AI AND IOT AS DRIVERS OF SUSTAINABLE DEVELOPMENT: OPPORTUNITIES FOR MOBILE NETWORK OPERATORS

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Abstract

This paper examines the concept of sustainable development in the context of the digital era, with a particular focus on the role of modern technologies such as artificial intelligence, the Internet of Things, and big data. It highlights the growing importance of digital transformation in addressing global challenges and achieving sustainability goals. The study emphasizes that, despite the widespread use of the term "sustainable development," there is still no unified interpretation in international legal frameworks, which creates difficulties in its practical implementation. Special attention is given to the role of mobile network operators as key enablers of digital technologies and sustainable innovation. The paper analyzes how the deployment of 4G and 5G networks, along with advanced solutions such as network slicing, cloud computing, and AI-based analytics, contributes to improving energy efficiency, reducing operational costs, and supporting environmentally sustainable practices. In addition, the research explores the challenges of monetizing 5G technologies in both B2C and B2B markets, particularly in emerging economies such as Uzbekistan. The findings suggest that mobile operators play a critical role in driving sustainable digital ecosystems by integrating technological innovation with efficient resource management and new business models.

Keywords

Sustainable development, digital technologies, mobile network operators, artificial intelligence (AI) , Internet of Things (IoT), digital transformation, Uzbekistan telecom market

Introduction

In the contemporary global landscape, the telecommunications sector has transcended its traditional role as a mere utility provider to become the fundamental architecture of the modern digital economy. The rapid proliferation of high-speed mobile connectivity, coupled with the integration of transformative technologies such as Artificial Intelligence (AI) and the Internet of Things (IoT), has fundamentally altered the paradigms of socio-economic interaction. For developing economies, particularly in Central Asia, the evolution of mobile networks is no longer a luxury but a prerequisite for national competitiveness, financial inclusion, and sustainable modernization. The Republic of Uzbekistan serves as a compelling case study of this rapid digital acceleration. Under the strategic framework of the "Digital Uzbekistan – 2030" program, the nation has prioritized the expansion of digital infrastructure as a core pillar of its developmental agenda. This commitment is reflected in the substantial fiscal contribution of the telecommunications industry to the national budget. As of the third quarter of 2025, the service sector remains a primary driver of tax revenue, contributing over 30.1 trillion UZS. Notably, the market is characterized by a high degree of fiscal concentration, where the top 20 organizations—led

by four major mobile network operators—account for nearly 17.8% of the total sector tax payments. However, the sector currently stands at a critical juncture. While 4G networks have achieved near-universal coverage, the commercial rollout of 5G and the integration of AI-driven analytics present new challenges in infrastructure investment and market monetization. The transition from a "voice and data" business model to a "digital ecosystem" model requires a sophisticated understanding of both consumer behavior (B2C) and industrial demand (B2B).

Furthermore, the concept of sustainable development has emerged as a vital lens through which telecommunications growth must be viewed. Beyond economic metrics, the industry is increasingly evaluated on its ability to reduce the digital divide between urban and rural populations and its capacity to implement energy-efficient, "green" network solutions. This paper aims to analyze the current trends within the Uzbekistan mobile communications market, evaluate the impact of recent regulatory reforms—such as the 2025 tax incentives—and explore the prospective roles of AI and IoT as drivers of a sustainable digital future.

1. Policy and Regulatory Framework in Uzbekistan

Moreover, paragraph 138 of the State Program "Year of Science, Education, and the Digital Economy Development" defines measures for the adoption of the Decree of the President of the Republic of Uzbekistan on the development of the "Digital Uzbekistan - 2030" program. It calls for the widespread implementation of digital technologies in telecommunications, public services, the real sector of the economy, healthcare, the state cadaster, and other areas, as well as the approval of the "Digital Uzbekistan - 2030" program. The document also provides for: improving the technical infrastructure of e-government; developing human capital and improving the system of training and professional development of personnel; transforming public services into a digital form and developing the information ecosystem; ensuring openness and transparency of the activities of government bodies and organizations, increasing the level of electronic participation of the population; ensuring information security, protecting information resources and systems; and defining a single authorized body in the field of digital economy and e-government, as well as introducing the position of deputy head for digital technologies and e-government in the government, ministries and departments, and local government bodies. The Decree of the President of the Republic of Uzbekistan dated October 5, 2020, "On Approval of the Digital Uzbekistan – 2030 Strategy and Measures for its Effective Implementation" No. UP-6079, ensures the implementation of this clause.

