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## Impact of 5G on Techno-Economic Evolution in India

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**Abstract-** Revolutionizing India's economic landscape, this paper explores the transformative analysis of the pivotal contributions of agriculture, healthcare sectors, and the Electrical Vehicle's (EV) industry to the nation's GDP. Going beyond quantifiable metrics, it confronts the challenges hindering the seamless integration of 5G technology and proposes innovative solutions. In agriculture, the study addresses infrastructural limitations, farmer access, and affordability, augmenting insights into GVA and export statistics. In healthcare, it pioneers by unveiling challengers in 5G implementation and forecasts anticipated GDP contributions. Expanding the scope of EV industry, the analysis transcends economic considerations, shedding light on the number of EV utilizing 5G technology and presenting holistic perspectives. This research not only illuminates the economic significance of these sectors but also positions itself as a trailblazer in addressing impediments to 5G adoption, fostering innovation and sustainable growth in India.

*Keywords—5G Technology, Agritech, Healthcare, Electric Vehicles, Economical Growth*

### Introduction

5G (Fifth-generation) technology has rapidly emerged as a transformative force in telecommunications, promising to reshape data transmission with its cutting-edge features like Orthogonal Frequency Division Multiplexing (OFDM), which combines the advantages of Quadrature Amplitude Modulation (QAM) and Frequency Division Multiplexing (FDM) for high-speed communications. In the dynamic landscape of India's economic tapestry, this research delves into the integral roles played by the agricultural, healthcare sectors and EV industry in shaping the nation's GDP. Existing studies [1] have primarily focused on quantifying the contribution of the agriculture sector to India's GDP, with an emphasis on Gross Value Added (GVA) and export statistics. While these statistics are crucial indicators of the sector's economic importance, they have overlooked the critical challenges hindering the seamless integration of 5G technology into agriculture. These challenges encompass various aspects, including infrastructure limitations, limited farmers' level access to technology, and issues related to connectivity and affordability. In the landscape of healthcare research, prior studies [2] [3] have predominantly focused on the architectural aspect and applications of 5G technology. However, this research explores the challenges and also offers a unique perspective on the practical hurdles faced in real-world 5G implementation. In the context of the automobile industry, existing literature [4-6] has extensively covered the general role

of the sector contributing to the Indian GDP. While research gap emerges in the exploration of specific details related to the integration of 5G technology in EV’s. This research aims to gain insights into the intersection of EV’s, 5G technology, and their collective impact on the Indian economy. Additionally, the study delves into the challenges associated with 5G technology.

### Impact of 5G on Different Industries

#### Agriculture Sector

Agriculture plays a pivotal role in the Indian economy, contributing more than 18.3% [10] to the Indian GDP and employing 58% of the population. While India is currently experiencing a technological revolution, including the advent of 5G, many farming practices remain conventional and disconnected from technological advancements. However, the integration of technology with conventional farming practices holds the potential to revolutionize the agricultural sector. This evolution in (Fig. 1), has reached a stage known as “Agriculture 4.0”, where digital agriculture and technology converge to bring significant changes to the field.

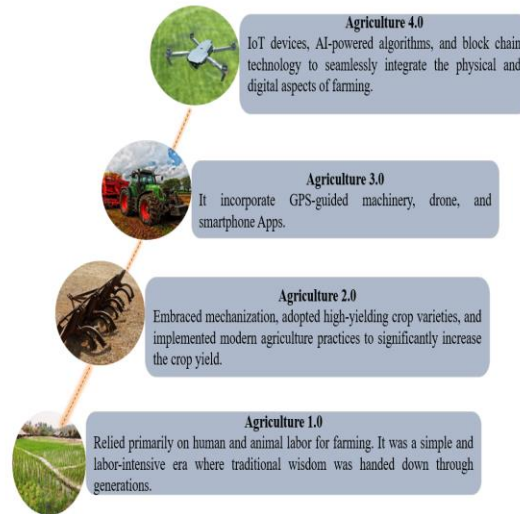
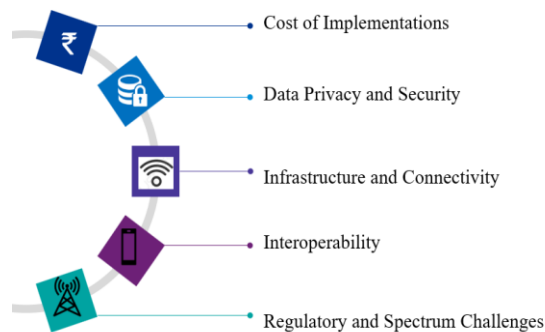


