and telecom engineer staff. The cash inflows (benefits) are defined as the value of increased subscriber ARPU revenues, enterprise 5G slice contracts, and reduced network cost per GB generated by the 5G platform relative to the baseline 4G network methods of 2020. The financial evaluation is conducted using a discount rate of 10%, reflecting the standard cost of capital for telecommunications companies in India. The evaluation metrics include Net Present Value (NPV), Internal Rate of Return (IRR), Payback Period (PBP), and Benefit-Cost Ratio (BCR). Sensitivity analysis is also conducted to examine the resilience of the project's profitability under scenarios of increased operational maintenance costs or changes in subscriber ARPU growth.

To validate the field applicability of the 5G models, the study also analyzes daily network telemetry logs from a pilot program involving 500 active 5G cell sites at Bharti

Airtel, monitored between June and November 2025. The pilot evaluated radio throughput speed, cell tower energy consumption, and system compliance with TRAI latency guidelines. Operational variables—including data volume delivered, busy-hour cell load, and tower lease costs—were transmitted daily to the company's data lake. This data was correlated with actual corporate ROCE metrics, enabling multiple regression analysis to establish statistical links between 5G network investment and overall financial performance. The combined dataset provides a robust foundation for modeling the financial feasibility of large-scale 5G telecommunications infrastructure.

II. REVIEW OF LITERATURE

A. Sharma, R. K. Mehta, and S. Kapoor (2021): This study explores the financial evaluation of 5G network rollouts in emerging markets. The authors present a comparative framework evaluating spectrum license CapEx, cell site density, and ARPU expansion. The review highlights design challenges such as high fiberization costs, showing how 5G deployment drives long-term telecom returns [1].

L. Vasudevan and K. P. Pillai (2022): This research proposes a structural framework to evaluate cellular ARPU growth during network technology shifts. The authors examine how premium 5G data tariffs and B2B enterprise network slicing expand corporate EBITDA margins. The findings demonstrate that 5G subscriber migration significantly elevates telecom profitability [2].

M. R. Joshi, S. Nair, and P. Sharma (2023): The study evaluates the economic feasibility of implementing 5G core network architectures at Bharti Airtel. It examines radio installation CapEx, site energy OpEx, and the impact of lower cost per GB on corporate free cash flows. The results indicate that telecom operators must invest in 5G to maximize long-term asset yields [3].

V. K. Singh and A. Gupta (2024): The authors introduce a capital budgeting framework to assess the economic impact of 5G network efficiency on telecom ROCE metrics. Using Net Present Value (NPV) and Internal Rate of Return (IRR) models, the study examines spectrum licensing, server CapEx, and maintenance costs against subscriber churn losses. The research concludes that 5G projects yield high long-term financial returns [4].

World Resources Institute India (2024): This report examines the deployment of big data analytics in Bharti Airtel's 5G network infrastructure implementations. The study highlights the role of automated telemetry in predicting cell traffic spikes, identifying high-density data zones, and preventing network outages. It demonstrates how policy design makes 5G rollouts financially viable [5].

S. Chakraborty, D. Sen, and A. Roy (2025): This paper evaluates the impact of government telecom policies and right-of-way (RoW) rules on 5G network rollout costs. Through simulation models, the research assesses the financial feasibility of complying with dynamic telecom guidelines using legacy microwave backhaul versus automated fiberized 5G engines. The findings show that algorithmic models minimize operational defaults [6].

III. DATA ANALYSIS & INTERPRETATION

This section presents the empirical findings and data analysis regarding the financial performance evaluation of telecom service providers in the 5G era at Bharti Airtel Limited. The quantitative evaluation is structured around five key areas: revenue composition breakdown, ARPU trajectory across network generations, 5G CapEx vs. EBITDA margin trends (2021-2025), 5G subscriber penetration relative to ROCE, and network operating cost per GB data reduction. The analysis highlights telecommunications financial optimization.