The Decree approved: The Digital Uzbekistan – 2030 Strategy and its implementation roadmap;

Programs for the digital transformation of territories and networks for 2020-2022.At the same time, the digital transformation of territories and industries in 2020-2022 provides for: Increase the number of settlements connected to the internet, including broadband access ports, to 2.5 million, from 78 to 95 percent, by constructing 20,000 kilometers of fiber-optic communication lines and developing mobile networks; Organize training in the basics of computer programming for 587,000 people, including 500,000 young people, as part of the "One Million Programmers" project; Introduce more than 280 information systems and software products to automate management, production, and logistics processes at enterprises in the real sector of the economy; Train 12,000 employees in information technology and information security to improve the digital literacy and skills of hakims, government employees, and organizations in the regions, with the involvement of relevant higher education institutions.

In accordance with the roadmap for the implementation of the "Digital Uzbekistan - 2030" Strategy for 2020-2022: Starting January 1, 2021, as part of the comprehensive "Digital Tashkent" program, a personal account for individuals will be created based on experience to facilitate interaction with government agencies and organizations when issuing ID cards.Starting July 1, 2021, government agencies and organizations will post statistical data on government procurement, patent registration, medicine and medical device registration, public transportation, land use, and other publicly available data online on the Open Data Portal of the Republic of Uzbekistan.Starting August 1, 2021, individuals and legal entities will be able to pay all established state duties, fees, fines, and other mandatory payments online using electronic payment systems.

For the development of the digital industry:

Starting November 1, 2020, resident status in the Software Products and Information Technology Park will be granted to legal entities that are residents of the Republic of Uzbekistan and provide services in the fields of information technology training, hardware and software development and sales, information services export via robotics, the internet, as well as data storage and processing services; By January 1, 2022, the digital transformation of commercial banks will be completed by providing a wide range of online services, including remote sale of credit products, opening of deposits and accounts;

For the development of digital education:

Starting January 1, 2021, a system for managing systems, databases, and a cloud platform, ensuring information security, and covering up to 50% of the costs of obtaining international IT certificates in other in-demand areas will be introduced for citizens;

By September 1, 2021, digital technology training centers for the general population, especially youth and women, will be opened in every district and city using existing infrastructure facilities;

By the end of 2023, more than 200 specialized schools for advanced computer science and information technology training will be gradually established in all districts and cities, using existing educational institutions to foster students' creative development and teach the basics of computer programming.

Regarding digital infrastructure development:

By the end of 2022, every locality will be provided with internet access with a data transfer rate of at least 10 Mbps.

By January 1, 2022, all popular tourist destinations will be provided with high-speed internet.

Starting January 1, 2021, the Decree provides for the creation of an open electronic platform for local software products and IT services. The platform's objectives are:

The creation of a unified database of domestic IT companies and software manufacturers, their products, and services, as well as assistance in promoting their products in domestic and foreign markets;

Publication of information on planned projects for the implementation of information systems and other software products in government agencies and organizations;

Addressing practical issues related to the development of the digital economy in the country and establishing an effective and open dialogue in the process of improving legislation in the field of information technology.

The decree also provides for the implementation of more than 400 information systems, electronic services, and other software products as part of digital transformation programs for regions and industries, including in various areas of regional socio-economic development.

Digital transformation projects will be implemented in 29 model districts (cities) in 2020 and by the end of the first quarter of 2021.

Starting November 1, 2020, at least 5 percent of investment project funds and funds attracted from international financial institutions, foreign government financial organizations, and donor countries will be allocated to digital components. In accordance with the Decree, the "Digital Institution" project will be implemented at the Ministry for the Development of Information Technology and Communications, the Ministry of Justice, and their subordinate organizations.

As part of the project, in particular, all administrative procedures and operational processes will be digitized, with the implementation of paperless electronic document management and office workflow by January 1, 2022.

It should be particularly noted that paragraph 2.5 of the "Digital Uzbekistan - 2030" Strategy, adopted by the Decree of the Head of State "On Approval of the "Digital Uzbekistan - 2030" Strategy and Measures for its Effective Implementation," takes into account a number of proposals developed by the Development Strategy Center.

