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Message

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Dr. P. S. Bhadouria

DIRECTIONS OF DIGITAL TRANSFORMATION AND AUTOMATION OF TAX ADMINISTRATION:NATIONAL AND INTERNATIONAL EXPERIENCE

Hujamuradov Abrorbek Ruzimurat ugli[1]

ABSTRACT

This article provides an in-depth analysis of the measures taken to align the tax system of our country with international standards by introducing digitalization — a trend that is gaining momentum worldwide. The focus is on ensuring transparent and open services for taxpayers through digital tools, thereby increasing the number of registered taxpayers and curbing the shadow economy. The article also explores the prospects of implementing digital technologies used in developed countries to improve tax administration, alongside reviewing scientific and theoretical views of both foreign and local scholars on this subject. Furthermore, specific proposals and recommendations are developed regarding the introduction of modern digital technologies into the sector.

Keywords*: Tax administration, Digital Technologies, Taxpayer, Tax Burden.*

Introduction.

In the context of globalization and the digital economy, the digitalization of tax administration plays an important role in ensuring the financial stability of the state. In particular, through digitalization and automation processes, it is possible to increase tax revenues, reduce the share of the shadow economy, and create favorable conditions for business entities.

At present, by reforming the tax system, progress is being achieved in developing the national economy, increasing the number of entrepreneurs, and supporting the social strata, along with improving many other sectors and areas.

On July 18, 2017, the President of the Republic of Uzbekistan signed Decree No. PF-5116 “On Measures for the Fundamental Improvement of Tax Administration and Increasing the Collection of Taxes and Other Mandatory Payments.”

The decree states the following:

the current state of introducing modern information and communication technologies into the activities of tax authorities does not ensure the transparency of tax administration, cooperation with relevant ministries and agencies on taxation issues, the effectiveness of control, as well as the accessibility of public services;

It was also noted that active work had not been organized to increase the interest of taxpayers, primarily business entities, in using the “personal taxpayer’s cabinet,” which provides services without direct interaction, and that a number of other shortcomings in the system were identified.

In order to implement the tasks set out in the Action Strategy on the five priority areas of development of the Republic of Uzbekistan for 2017–2021, such as consistently simplifying the taxation system and

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reducing the tax burden by expanding the taxable base, as well as for the purpose of introducing modern methods of tax administration and increasing the collection of taxes and other mandatory payments:

The main directions of reforming the system of the state tax service bodies of the Republic of Uzbekistan were outlined, and separate directions were defined for the digitalization of the system, which include the following:

- The wide introduction of modern information and communication technologies and advanced automated analytical methods into the process of tax administration, and the full transition to providing electronic services to taxpayers, primarily business entities, without direct interaction;
- Ensuring the timely and reliable accounting of taxation objects and the taxable base, as well as strengthening the responsibility of officials of authorized bodies and organizations for the timely provision of reliable information related to taxation issues;
- Providing comprehensive assistance to taxpayers in fulfilling their tax obligations, developing effective mechanisms for the prevention of tax violations and improving taxpayers' legal awareness, as well as introducing modern methods of tax control.

In recent years, along with the adoption of numerous legislative acts aimed at creating a transparent economic environment, increasing the number of entrepreneurs, and reducing shadow entrepreneurship through tax system reforms, special attention has also been paid to the development of information and digital technologies within the system.

Tax system reform not only ensures budget revenues but also creates opportunities for entrepreneurs and provides the possibility of reducing the tax burden.

Research Methodology.

In studying the introduction of modern information exchange and digital technologies in tax administration, methods of analysis, synthesis, induction and deduction, as well as comparison were applied. Foreign and domestic scientific-theoretical sources were examined, and relevant conclusions and proposals were developed using analytical research methods.

Literature Review.

Professor of Bangor University (Bangor Business School), Nasser Salim Al-Bimani, and Aziza Abdallah Al Qamashoui (2025) emphasized the importance of tax and customs authorities extensively using digital technologies — such as artificial intelligence (AI), machine learning, and blockchain innovations. Modernization measures were highlighted, including providing tax authorities with real-time data, simplifying procedures, automating control and inspections, and expanding the digital portfolio of services [1].

Gustavo Reyes-Tagle (2023), a specialist at the Inter-American Development Bank, expressed the view that, based on the experience of Latin America, it is possible to improve tax collection through electronic services (e-services), taxpayer-facing interfaces, and automation [2].

Daeyong Kim (2023), Director of the Center for International Development (CID), Korea Development Institute (KDI), analyzed the digitalization processes in the field of tax administration in the Republic of Korea. The aim was to demonstrate which strategies can increase the efficiency of tax collection, reduce administrative costs, ensure taxpayer compliance, and decrease tax fraud. In addition, he suggested guidelines for developing countries to study Korea's experience and implement similar e-tax systems.

In the Korean tax administration system, large volumes of data are collected and analyzed automatically using artificial intelligence algorithms to quickly identify risky situations, detect fraud, or uncover cases of tax evasion.

Digital services, online declarations, and processes that reduce costs help taxpayers and organizations save time and resources. Automation in tax collection simplifies administrative tasks.

It was noted that, in cases where traditional audits are insufficient, digital technologies (such as data exchange and third-party data) make it possible to reveal previously unidentified income sources subject to taxation [3].