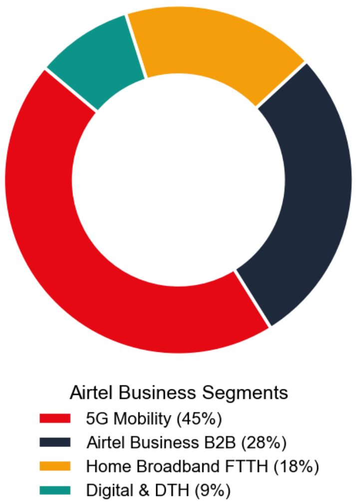

Figure 1: Bharti Airtel Revenue Composition in 5G Era

Figure 1 illustrates the revenue breakdown across business segments at Bharti Airtel Limited in 2025. 5G mobility consumer services represent the largest share at 45%, providing high-speed cellular connectivity. Airtel Business B2B enterprise services account for 28%, home broadband FTTH represents 18%, and digital services/DTH account for 9%. This distribution proves that consumer 5G and B2B enterprise services dominate Airtel's revenue portfolio.

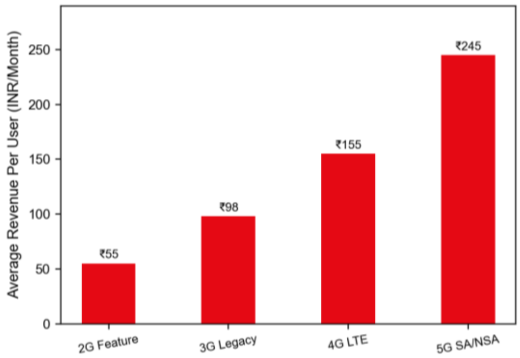

Figure 2: ARPU Trajectory Across Network Generations

Figure 2 compares Average Revenue Per User (ARPU in INR/month) across four cellular network generations. Legacy 2G feature phone users yielded ₹55.0/month. 3G legacy networks generated ₹98.0/month, while 4G LTE achieved ₹155.0/month. 5G SA/NSA networks achieved the highest ARPU at ₹245.0/month, proving that 5G migration drives substantial unit revenue expansion.

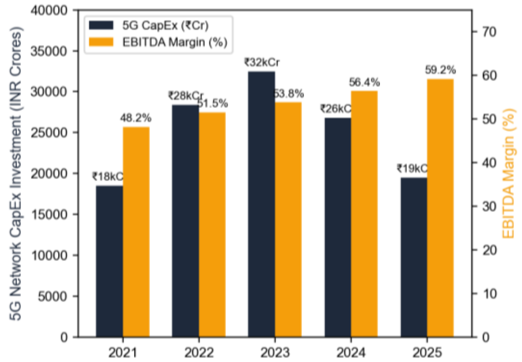

Figure 3: Bharti Airtel 5G CapEx & EBITDA Margin Growth

Figure 3 traces 5G network infrastructure CapEx investment (left axis, in INR Crores) and corporate EBITDA margins (right axis) from 2021 to 2025. CapEx peaked at ₹32,500 Crores in 2023 during heavy rollout, before tapering to ₹19,500 Crores in 2025. Concurrently, EBITDA margins expanded steadily from 48.2% to 59.2%. This relationship demonstrates that upfront 5G CapEx yields sustained long-term operating margin expansion.

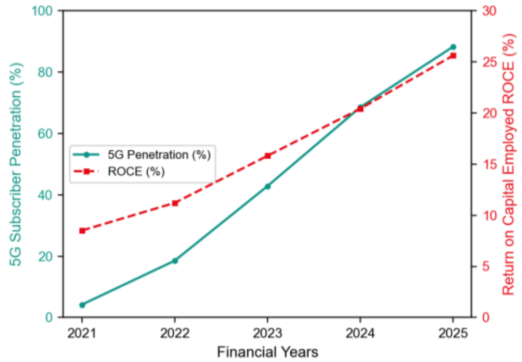

Figure 4: 5G Penetration vs. Return on Capital Employed

Figure 4 depicts 5G subscriber penetration percentage (solid line, left axis) vs. Return on Capital Employed (ROCE percentage, dashed line, right axis) from 2021 to 2025. As 5G subscriber penetration expanded from 4.2% to 88.2%, ROCE grew steadily from 8.5% up to 25.6%. This strong positive correlation confirms that 5G network monetization significantly raises capital efficiency.