In particular:

- the implementation and development of distance, online, and virtual learning technologies in the field of information technology, and the development of a platform for online courses;

- the creation of public-private partnership mechanisms with the involvement of large IT enterprises in the area of digital skills development among the population;

– implementation of the "One Million Programmers" project to train highly qualified specialists from among the population;

– development and continuous improvement of a mechanism for improving the skills and qualifications of civil servants in the field of information and communication technologies;

– development of mechanisms for assessing skills in the use of digital technologies, taking into account the following aspects: information literacy (the ability to find information necessary for decision-making); computer literacy (the ability to work with digital devices); media literacy (the ability to critically study the media); communication

Literacy (ability to use modern digital communications); fostering a positive attitude toward technological innovation (new technologies).

- Amendments to the core curricula of comprehensive schools to improve the overall use of digital technologies by students;

- Conducting national competitions and events (hackathons, contests, olympiads, etc.) that foster the emergence of ideas and new technologies;

- Developing human capital, including the development of specialized education and the popularization of IT professions, improving the institutional environment for IT enterprises, and reducing administrative barriers. In short, this Decree is crucial in ensuring the effectiveness of our country's ongoing efforts to actively develop the digital economy and the widespread adoption of modern information and communication technologies across all sectors and areas, primarily in public administration, education, healthcare, and agriculture. Literacy (ability to use modern digital communications); fostering a positive attitude toward technological innovation (new technologies).

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2. The Economic Impact of Mobile Network Operators: A Market Overview (2025)

The telecommunications sector plays a fundamental role in the advancement of modern digital economies. This is evidenced by the fact that **four mobile network operators** are currently ranked among the **top 10 taxpayers** in the country. In aggregate, service-oriented organizations contributed more than **30 trillion UZS** in tax revenue.

Between January and September 2025, 161,351 legal entities operating within the service sector paid over **30.1 trillion UZS** in taxes. Of this amount, more than **5.3 trillion UZS** (representing **17.8%** of the total) was contributed by just **20 major organizations**. The turnover of these top entities reached **65.2 trillion UZS**, while the tax incentives applied to them totaled **5.7 trillion UZS**. The rapid evolution of information and communication technologies has fundamentally transformed the paradigms of communication and information exchange among individuals, enterprises, and government institutions. Mobile communication networks have emerged as a cornerstone of digital infrastructure, facilitating seamless access to information, digital services, and global connectivity.

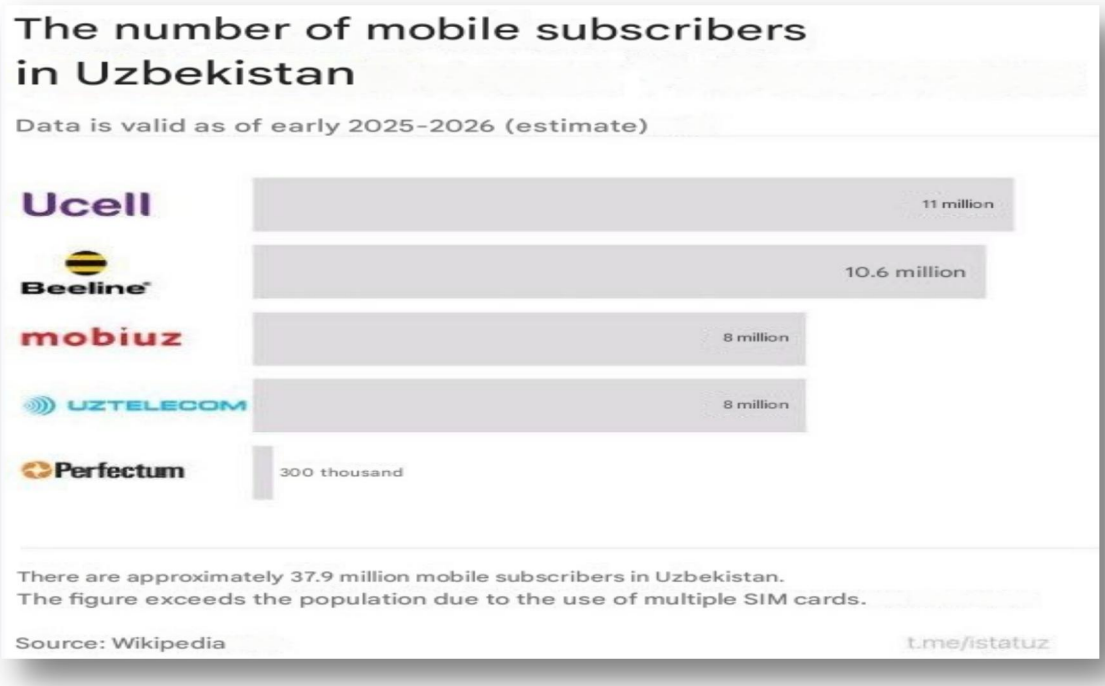
Rank	Organization	Industry	Taxes Paid
🥇 1	**Asia Trans Gas LLC**	Oil & Gas Services	**1,051.1**
🥈 2	**Uzbektelecom JSC**	Telecommunications	**848.1**
🥉 3	**Uzbekistan Airways JSC**	Aviation	**633.1**
4	Uzbekistan Railways JSC	Transportation	491.8
5	Unitel LLC (Beeline)	Telecommunications	292.1
6	Coscom LLC (Ucell)	Telecommunications	224.2
7	Uzbekistan Airports JSC	Aviation	193.8
8	Toshshahartransxizmat JSC	Public Transport	162.1
9	Universal Mobile Systems LLC (Mobiuz)	Telecommunications	158.6
10	Tashkent International Airport LLC	Aviation	157.0