According to Pogorleskiy and Keshner (2020): “The introduction of digitalization and new information technologies into tax administration is expected to reduce the workload of tax authorities and decrease debts on taxes and insurance contributions” [4].

Analysis and Results:

In recent years, a number of digital reforms have been implemented in the tax system of the Republic of Uzbekistan:

- Innovations in the Tax Code have established procedures for submitting digital reports.
- Through the unified interactive platform my.soliq.uz, legal entities and individuals have been provided with the opportunity to submit declarations, reports, and applications online.
- Online cash registers and virtual receipts have been introduced, enabling real-time monitoring of tax revenues in retail trade.
- The electronic invoicing system has been implemented, giving entrepreneurs the ability to maintain tax records automatically.
- Integration between tax authorities and banks has ensured transparency in tax payments.

In the Presidential Resolution of the Republic of Uzbekistan dated December 30, 2019, No. PQ-4555, “On Measures to Ensure the Implementation of the Law of the Republic of Uzbekistan ‘On the State Budget of the Republic of Uzbekistan for 2020,’” it was envisaged to increase the number of electronic invoicing system operators and, in cooperation with these operators, to fully implement the system of electronic invoice exchange by April 1, 2020.

Exchange and settlement of electronic invoices are carried out through a centralized platform (SoliqOnline / Uzasbo Faktura / faktura.uz). This system has been made mandatory for B2B, B2G, and, in some cases, B2C transactions.

The State Tax Committee adopted Resolution No. 2022-10 of March 18, 2022, “On Approval of Tax Reporting Forms,” which updated the forms of tax reporting and digital services, as well as introduced electronic reporting and its formats.

In 2024, the volume of goods turnover formalized through electronic invoices amounted to 2,041.6 trillion soums, which is an increase of 367.1 trillion soums (22%) compared to 2023, while the VAT amount reached 169.5 trillion soums, up by 32.0 trillion soums from the previous year.

In addition, the number of registered online cash registers (ONKT) increased by 6% (+13,022 units) compared to 2023, the number of issued receipts grew by 14% (+173.8 million), and the total value of receipts rose by 20% (+31.5 trillion soums).

The number of electronic contracts in 2024 increased by 101,032, or 9%, compared to the previous year, reaching 1,222,583.

Within the “E-IJARA” interactive service, 322,490 rental objects (300,876 in 2023) were registered, and 606,046 contracts (531,757 in 2023) were concluded, with a total value of 11.9 trillion soums (8.7 trillion in 2023) and calculated taxes of 799.5 billion soums (756.4 billion in 2023).

By Resolution No. 737 of the Cabinet of Ministers of the Republic of Uzbekistan dated November 20, 2020, “On the Introduction of a Mandatory Digital Labeling System for Certain Types of Products,” the list of products subject to mandatory digital labeling was established.

As of December 31, 2024, 3.5 thousand participants registered in the “Digital Labeling” system had included 83.6 thousand product types in the digital labeling catalog, and nearly 7.4 billion labeled goods were produced.

The electronic waybill system was launched on April 1, 2024, for large taxpayers and from July 1 for all business entities.

In addition, during 2020–2024, desk audits in Uzbekistan were significantly modernized both legally (through new regulations and resolutions) and technically (through data centralization, automated selection, and monitoring modules). This process included elements such as e-invoicing, online cash registers (NCM), the Soliq/SoliqOnline module, and the establishment of the Data Processing Center of the Tax Committee. As a result, progress was achieved in increasing tax revenues, improving compliance levels, and enhancing the targeting of inspections through automatic selection.

By cross-analyzing (data matching) electronic invoices, bank data, online cash registers, and other sources, high-risk entities are automatically selected — which improves the targeting and efficiency of inspections.

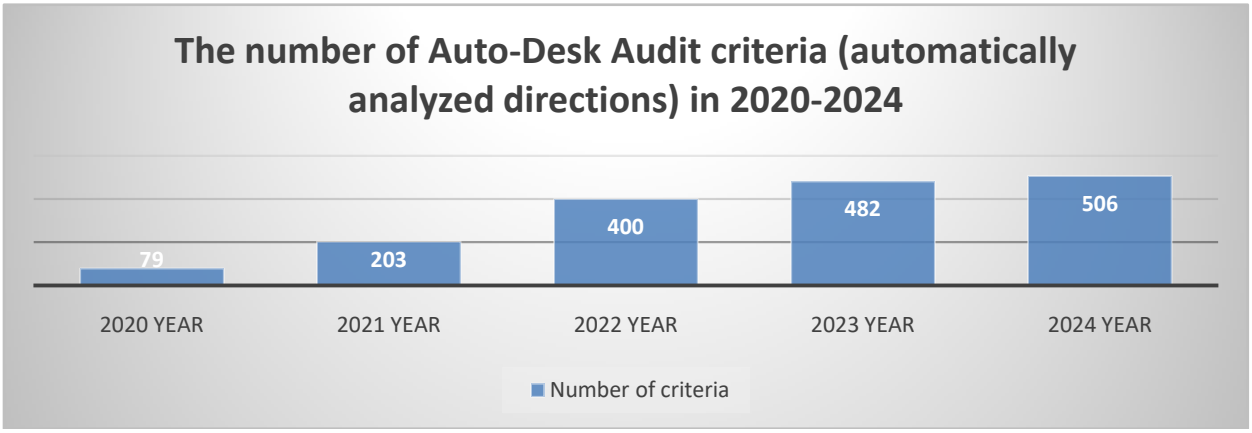

Figure 1 : **The number of Auto-Desk Audit criteria (automatically analyzed directions) in 2020-2024**

As can be seen from the diagram above, the pre-audit analysis – the criteria for automated analysis in the "Auto-Desk Audit" IT system – increased year by year during 2020–2024, as part of ensuring transparency in tax inspections. These criteria amounted to 79 in 2021, reached 400 by 2022, and by 2024 their number had risen to 506.