Fig. 1. Agriculture 1.0 to 4.0 evolutions

Recognizing the hurdles in Agriculture [11], the research delves into infrastructural limitations, farmer access issues, and concerns regarding affordability. These aspects collectively shape the landscape for seamless 5G integration in the agricultural sector is (Fig. 2).



**Fig. 2.**

**Challengers in Agriculture with respect to 5G technology**

Implementing 5G technology on farms involves substantial costs. This includes upgrading equipment's to be 5G-compatible, installing 5G infrastructure (base stations and towers), and providing training to farms workers to use new technologies efficiently. These costs can be a significant barrier for smaller farms and those with limited financial resources.

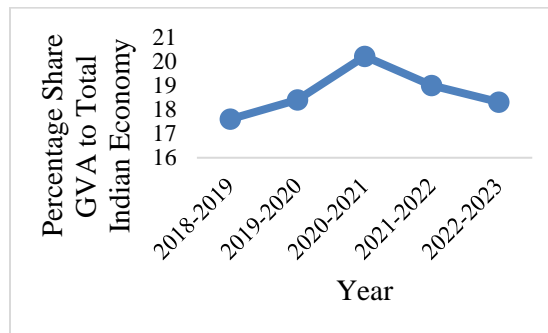
The agriculture sector generates vast amounts of sensitive data, including crop and soil information, weather data, and machinery performance. Ensuring the privacy and security of this data is critical. Unauthorized access or breaches can lead to data theft, intellectual property loss, or misuse of critical information. Implementing robust cybersecurity measures is imperative to ensure the protection of farmer's data.

Many agriculture operations are located in rural or remote areas with limited access to high-speed internet and cellular networks. The deployment of 5G infrastructure in these areas is expensive and can face logistical challenges due to the vast and often uneven terrain. Without reliable connectivity, farmers cannot fully leverage 5G's capabilities for real-time data collection, remote monitoring, and precision agriculture.

The lack of standardization in agriculture equipment and sensors, with diverse communication protocols and data formats, poses a major challenge. This lack of uniformity can hinder the seamless integration and effective management of data from various sources. Achieving interoperability is essential for maximizing the benefits of 5G technology in agriculture.

Varying spectrum allocations and regulatory frameworks for 5G networks across countries and regions create challenges. These inconsistencies, coupled with limited spectrum availability, can impede the planning and investment in 5G infrastructure for agriculture. To enable widespread adoption, it's crucial to harmonize regulations and ensure sufficient spectrum availability in the agriculture sector.

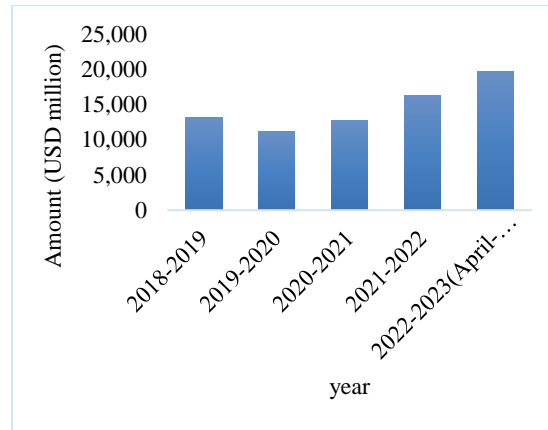
Despite the inherent challenges uncounted in integrating 5G technology into the agriculture Sector, it also plays a crucial role in the Indian economy. The sector continues to serve as a cornerstone, contributing significantly to the country's Gross Value Added (GVA). According to the data from the Ministry of Agriculture & Farmers Welfare [12] [13], the share of the GVA of agriculture and the allied sectors to the total Indian economy (Fig. 3).