In recent years, the development of mobile communications has become a critical factor in economic and technological progress. Access to reliable, high-speed networks fosters innovation, supports entrepreneurship, and enables the expansion of digital services. Governments around the world increasingly recognize the importance of telecommunications infrastructure for sustainable economic development.

The Republic of Uzbekistan is actively developing its telecommunications sector as part of its national digital transformation strategy. Government initiatives aimed at improving internet accessibility, expanding mobile network coverage, and supporting technological innovation have contributed to the growth of the telecommunications market. The expansion of fourth-generation (4G) mobile networks has significantly increased internet speed and availability, and the introduction of fifth-generation (5G) technologies is expected to further improve digital communications.

The main objective of this study is to analyze the development of the mobile communications market in Uzbekistan, identify its current trends, and assess future prospects. The study also examines the role of telecommunications operators and analyzes the challenges and opportunities associated with sector development.

3. Market Analysis and Monetization Challenges



3.1Subscriber Landscape and Market Segmentation

- The quantitative expansion of the mobile subscriber base in Uzbekistan serves as a primary indicator of the nation's rapid digital integration. According to the latest data from the Statistics Agency under the President of the Republic of Uzbekistan (Stat.uz), the total number of active mobile subscriptions has reached approximately **37.9 million**. This figure notably exceeds the national population, indicating a high penetration rate and the prevalent use of multiple SIM cards by individual users to optimize connectivity and service costs.
- As illustrated in the subscriber distribution analysis, the market is currently led by **Ucell (11 million)** and **Beeline (10.6 million)**, followed by **Mobiuz (8 million)** and **Uztelecom (8 million)**. While these figures represent the overall market reach, a granular analysis reveals a critical shift in how these connections are structured across different market segments.

3.2. B2C (Business-to-Consumer) Segment

The B2C sector remains the traditional core of the industry. However, it is approaching a point of relative saturation. Growth in this segment is increasingly driven not by new voice subscribers, but by the transition of existing users to high-speed **4G and 5G mobile broadband**. The focus here has shifted toward maximizing **ARPU (Average Revenue Per User)** through rich content services and digital financial tools.

3.3. B2B (Business-to-Business) and M2M (Machine-to-Machine)

- A significant portion of the recent growth is attributed to the B2B segment. Enterprises are increasingly adopting mobile solutions for corporate communication, logistics tracking, and remote workforce management. Within this, **M2M connections** (e.g., SIM cards in ATMs, payment terminals, and GPS trackers) are growing at an accelerated pace. These connections are vital for the financial and transport sectors, which are among the top-tier industries in the Uzbek economy.

3.4. The Emergence of IoT (Internet of Things)

- The most prospective driver for future expansion is the **IoT ecosystem**. As Uzbekistan implements "Smart City" projects and digitalizes its industrial sectors (Oil & Gas, Energy, and Agriculture), the demand for low-latency, high-reliability connectivity for sensors and automated systems

is surging. Unlike traditional B2C connections, IoT subscriptions often involve massive deployments managed through specialized **Connectivity Management Platforms (CMPs)**.

- The integration of these diverse segments—B2C, B2B, M2M, and IoT—creates a multifaceted digital ecosystem. While the fiscal strength of the operators is built on the current B2C base, their long-term sustainability and strategic value to the **"Digital Uzbekistan – 2030"** goal will depend on their ability to effectively monetize the burgeoning M2M and IoT markets.
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3.5 The specifics of the Uzbek market: A combination of traditional management models and best practices in digital government services.