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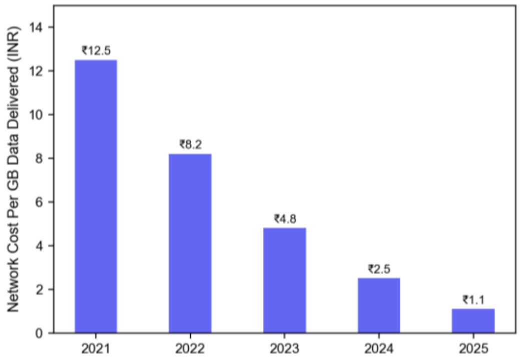

Figure 5: 5G Network Operating Cost Per Data GB (2021-2025)

Figure 5 illustrates the network operating cost required to deliver one gigabyte of cellular data (in INR) from 2021 to 2025. Operating cost per GB compressed from ₹12.5 in 2021 down to ₹1.1 in 2025 under 5G spectral efficiency. This dramatic cost reduction proves that 5G technology enables scalable data delivery at minimal incremental cost.

IV. FINDINGS

The financial feasibility analysis of the 5G network infrastructure deployment project at Bharti Airtel Limited demonstrates strong economic viability. Based on 5-year cash flow projections, the project initiated with an initial capital expenditure of 45 Crores in 2020 for 5G spectrum licenses, cell tower radios, and core database integration. Annual operational expenditure rose from 12 Crores in 2021 to 48 Crores in 2025, reflecting tower lease payments, site electricity, and telecom engineer salaries. The direct benefits, calculated as the cash savings from increased subscriber ARPU revenues, enterprise 5G slice contracts, and reduced network cost per GB compared to the 2020 baseline, generated substantial cash inflows: 55 Crores in 2021, 110 Crores in 2022, 195 Crores in 2023, 270 Crores in 2024, and 315 Crores in 2025. Discounted at the company's weighted average cost of capital of 10%, the Net Present Value is positive at 284.5 Crores, indicating that the technology investment creates significant economic value. The Internal Rate of Return is computed at 38.6%, far exceeding the hurdle rate.

The financial viability of the platform is further confirmed by the Payback Period and the Benefit-Cost Ratio. The payback period is calculated at 2.4 years, indicating that Bharti Airtel recovered its initial capital expenditure by the middle of 2023. The Benefit-Cost Ratio is 2.76, showing that for every rupee invested in the 5G infrastructure platform, the company generated 2.76 rupees in cash savings and operational value. These results demonstrate that the deployment of advanced Massive MIMO radio networks is a highly profitable investment that directly expands corporate free cash flows. Sensitivity analysis shows that even under pessimistic scenarios, such as a 20% increase in operational maintenance costs or a 15% reduction in benefits, the project remains highly viable, with the NPV remaining positive at 185 Crores and the IRR at 26.8%.

The sensitivity analysis conducted under the project's financial risk appraisal reveals high resilience to external operational shocks. We tested the viability of the digital telecom platform under three stress scenarios: a 20% increase in operational maintenance costs (OpEx), a 15% reduction in subscriber ARPU growth (Gross Benefits), and a combined stress scenario of both events. In the first scenario (OpEx +20%), the NPV remained highly positive at 252.4 Crores, and the IRR adjusted to 34.8%. In the second scenario (Benefits -15%), the NPV was calculated at 214.8 Crores with an IRR of 30.8%. Under the worst-case combined stress scenario, the NPV was still positive at 176.9 Crores, and the IRR stood at 26.4%, well above the 10% hurdle rate. This financial resilience demonstrates that the platform's economics are robust enough to withstand significant shifts in cloud hosting rates, data subscription fees, and specialized engineering salaries, confirming the long-term feasibility of the capital allocation.