**Fig. 3.**

Share of GVA of agriculture and allied sectors in total economy (%) at current prices

Furthermore, as per the Department of Commerce and Industry in India [14], the statistical data over the past five years regarding agriculture exports (Fig. 4), demonstrates a substantial contribution to India's foreign exchange earnings and reinforces its prominence in the global trade market.



**Fig. 4.**  
Export products (Agriculture)

### Health Care

The advent of 5G technology is transforming healthcare by enabling high-resolution telemedicine, reducing unnecessary clinic visits, and facilitating remote consultations for patients with limited access to medical facilities. Additionally, 5G paves the way for tele surgery, allowing doctors to assist in surgeries remotely through robotics systems. This technology aids in faster disease prediction, diagnosis, and efficient treatment while advancing preventative care and integrating AI, analytics, IoT, and robotics into healthcare. Overall, 5G is poised to create a global healthcare ecosystem that meets patient needs accurately, efficiently, conveniently, and cost-effectively, making a significant impact on healthcare worldwide.

The implementation of 5G technology in healthcare holds the potential to revolutionize the industry in several ways. Firstly, it provides high-speed data transmission, enabling real-time sharing of large medical files, which is crucial for remote consultations and telemedicine. Secondly, its low latency ensures minimal data transmission delay, vital for scenarios like remote surgeries to ensure patient safety. Thirdly, 5G enables seamless remote monitoring and telemedicine, reducing the need for frequent in-person visits. Additionally, it facilitates the use of Virtual Reality (VR) and Augmented Reality (AR) for medical training and simulations. Moreover, 5G supports IoT-enabled healthcare, enabling the monitoring of patients, equipment, and environment in real-time. Lastly, it contributes to global health equity by bringing quality healthcare services to remote and underserved areas through telemedicine and remote consultations.

While 5G technology has the potential to revolutionize healthcare in India, there are several challenges that need to be addressed for its successful implementation and adoption in the healthcare sector.

**Data privacy and Security:** Securing the sensitivity of patient data in healthcare amid the increased connectivity of 5G network is a top priority. The challenge lies in preventing potential data breaches. To address this, robust security measures are essential. These include implementing strong data encryption, multifactor authentication, and stringent access controls. Additionally, continuous security audits,

updates, and staff education on data security protocols are crucial to ensure patient information remains confidential and protected.

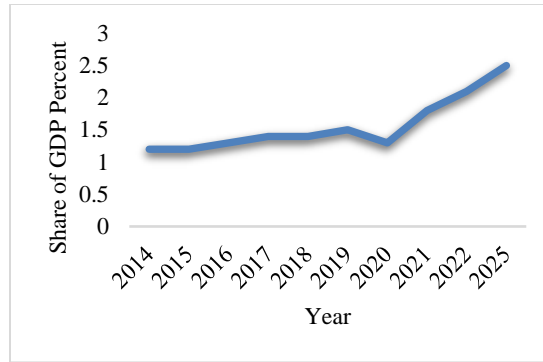
**Regulatory Approvals:** Obtaining regulatory approvals for 5G healthcare applications like telemedicine and remote surgery can be intricate and time-intensive. The challenge involves ensuring patient safety and adherence to medical guidelines. To overcome this challenge, close collaboration with regulatory authorities is key. Establishing clear communication channels and dedicating resources to streamline approval processes can expedite the adoption of innovative 5G healthcare solutions, benefiting patients and providers alike.