Since 2017, many have experienced the changes and transformations taking place in the telecommunications industry with the launch of various services. Consequently, technological solutions have advanced at lightning speed. Since then, 4G technology has begun to permeate our daily lives, and thanks to its high internet speeds, subscribers are overwhelmed and are using its full potential. As a result, there's been a global explosion in data volumes, leading content companies to create rich content for online broadcasting and digital consumption. Of course, voice has also seen promising innovative solutions like VoLTE. Digitalization has begun to develop in virtually every industry, radically and irreversibly changing the way we think about business strategies and customer service.

3.5 The B2B challenge: Difficulty convincing corporate clients of the value of new services.

With the recent rise in popularity of the Internet of Things, more and more companies in the IT sector are starting to look to this opportunity: no one wants to miss out on the market. Mobile operators are the ones most afraid of missing out. The boom years of telecoms, when people were just getting used to using mobile communications and the internet, are over, and now the number of new customers who previously didn't have a carrier is much smaller. In this context, the prospect of a new market with devices replacing people is extremely exciting for operators. But, as is usually the case, things aren't so simple. In fact, the IoT isn't all that new. It's been widely discussed in the last year or two, but companies involved in this market (telecom operators, equipment manufacturers, integrators, and organizations that define communications standards) have been working with the Internet of Things in one form or another for some time.

Mobile operators began their journey toward the Internet of Things when it still seemed like a distant prospect, a mere concept. Demand gradually emerged for plans that either charged per megabyte or included a minimum data package, along with CSD (circuit switched data, similar to a modem). Initially, these were primarily banks that needed to connect or back up ATM connections. But over time, requests also began to emerge from other companies, and sometimes even individuals. Creating a new plan within a mobile operator's structure is far from as simple as it might seem, so the introduction of dedicated plans for a specific group of consumers already indicates that these consumers are numerous enough for the operator to pay attention, analyze the situation, see the potential for development in this area, and invest resources in it. This moment, roughly coinciding with the advent of 3G, can be considered the beginning of mobile operators' entry into the M2M market (machine-to-machine interaction, a synonym for IoT, commonly used in some circles, including operator circles). While smart homes with connected smartphones and smartwatches are quite common today, 5G and IoT are poised to enable applications that seemed impossible just a few years ago. The potential and use cases are enormous, spanning virtually every industry and sector, including agriculture, manufacturing, healthcare, logistics, energy, and much more. Imagine being able to control your smart car digitally: it should drive from home to the office and automatically charge along the way. All this is possible if appropriate use cases are developed and integrated with apps that support such integration and connectivity.

- Experts are debating whether 5G will be as revolutionary a technology as 4G networks once were, and mobile operators are already recognizing the potential and high demand for 5G in the B2B and B2C segments. At first glance, the Uzbek market appears to be focused on monetizing 5G in the B2C sector, as there are various promotional and advertising tools available, and this applies to all mobile operators whose 5G networks are steadily expanding. In this case, ARPU seems to be the primary tool, as it's not a

favorite in the B2B sector. This is because the Uzbek B2B market is unpredictable, in the best sense of the word. Many experts repeatedly point to the growth of digitalization, and the telecom industry plays a significant role in this. For example, banking specialist Alexey Puznyak, who has worked in the Uzbek market for many years, emphasized that the market is unique: "The banking market here is on one foot, one foot, and the other." "One in 2000, the other in 2023, when I arrived. That is, on the one hand, the regulation of the management model in organizations—they're all from the early 2000s—and on the other hand, digitalization and the availability of digital government services are so impressive that when I first got acquainted, when I saw everything that was possible here, my eyes simply lit up. Well, these are completely incompatible things. To put it simply, in the 2000s, people usually shuffled papers and stamped and signed them by hand. In Russia, Ukraine, and Europe, PIN envelopes are still mailed separately from cards. There are many interesting examples where Uzbekistan is far ahead of most countries, especially European ones, in particular, the availability of digital citizen information from government registries and the possibility of remote identification and remote contracting" (https://www.youtube.com/watch?v=EhSGfnvPdLk).

Telecom companies around the world are looking for ways to monetize their investments in transforming and expanding infrastructure to support 5G technology. The challenge lies in the mindset of consumers, who continually demand more data, better connectivity, and more features without increasing their monthly telecommunications costs. This requires telecom operators to find new and effective offerings for consumers without significantly increasing costs.