As a result of the introduction of this system, in 2023, based on the automated analysis carried out, 114,037 enterprises submitted revised reports due to identified discrepancies, leading to an increase of 6,633.0 billion soums. Of this amount:

43.8% fell to the share of manufacturing, with corrected reports totaling 2,906.6 billion soums;

22.2% corresponded to public catering, trade, and services, with corrected reports amounting to 1,470.4 billion soums;

12.1% related to the construction sector, with corrected reports totaling 802.2 billion soums;

5% corresponded to the transport sector, with 331.5 billion soums;

4.8% to agriculture, with 316.3 billion soums;

and 12.2% to other sectors, with corrected reports amounting to 806.1 billion soums.

By 2024, as a result of automated analyses, 76,421 enterprises submitted revised reports in 2023 due to identified discrepancies, amounting to 3,138.6 billion soums. Of this amount:

23.3% fell to the share of manufacturing, with corrected reports totaling 732.5 billion soums;

37.7% to public catering, trade, and services, with corrected reports totaling 1,183.3 billion soums;

15.8% to the construction sector, with corrected reports amounting to 495.0 billion soums;

4.8% to the transport sector, with 149.9 billion soums;

6.5% to agriculture, with 203.3 billion soums;

and 11.9% to other sectors, with corrected reports totaling 374.6 billion soums.

As can also be seen from the above data, despite the increase in the number of Auto-Desk Audit criteria, in 2024 fewer discrepancies were identified compared to 2023 due to fewer mistakes made by taxpayers. This indicates that the Auto-Desk Audit system is creating opportunities for taxpayers to operate transparently and honestly, as well as to submit tax reports correctly.

In addition, one of the newly introduced concepts in tax administration is the "Tax Partner" system — a mechanism developed in Uzbekistan to reduce the shadow economy, detect tax violations, and strengthen public oversight.

The main objectives of introducing the "Tax Partner" system are:

Reducing the shadow economy — decreasing the scale of practices such as unregistered trade, non-use of payment terminals, and failure to issue receipts;

Increasing tax revenues — when violations are detected, payments to the state budget increase;

Strengthening public oversight — citizens and consumers act as serious monitors with the ability to report violations;

Enhancing the transparency and trust of tax administration — contributing to strengthening public confidence in fairness and legality within the tax system.

From January to August 2023, a total of 84,786 appeals were received through the “Tax Partner” system, of which 32,968 cases resulted in inspections.

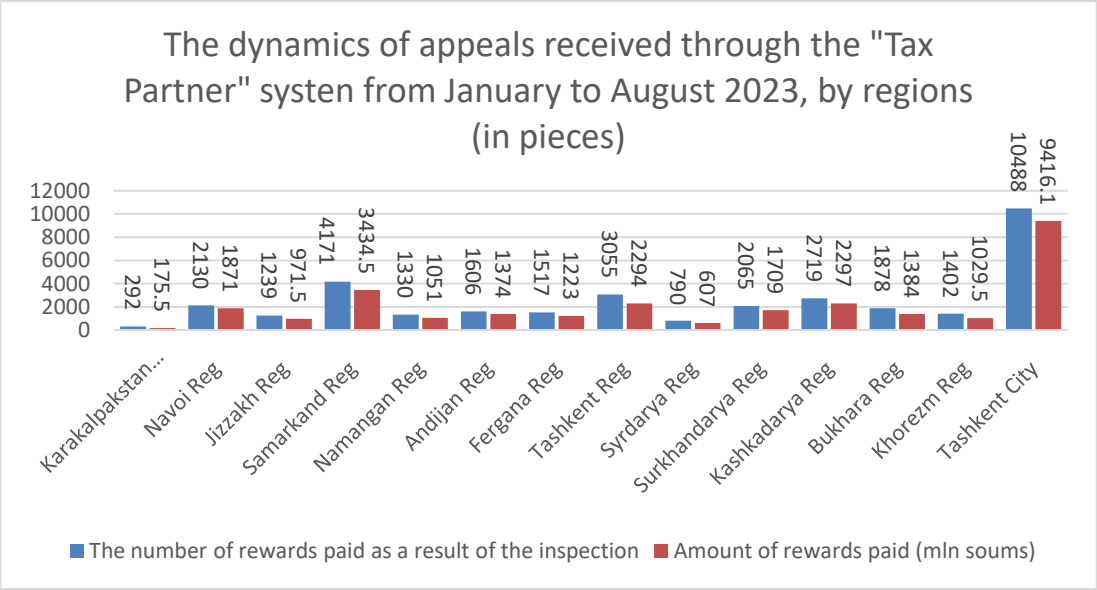

Figure 2 : **As of September 1, 2023, the dynamics of appeals received through the “Tax Partner” system and the rewards paid by regions.**

As can be seen from the diagram above, based on the appeals received, in 34,682 cases a total of 28,838.1 million soums in rewards was paid to consumerswho reported violations.