**Skilled Workspace:** Ensuring a skilled workspace is pivotal for the successful integration of 5G technology in healthcare. The challenges lie in having the expertise to operate and maintain new infrastructure and devices effectively. To address this, investing in comprehensive training programs and upskilling initiatives for healthcare professionals and IT staff is essential. Promoting a culture of continuous learning and collaboration between healthcare and technology experts will empower the workforce to harness the full potential of 5G, driving innovation and improved patient care.

**Economic Considerations:** Evaluating the cost-effectiveness of implementing 5G-enabled healthcare solutions is crucial. The challenge revolves around assessing the return on investment and the long-term sustainability of such initiatives. To address this, thorough cost-benefit analyses should be conducted, considering both short-term gains and long-term benefits. Exploring public-private partnerships to share costs and resources can enhance economic viability while ensuring scalability and sustainability in the deployment of 5G technology in healthcare.

**Health Concerns:** Addressing health concerns around 5G technology is critical. The challenge is countering misinformation and instilling public confidence. To address this, transparently share accurate information on 5G safety, collaborate with health authorities, provide scientific evidence, and if needed conduct independent studies to reaffirm its safety, ensuring responsible deployment in healthcare and beyond.

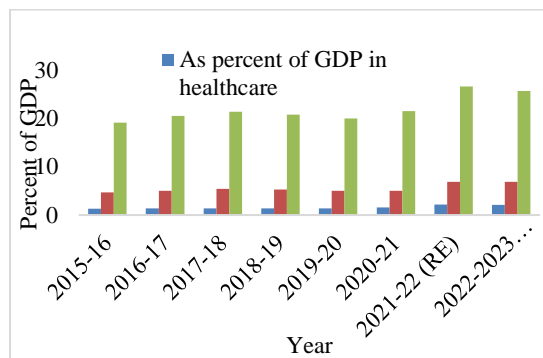
The Indian government has significantly increased its budgeted expenditure on the health sector, both at the central and state levels. In Financial Year (FY)23, the budget estimate allocates 2.1 per cent of the GDP to healthcare, representing a notable rise from the 1.6 per cent allocated in FY21. This increase underscores the critical role that healthcare sectors play in contributing to India's overall economy. The Fifteenth Finance Commission has recommended a gradual and steady increase in combined public health expenditure, considering contributions from both the union and state governments. Their aim is to achieve a target of 2.5 per cent of GDP by the FY25 [15] (Fig. 5). This long-term commitment reflects the government's understanding of healthcare sectors as a fundamental component of India's economic growth and the well-being of its populace.



**Fig.5.**

Share of GDP in India from the FY 2014- 2022, and expecting for 2025

In parallel, the National Health Account (NHA) [15] has provided a comprehensive report detailing the total expenditure allocated to the healthcare sector. This report also demonstrates how the percent of total GDP allocated the healthcare significantly influences the Indian economy (Fig. 6).



**Fig. 6.**

Percentage of GDP, total expenditure and social service

### Automobile Industry

The Indian automotive industry plays a crucial role, contributing approximately 7.1% to the country's total GDP, a significant increase from 2.77% in 1992-1993. Automobile sector directly or indirectly employs around 19 million people [16].

Furthermore, the automotive industry presents a substantial market opportunity for 5G IoT endpoints, particularly in driving the growth of connected cars and addressing road safety concerns in the new era of intelligent autonomous vehicles. The adoption of 5G services in cars is projected to rise significantly, from 15% in 2020 to 74% in 2023, and is expected to reach 94% in 2028, driven primarily by the rapid increase of Electric vehicles (EVs).