4.Technological Drivers of Growth: IoT, AI, and 5G (Technological drivers)

The evolution of M2M and IoT: At the time tariffs for the new segment emerged, IoT was still just a concept, and traffic from connected devices was referred to by various names: telematics, telemetry, M2M. Many devices used SMS and CSD for data exchange instead of the now-common GPRS. But everything changed with the spread of 3G. The cost per megabyte began to decrease significantly, and packet data transfer at the speeds available in 3G networks made it possible to connect various types of devices that were impractical under previous conditions. Furthermore, and no less importantly, device manufacturing technologies began to rapidly develop at this time, becoming more diverse and cheaper. However, as a limiting factor, most operators are also seeking effective solutions that will reduce their carbon emissions (achieving carbon neutrality by 2050) while simultaneously providing better network capabilities.

Public Cloud:

Most consumer-facing applications (connected cars, smart homes, OTT, etc.) will require faster data transfer and processing, which will require faster computing, lower latency, and greater bandwidth. Such services or applications will rely heavily not only on connectivity but also on the ability to collect more data, process it faster, and, most importantly, navigate and perform actions at very high speeds. This creates the imperative for operators to provide faster 5G network speeds and faster edge computing and data processing capabilities to applications or service providers to improve the end-user experience.

5. The Role of AI: RAN Optimization, Energy Reduction, and Achieving Carbon Neutrality.

The complexity of this challenge can be addressed not only by implementing solutions with a lower carbon footprint, but also by using artificial intelligence (AI)-based analytics to predict network traffic patterns and automatically adjust power consumption to achieve an optimal balance between capacity and performance. One example of effective power management is the use of AI to dynamically and automatically shut down certain parts of the radio access network (RAN) during off-peak hours to avoid energy waste and reduce costs.

Some market participants were already beginning to wonder what market demand would arise from these changes. As always, there were many ideas, many of which remained just that—ideas or ultimately failed. But one of them was ingenious in that it could be sold not to individuals who find it difficult to convey the value of connected devices, or even to companies in a niche industry not related to IT, but to big players like mobile operators, who see this as a growth area for their business and are themselves searching for a solution.

The idea is rooted in the obvious assumption that a significant portion of devices connected to the Internet of Things will be connected via mobile operator networks. The management model for such devices will differ significantly from that of a standard subscriber: each user typically has their own SIM card, data plan, and account, which are managed through a personal account on a website, in the office, by phone, or via an app. Meanwhile, the number of connected devices for an operator's corporate client can reach hundreds of thousands, and they will be managed by a small group of administrators. Operators have embraced this idea, and so-called CMPs (Connectivity Management Platforms), have begun to appear on the market. In conclusion, solutions such as network slicing, artificial intelligence (AI), the Internet of Things (IoT), and public cloud services are powerful tools that can help operators leverage 5G opportunities and offer new and innovative services, improve network efficiency with a focus on sustainability, reduce operating costs, and create new revenue streams.

Conclusion

The findings of this study underscore the transformative role of the telecommunications sector as the primary catalyst for Uzbekistan's transition toward a robust digital economy. As evidenced by the fiscal analysis, the strategic concentration of tax contributions among the leading mobile network operators—ranking consistently within the nation's top ten taxpayers—highlights the industry's critical importance to the state's macroeconomic stability. However, the true value of the sector extends beyond fiscal revenue; it lies in its function as the "digital backbone" for sustainable development.The transition from 4G to 5G, integrated with Artificial Intelligence (AI) and the Internet of Things (IoT), represents more than a mere technical upgrade. It is a paradigm shift that enables high-efficiency resource management and expands the accessibility of vital social services. The implementation of the **"Digital Uzbekistan – 2030"** strategy has proven to be a pivotal regulatory framework, fostering an environment where technological innovation—such as network slicing and edge computing—can be effectively leveraged to meet the growing demands of both B2C and B2B markets.Furthermore, the unique positioning of the Uzbek market, characterized by a rapid leap from legacy administrative models to advanced digital governance, presents both a challenge and a significant opportunity for monetization. While the B2C segment remains focused on high-speed data consumption, the future of the industry's sustainability lies in the B2B sector and the successful integration of Connectivity Management Platforms (CMPs).

In summary, for Uzbekistan to achieve its long-term goals of economic modernization and carbon neutrality by 2050, continued reinvestment in digital infrastructure is imperative. Mobile network operators must continue to evolve from traditional connectivity providers into integrated digital service enablers. By aligning technological advancements with the principles of sustainable development, Uzbekistan is well-positioned to emerge as a regional leader in the global digital landscape.

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