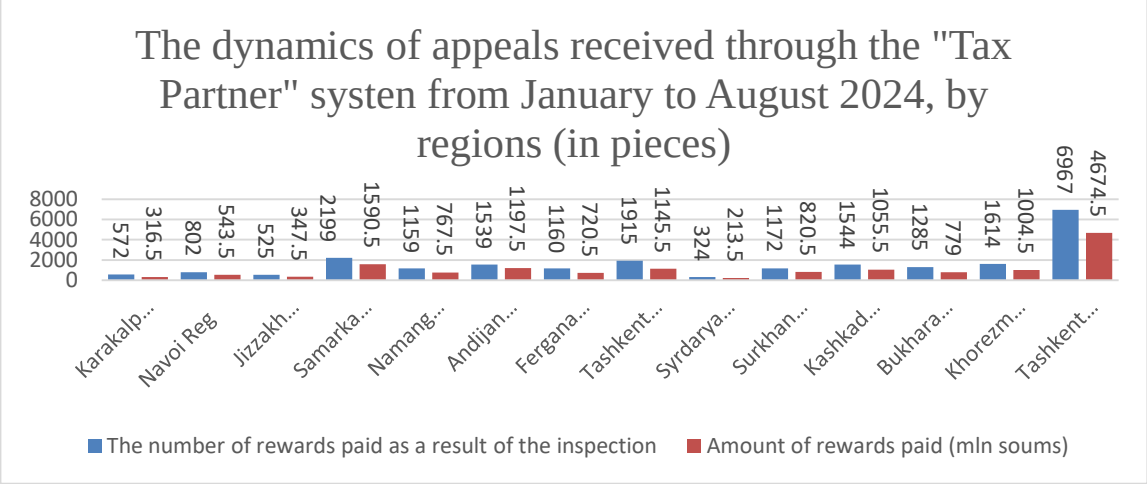

Figure 3 : **As of September 1, 2024, the dynamics of appeals received through the “Tax Partner” system and the rewards paid by regions.**

In the diagram above, we can see how the “Tax Partner” system, introduced by the tax authorities, functions over the years by encouraging consumers to monitor taxpayers. From this diagram, we can observe that during the first eight months of 2024, rewards totaling 15,176.0 soums were paid out based on 22,837 appeals. This figure shows that compared to 2024, in 2025 more consumers reported violations of their rights, which indicates that consumers’ legal knowledge regarding taxation is increasing. This, of

course, reflects the effectiveness of the reforms carried out in recent years and the convenient digital technologies that have been introduced.

During the first eight months of 2025, a total of 73,309 appeals were received through the “Tax Partner” system, of which 36,332 were returned due to being repetitive or because inspections were still in progress, while inspections were carried out based on 29,640 appeals, and as of September 1, 7,337 appeals were announced as still under review.

Of these appeals, 66,198 (90.3%) concerned failure to issue receipts, 2,658 (4%) related to refusal to accept payments via bank cards, 169 (0.2%) to overcharging for payments by bank card, and 4,284 (5.8%) to other cases.

In 98.9% of the cases, the inspections confirmed the reported violations.

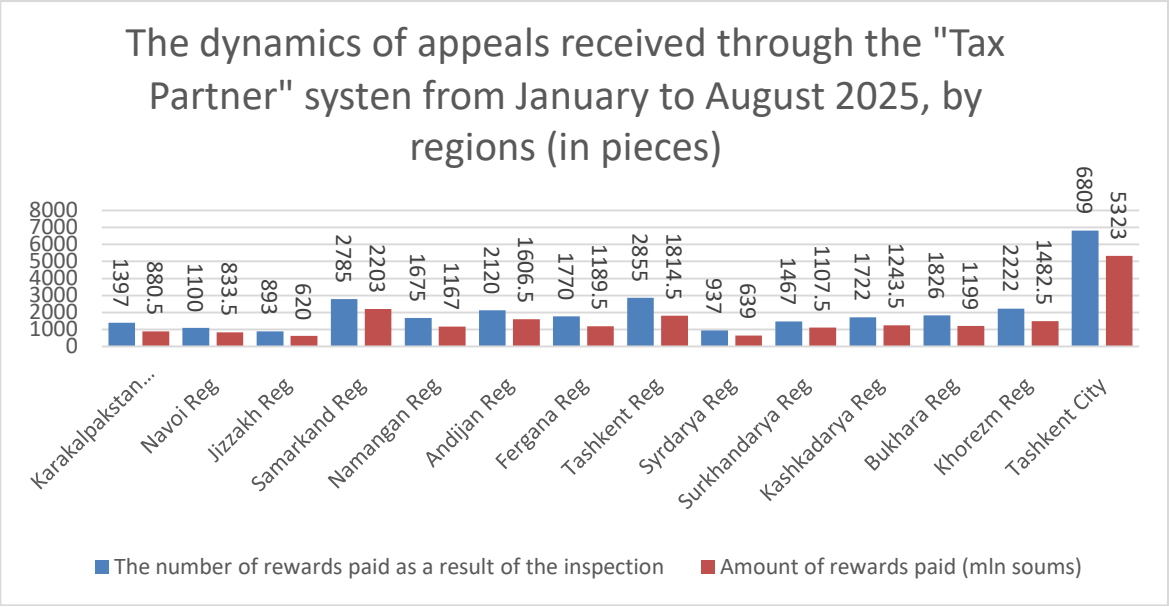

Figure 4 : **As of September 1, 2025, the dynamics of appeals received through the “Tax Partner” system and the rewards paid by regions.**