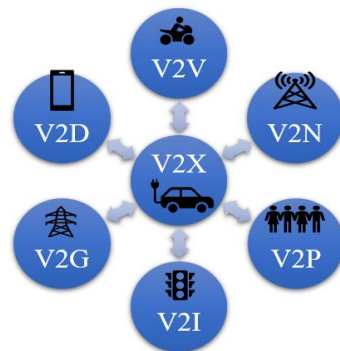
Implementing a vehicular communication system in electrical vehicles (EV's) with the help of 5G technology can be categorized into several types (Fig. 7), each serving a specific purpose and its drawback solutions. Some primary types of vehicular communication systems in EV's with 5G technology are.

V2X(Vehicle-to-Everything) Communication: V2X in EV's leverages 5G to connect with various entities, including other vehicles, infrastructure, pedestrians, and the cloud, forming a comprehensive network. Challenges of seamless connectivity and network congestion are tackled through advanced 5G protocols, optimization, infrastructure expansion, and efficient data management, enhancing EV functionality and safety.

V2V (Vehicle-to-Vehicle) communication with 5G utilizes cellular networks for real-time safety information exchange, enabling features like collision avoidance and adaptive cruise control. Challenges include spectrum congestion and data security, which are addressed through 5G's spectrum management and advanced encryption/authentication protocols, ensuring reliable and secure V2V communication.

V2I(Vehicle-to-Infrastructure) Communication: Incorporating 5G-powered V2I communication empowers EV's to optimize traffic flow by interacting with traffic infrastructure. To overcome challenges of compatibility and cybersecurity, standardization and robust cybersecurity measures are essential safeguards.

V2P(Vehicle-to-Pedestrian) Communication: It allows EV's to connect with pedestrians' smart devices for enhanced safety through warnings and alerts. Challenges include interoperability complexities and data privacy, which are addressed through standardization and robust 5G encryption and authentication protocols, ensuring secure and compatible V2P exchanges [17].



**Fig. 7.**

**Vehicle-to-Everything Communication**

V2N(Vehicle-to-Network) Communication: It employs 5G technology to link EV's with a vast network infrastructure, enabling real-time data access and enhanced functionality. Challenges such as ensuring seamless connectivity and managing network congestion are overcome through advanced 5G protocols, network optimization, and infrastructure expansion, resulting in improved EV capabilities.

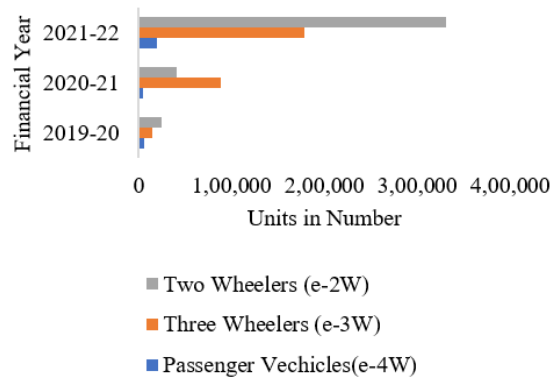
V2G (Vehicle-to-Grid) Communication: EV's interact with the electrical grid, allowing bidirectional energy flow. Challenges include coordinating this flow and ensuring data security, addressed by advanced 5G connectivity and authentication protocols, streamlining energy exchange while safeguarding transactions.

V2D (Vehicle-to-Device) Communication: It leverages 5G technology to enable EV's to connect with smart gadgets for remote control and interaction. Challenges revolve around device compatibility and data

privacy, both addressed through standardization efforts for compatibility and robust 5G encryption and authentication protocols to ensure secure V2D interactions.

The Compound Annual Growth Rate (CAGR) for automotive market size is 65.3% during 2022-2030. The automotive industry is expanding by the using of Machine-to Machine (M2M), low-latency communication in (V2V) and the market is increasing because of the Ultra Reliability Low Latency (URLL) in vehicle-to-Network(V2N), vehicle -to-pedestrian (V2P). Notably, the V2V segment stands out, claiming the majority of shares in India’s 5G automotive market.

The Ministry of Road Transport and Highway (MoRTH) has released the data on the sales of EV for domestic use in India [18] (Fig. 8).