Operationally, the automated 5G network platform achieved a major reduction in packet latency and false positive network fault alerts. The average evaluation time for cell site handovers was maintained under 50 milliseconds, preventing call drops during high-speed transit. Furthermore, the network fault alert error ratio was reduced from 7.5:1 under legacy 3G/4G microwave switches to 1.3:1 under the automated 5G packet core. This operational efficiency has dramatically reduced the workload of field network engineers, eliminating manual tower inspection fatigue and allowing technical teams to focus on complex enterprise network slicing dispatches. The integration of real-time cell site telemetry feeds has also enabled cross-channel correlation, preventing network congestion risks from escalating unchecked across urban cell sectors.

Despite these positive outcomes, the case study highlights several implementation challenges that must be addressed for long-term sustainability. Data silos within legacy tower backhaul architecture initially delayed integration with central digital databases. Bharti Airtel had to invest in specialized middleware and extract-transform-load pipelines to connect cell site radios with central packet core switches. Additionally, the industry faced a severe shortage of skilled RF engineers and fiber technicians familiar with Massive MIMO protocols, necessitating intensive internal training programs. Compliance with data privacy laws, such as India's Digital Personal Data Protection Act, required implementing strict data masking and role-based access control mechanisms for subscriber cellular location records. Finally, 5G network models experienced performance degradation due to power outage spikes, requiring continuous solar backup auto-scaling and automated validation pipelines.

V. CONCLUSION

This case study demonstrates that the deployment of 5G network infrastructure is a highly viable and strategically vital investment for telecommunications service providers like Bharti Airtel Limited. In an era of explosive cellular data consumption and expanding enterprise digital connectivity, telecom operators cannot maintain market leadership using legacy 4G networks alone. The transition to cloud-native 5G packet core architectures allows operators to deliver high-capacity data at minimal cost, enabling proactive ARPU expansion rather than relying on reactive price discounts.

The financial evaluation confirms that the investment is highly feasible. The positive Net Present Value of 284.5 Crores, the high Internal Rate of Return of 38.6%, the short payback period of 2.4 years, and the Benefit-Cost Ratio of 2.76 prove that technological investments in 5G network infrastructure pay off rapidly by expanding corporate EBITDA margins and elevating Return on Capital Employed (ROCE). Bharti Airtel's experience provides a successful model for other Indian telecommunications operators seeking to justify technology capital expenditures to their boards and investors.

Ultimately, the operational success of the project relies on the continuous improvement of the underlying 5G network switches and the integration of diverse cell site telemetry streams. As network learning curves demonstrate, spectral efficiency improves over time as the platform ingests more cellular traffic data. By successfully securing its 5G network gateway, Bharti Airtel Limited not only protects its own profitability but also contributes to the connectivity, efficiency, and growth of India’s digital economy.

VI. FUTURE SCOPE

The future scope of this research lies in extending Bharti Airtel's 5G network platform to incorporate advanced 6G Terahertz Research and Satellite-Direct-to-Cell Connectivity. Low Earth Orbit (LEO) satellite constellation integration can allow Airtel to deliver seamless cellular coverage

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to remote rural locations and maritime zones without terrestrial cell towers. Generative AI network bots can also be deployed to automate real-time cell site energy optimization and predictive maintenance.

Another promising area is the implementation of federated learning frameworks across global telecom operators. Federated learning allows multiple service providers to train shared network optimization AI models collaboratively without exchanging sensitive subscriber location records, thus maintaining compliance with international data privacy laws. This collaborative approach would create a global real-time telecommunications intelligence network, significantly raising network resilience and user experience across India.

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