In the diagram above, we can see how the “Tax Partner” system, introduced by the tax authorities, operates over the years by encouraging consumers to monitor taxpayers. From this diagram, we can observe that during the first eight months of 2025, rewards totaling 21,309.0 soums were paid out based on 29,578 appeals. Among them, the highest number of appeals came from Tashkent City, where 6,809 appeals resulted in rewards amounting to 5,323.0 million soums. According to the diagram, during the past eight months, the lowest figures for rewards paid based on appeals were recorded in Jizzakh Region, where 893 appeals led to rewards amounting to 620 million soums.

Looking at international practice, in the USA, the UK, and Canada, tax authorities are using AI to detect tax fraud, conduct risk scoring, and provide services to taxpayers through “chatbots” and “virtual assistants.” Automatic audit systems have been launched through machine learning technologies.

Some countries (Singapore, Korea, Japan) are piloting tax payments using CBDCs (Central Bank Digital Currencies).

In Estonia and Korea, blockchain technology has been introduced as a pilot project to ensure transparency of data in tax reporting.

It should be noted that in order to ensure transparency, modern tax systems are introducing:

real-time data exchange (e-invoice, online cash registers);

analysis through AI and Big Data;

immutable registers based on blockchain;

automatic reporting and electronic audit systems.

These systems not only streamline the activities of tax authorities and conduct oversight in a transparent manner but also provide convenience for taxpayers, enabling them to prepare tax reports more easily.

Conclusion:

The introduction of digital technologies into tax administration processes serves as an important factor in increasing the efficiency of the system. First of all, through digitalization, the submission of reports by taxpayers and their interaction with tax authorities have been simplified. This has led to saving time and costs and reducing bureaucratic barriers.

In addition, transparency and accountability have increased through tools such as electronic invoices, online cash registers, and a unified database. Based on real-time information about the activities of taxpayers, tax authorities have been able to carry out more effective monitoring.

The introduction of digital technologies has expanded opportunities for forecasting and analyzing tax revenues and reducing cases of tax evasion. At the same time, in line with international practices, automated tax control systems also enhance the country's investment attractiveness.

Overall, the application of digital technologies to tax administration not only ensures the stability of the state budget but also contributes to creating a favorable tax environment for business entities.

Based on the above, we can say that the introduction of digital technologies in tax administration creates opportunities to establish a convenient environment for taxpayers and to simplify tax control. In this regard, some proposals on the digitalization of the sector are as follows:

Among the most important types of information received by tax authorities today are bank data. However, in our Republic, data exchange between banks and the tax service has not yet been fully established, which hinders the complete implementation of control through digitalization. Therefore, it is necessary to bring the volume of information provided by banks up to 100 percent.

For goods subject to labeling in export and import, it is advisable to introduce labeling codes uniformly in other countries, as is done in the Republic, or to create an interstate system in order to prevent re-labeling of goods when they enter Uzbekistan.

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FOR INDUSTRY 6.0 FUTURE BUSINESS LEADERSHIP COMPETENCY IS STATE OF MIND A CONCEPTUAL REVIEW

Saurav Kumar[1]

ABSTRACT

The need for leadership development has never been more urgent. Companies of all sorts realize that to survive in today's volatile, uncertain, complex, and ambiguous environment, they need leadership skills and organizational capabilities different from those that helped them succeed in the past. There is also a growing recognition that leadership development should not be restricted to the few who are in or close to the C-suite. With the proliferation of collaborative problem-solving platforms and digital "adhocracies" that emphasize individual initiative, employees across the board are increasingly expected to make consequential decisions that align with corporate strategy and culture. It's important, therefore, that they be equipped with the relevant technical, relational, and communication skills.

Research Objective: *The research argues that the emerging business environment now demands a new state of mind as leadership skill that is aligned to the requirements of the future industry 6.0.*