**Fig. 8.**  
Electrical vehicles Sold in India

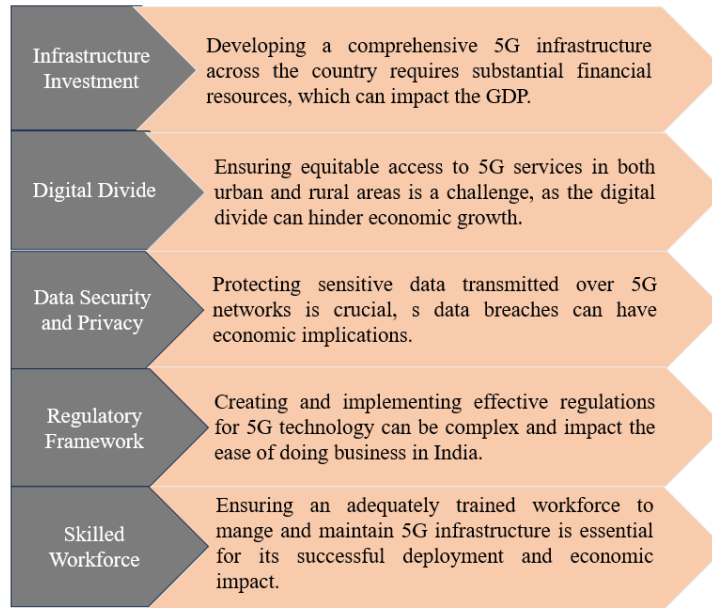
According to the information released by the Ministry of Heavy Industry on 3rd August 2022, a total of 13,92,265 Electrical Vehicles are being used on the road, and according to the information available on VAHAN-4 [19] centralized database of Registration Certification (RC), for the FY 2021-2022 EV’s (4,28,224) are increased up to 3 times when compares to FY 2020-2021 EV’s (1,34,460). In support of EV promotion in India, the Ministry aims to further these efforts [18].

In the coming year we can also expect to can have fully autonomous vehicles because of the growth of 5G. With the help of 5G IoT, we can have advanced driver-assist Systems (ADAS), in-vehicle infotainment systems, speed, fuel tracking, speed and cruise control, improving Vehicle -to-Everything (V2X) communication solutions to improve safety measures and reduce road accidents. 5G in the automotive space in 2023 will be embedded connected car module for consumer and commercial vehicles (39% market share), fleet telematics devices (11% market share) and vehicle in -vehicle toll devices (3% market share).

### Key Challengers of 5G Technology Impacting India’s GDP

The challenges (Fig. 9), of 5G technology with respect to the GDP of India revolve around infrastructure investment, the need to bridge the digital divide, ensuring data security and privacy, crafting an effective regulatory framework, and fostering a skilled workforce capable of harnessing the potential of 5G, all of which collectively impact the country’s economic growth and development.





**Fig. 9.**

### Challengers of 5G Technology

### Conclusions

In the dynamic landscape of India's economic canvas, this research has meticulously unravelled the intricate contributions of the agriculture, healthcare sectors, and the EV industry to the nation's GDP. Moving beyond the conventional discourse, the research not only quantifies the economic impact but addresses critical challenges hindering the seamless integration of 5G technology. Some solutions are proposed for agriculture, tackling infrastructure limits and enhancing farmer access. In healthcare, the focus on implementation challenges and forecast of GDP contribution, with a healthcare percentage breakdown, adds depth. The EV industry analysis extends to the number of 5G-enabled vehicles, providing a holistic view of challenges and solutions in the Indian economic landscape. In conclusion, this paper not only illuminates the economic significance of these sectors but positions itself at the forefront of addressing the hurdles to 5G adoption. The amalgamation of quantifiable data, innovative solutions, and future projections forms a robust foundation for guiding policymakers, industry stakeholders, and researchers towards a future where these sectors, empowered by 5G, contribute not just economically but also foster technological innovation and sustainable growth in India.

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