Keywords: *Leadership, Human Resource Management, Industry 6.0.*

Introduction

Regardless of industry, location or size, the world is undergoing a fundamental shiftthat will affect the every nature of work and leadership (Hamel, 2007; Wheatley, 2001).Unlike any other time in history, the global business world is more connected,interdependent and transient. However, this is just the beginning. Over the next fewyears, information overload and attention-deficit will increase, uncertainty will prevailand hyper-competition will expand to virtually every corner of the globe. The pace ofchange will also continue to accelerate, so much so, that during some point within thenext decade, organizations will be forced to change in a way for which there has beenno precedent (Hamel, 2007).Given such unprecedented changes, it is no surprise that an assortment of rapidlygrowing demands and expectations, are increasingly being placed on organisationalleaders. Increasingly, leaders are expected to untangle paradox and uncertain,balance conflicting demands, connect and empower those around them and adapt tochange within an instant (Hamel and Prahalad, 1994; Hamel, 2000). At the same time,employee expectations and value propositions are demanding leaders to cultivatea more playful and meaningful workplace, whilst simultaneously balancing autonomyand direction (Barsh, 2008; Ready and Conger, 2007). What is more, society is alsoplacing new and burdensome expectations on organisational leaders, as it increasinglydemands transparency, authentic corporate social responsibility, and societalcontribution (Martin, 2007; Bonini *et al.*, 2007).Against the backdrop of such increasing demands and looming challenges,organisations are increasingly expressing concern about the capabilities of theircurrent and future leaders. In fact, over 75 per cent of companies surveyed in IBM'sglobal human capital study claimed that developing future leaders was an area ofcritical concern (IBM, 2008). Hence, it is becoming increasingly clear that a reliance onleadership competencies that are rooted in the past will no longer be successful. Rather,the emerging business environment now demands a new set of leadership skills, whichrequire traditional leadership competencies to be realigned

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towards the future.The research argues that the emerging business environment now demands a new state of mind as leadership skill that is aligned to the requirements of the future industry 6.0.

Literature review Industry 6.0

Industry is defined as the production of goods and services through the transformation of raw materials and resources into valuable products. It involves the creation of finished products or services through various stages of production that may include manufacturing, processing, assembly, packaging, and distribution. Industries have played a significant role in the economic growth and development of nations throughout history. They have contributed to the creation of employment opportunities, the development of new technologies, and the improvement of living standards. Over the years, the industrial sector has gone through numerous changes, and each of these changes has been termed as an "Industry Revolution."

Industry 1.0: The Birth of the Industrial Revolution

Industry 1.0, also known as the first industrial revolution, began during the late 18th century and lasted until the mid-19th century. It was characterized by the widespread use of mechanized production, the utilization of energy sources such as coal and steam-power, and the emergence of the first factories. This revolution allowed for mass production to become possible and saw the emergence of the first industrial giants such as the cotton mills and ironworks.

Industry 2.0: The Era of Mass Production

Industry 2.0 was marked by the introduction of electricity and the invention of new technologies such as the assembly line. This revolution led to increased productivity, efficiency, and quality in the production of goods, as well as the emergence of new industries such as the automobile industry.

Industry 3.0: The Rise of Automation

Industry 3.0, also known as the digital revolution, saw the use of electronic technologies to create computer-based systems, robotic production lines, and automated factories. This revolution allowed for the emergence of the internet, as well as the development of new technologies such as 3D printing, big data, and cloud computing.

Industry 4.0: Automation and Digitization

Industry 4.0, also known as the fourth industrial revolution, began in the early 21st century and is characterized using automation and data exchange. This revolution has allowed for the development of the internet of things (IoT), artificial intelligence, and machine learning. It has also enabled the use of 3D printing, big data, and cloud computing.

The growth of Industry 4.0 is driven by several factors, including the need to increase productivity and efficiency, the emergence of new technologies such as artificial intelligence and machine learning, and the increasing use of the internet of things (IoT). The use of automation and data exchange allows for faster and more accurate data processing, as well as increased efficiency in the production of goods. Additionally, the development of new technologies such as artificial intelligence and machine learning allow for more efficient decision-making and problem-solving capabilities. Finally, the use of the internet of things (IoT) allows for improved communication and data-sharing between connected devices.

The Evolution of Industry 5.0: Humans and Machines Working Together

Industry 5.0, also known as the Human-Tech partnership, aims to bring together the benefits of Industry 4.0 with the human touch. It emphasizes the importance of human creativity, innovation, and problem-solving skills, while also utilizing advanced technologies such as AI, robotics, and IoT. Industry 5.0 aims to create a work environment where machines and humans work in collaboration, with machines performing repetitive and dangerous tasks while humans focus on more complex and creative work. This approach is expected to lead to increased efficiency, productivity, and job satisfaction, while also promoting social responsibility and sustainability.

The need for Industry 5.0 is driven by the need to remain competitive in the global market, as well as the increasing demand for increased efficiency, productivity and quality. Additionally, the use of advanced technologies such as cognitive computing, artificial intelligence and machine learning allow for improved decision-making and problem-solving capabilities, as well as the potential for new business models.

Unique characteristics of Industry 5.0:

Collaboration : Industry 5.0 emphasizes the importance of collaboration between humans and machines. This means that humans and machines will work together to achieve common goals, with each one complementing the other's strengths and weaknesses.

Customization : Industry 5.0 is characterized by the customization of products and services. This means that products will be designed and produced based on the specific needs and requirements of individual customers.

Sustainability : Industry 5.0 places a strong emphasis on sustainability. This means that manufacturing processes will be designed to reduce waste and minimize the impact on the environment.

Decentralization : Industry 5.0 emphasizes decentralization, with a focus on distributed production and manufacturing. This means that production will be closer to the point of consumption, reducing the need for transportation and logistics.

Flexibility : Industry 5.0 emphasizes flexibility, with the ability to quickly adapt to changing market conditions and customer needs. This means that manufacturing processes will be designed to be easily reconfigured and adapted to meet changing demands.

Industry 5.0 is a revolutionary advancement in the industrial sector, with the potential to drastically improve productivity, efficiency, and quality across various industries. This revolution is characterized by using advanced technologies such as artificial intelligence, machine learning, and the internet of things (IoT). The prospects of Industry 5.0 are promising, as the use of advanced technologies and automation will continue to improve productivity and efficiency across various industries. Additionally, the development of new technologies such as blockchain, quantum computing, and advanced robotics will allow for the potential for new business models and the development of new products. Overall, Industry 5.0 is focused on creating a more sustainable, collaborative, and customer-centric manufacturing environment that leverages the strengths of both humans and machines.

Industry 6.0: Advancements and Challenges

Industry 6.0(Future Concept), also known as the sixth industrial revolution, is characterized by using advanced technologies such as quantum computing, and nanotechnology over the pre-built Industry 5.0

architecture. These technologies will enable more efficient and effective solutions to solve complex problems, as well as the potential for new business models.

The use of Industry 6.0 technologies will also provide the potential for advanced robotics, and increased safety and security in production and manufacturing processes. Additionally, the use of blockchain technology will enable secure and reliable data-sharing and communication between connected devices, as well as the potential for new economic models. Ultimately, the use of Industry 6.0 will continue to revolutionize the way we produce, manage, and consume goods, services, and information but as with any technological advancement, Industry 6.0 may also have some potential drawbacks or negative impacts.

Addressing the Drawbacks of Industry 6.0: Strategies and Solutions

The advent of Industry 6.0 presents a multitude of challenges that require substantial investment in the development of technological, social, and economic infrastructures to ensure their smooth integration into society. The development of new technologies and automation is likely to have a profound impact on employment, with many jobs being rendered obsolete or transformed. This may exacerbate existing inequalities in society and result in job displacement for many people, particularly those with lower levels of education or training. Additionally, the widespread adoption of Industry 6.0 technologies may also result in increased environmental degradation, resource depletion, and pollution, which could have serious consequences for future generations. To address these challenges, policymakers must take a proactive approach to ensure that Industry 6.0 is implemented in a socially and environmentally responsible manner. This may involve the implementation of new regulations and policies aimed at mitigating the negative impacts of automation and ensuring that the benefits of technological progress are shared equitably across society.

Potential directions for Industry 6.0 could involve advancements in areas such as:

1. *Biotechnology Integration:* Further integration of biotechnology into industrial processes, including bioengineering, biomanufacturing, and bioinformatics.
2. *Sustainable and Circular Economy Practices*: Greater emphasis on sustainable manufacturing practices, resource efficiency, and circular economy models to minimize waste and environmental impact.
3. *Quantum Computing and Quantum Technologies:* Utilization of quantum computing and other quantum technologies to solve complex optimization problems, enhance data security, and revolutionize computation capabilities.
4. *Advanced Robotics and Autonomous Systems:* Development of more sophisticated robotics and autonomous systems capable of handling complex tasks in diverse industrial settings.
5. *Augmented Reality (AR) and Virtual Reality (VR):* Expanded use of AR and VR technologies for training, maintenance, design, and collaboration in industrial settings.
6. *Advanced Materials and Nanotechnology:* Continued development of advanced materials and nanotechnology for applications in manufacturing, energy, healthcare, and other industries.
7. *Decentralized Manufacturing and 3D Printing:* Increased adoption of decentralized manufacturing models enabled by advancements in additive manufacturing (3D printing) and distributed production networks.

8. *Cyber-Physical Systems and Digital Twins:* Integration of cyber-physical systems and the widespread adoption of digital twin technologies for real-time monitoring, optimization, and predictive maintenance.

In summary, Industry 6.0 is a futuristic industry that transcends previous revolutions, emphasizing sustainability, intelligence, and holistic integration. Its impact will be profound, shaping the way we work, interact, and live in the coming decades.

A Roadmap for Continuous and Rapid Change

So, what does it take for a company to be future-ready? A leader, need to focus on delivering higher productivity, greater efficiency, and ultimately more profitable growth by concentrating on seven interlocking business domains, which we divide into four categories on the basis of specific leadership approaches. Managers should be:

- **Decisive and unsentimental** when reviewing a corporate portfolio.
- **Experimental and ambitious** when pushing for breakthrough innovation, rethinking global supply chains, improving sustainability, and applying technology.
- **Prudent** when managing your company's capital and liquidity requirements.
- **Patient** when building managers teams and managing your talent.

And for all the categories, managers should be persistent, because managers will need to overcome many obstacles on managers journey of continuous and rapid change.

The Corporate Portfolio

In one way or another, every large company is a portfolio of businesses. Some companies have grown their portfolio organically over time, while others have acquired new businesses or merged with other firms and thus ended up with an array of businesses (Albrecht, K., 1987). The performance of these different businesses can vary greatly. Indeed, for many companies, the 80–20 rule holds true: 20% of their businesses generate 80% of the value, or even more.It is crucial, therefore, that managers continuously evaluate managers entire corporate portfolio and determine which businesses are creating value and which ones aren't—and which ones may even be destroying value.

Too often, we find that businesses are kept for historical or sentimental reasons.

Too often, we find that businesses are kept for historical or sentimental reasons. "This is where it all started, we can't give it up," was the response of one of our clients when we laid out their huge losses over many years in consumer electronics and suggested closing down the unit. It took the leaders another three years to exit the business after they finally accepted that they could not stop the bleeding.

It can certainly be tough to undertake a clear-eyed, dispassionate analysis of the performance of managers company's portfolio. After all, by acknowledging that managers must give up those businesses that are no longer competitive, managers are admitting that managers have, in some senses, failed. But to build a successful future, it is absolutely necessary for managers to do this. Managers focus should always be on tomorrow—not yesterday.

Innovation

If managers don't change, managers won't progress, and you won't deliver profitable growth—and to deliver change, managers need to innovate. That's what the top companies do. In the latest report on the world's most innovative companies, BCG found that, since 2005, the top 50 have outperformed the MSCI World Index on shareholder return by 3.3 percentage points per year. But what kind of innovation delivers this level of sustained outperformance?Today, there is a tendency to equate innovation with AI, especially generative AI. Indeed, BCG is helping clients deploy these fast-evolving technologies to transformative effect—integrating GenAI into their daily operations and processes, reshaping core company functions end to end, and inventing new products, services, and business models.But innovation isn't just about technology—it's a mindset. Although four of the world's most innovative (and valuable) companies are technology-led companies—Apple, Amazon, Alphabet, and Microsoft—what really distinguishes them is not their technology but rather their *approach* to innovation. Their leaders think expansively about the opportunities to create value for their customers. They understand that innovation comes in all shapes and sizes: better, faster services; lower-cost products with less waste; higher-quality materials with more durability; more personalized services; new business models; and so on. They also understand that innovative ideas can come from many different sources—not just from the wizardry of an AI algorithm or from the people working in the central R&D or strategy departments.

Innovation isn't just about technology—it's a mindset.

Subsidiaries, operating on the edge of managers company's core business, are a good source of new ideas because they come into contact with customers, competitors, and local communities that can spark ideas for new products and services. Engaging with customers and identifying their wants, needs, and pain points can lead to what BCG calls "deep client discoveries": new ideas that lead to new solutions. Other good sources of ideas include the vast repositories of data managers company holds on managers customers; the patent landscape; adjacent businesses; and managers suppliers.

But nothing about the process of innovation is easy. Indeed, experimenting is necessarily disruptive and often uncomfortable. This is why there seems the importance of persistence. Ultimately, leadership is about choices.

Supply Chains

There are two critical dimensions to consider when thinking about managers company's supply chains: the geographical and the value-added. Let's take the geographical dimension first. In a fracturing world, it is important that you reorganize managers supply chains so managers company can seize what BCG calls "fractal advantage": the growing opportunities emerging at the edge of a business. While managers company may retain a footprint that spans the globe, it should be much more multiregional or even multilocal—and managers supply chains will need to reflect this.Indeed, many companies are reorganizing their businesses in three overlapping regional circles: North America; Europe, North Africa, and the Middle East; and China and Southeast Asia. They are starting to develop, produce, and market their goods and services for the customers within each of these three regions while limiting their dependence on the supply of raw materials, parts, and components from other regions.Many US companies have reduced their reliance on China as a manufacturing hub and switched to suppliers at or closer to home. Reflecting this, Mexico last year overtook China as the biggest source of goods to the US for the first time in 20 years. But the story is not just one of "reshoring" and "near-shoring." Some Chinese companies are reorganizing their

supply chains to build a presence in North America and Europe. For example, BYD, the world's largest electric vehicle company by sales, is "offshoring" by planning factories in Mexico, Brazil, Hungary, Uzbekistan, Thailand, and Indonesia. Given that costs, risks, and access to markets are constantly changing, it is crucial that you keep the geographical scope of managers company's supply chains under constant review—and make the necessary adjustments. At the same time, managers should consider what we call the value-added dimension: in other words, managers company's place in the supply chain. In some senses, every company is a buyer *and* a supplier, and so you need to work out managers company's role in a particular ecosystem.

It's crucial to keep the geographical scope of company's supply chains under constant review.

Companies with a global reach will probably aspire to become orchestrators—those that reduce risk and generate excess profits by wielding influence through the management of a diverse range of companies. Apple is the classic example of an orchestrator: it takes charge of the development and design of goods and services but collaborates with contract manufacturers (who assemble its products) and software providers (who create the apps and other user interfaces).

Sustainability

Once seen as a nice-to-have for companies, sustainability is now generally viewed as a necessity for a company to keep its license to operate and, by making the company more efficient, ensure its future commercial success. But following the rise of geopolitical tensions and the global pandemic, sustainability appears to be sliding down the CEO agenda in many parts of the world. Leaders should remember that sustainability is not only about doing good but also about doing well.

Over the years, the word "sustainability" has come to incorporate many things including human rights, labor conditions, ethical business governance, and biodiversity. But the top of managers priority list should be reducing waste and leakage. There is no company in the world that can seriously claim to have eradicated all its waste and leakage (Avolio, B.J. and Gardner, W.L., 2005). And the opportunities to drive productivity and efficiency are huge: it has been estimated that one-third of the world's food is being lost between the field and the fork; similarly, as much as 60% of potable water already a scarce resource is lost through leaking pipes.The next big task is reducing carbon emissions. Many companies have set ambitious goals for reaching net zero by switching to wind, solar, hydroelectricity, and other forms of sustainable energy (Kumar, S., 2024). But sustainability is not just about driving productivity and efficiency by cutting down on waste and greenhouse gas emissions—it's also about driving profitable growth by capturing new opportunities. On its own, the circular economy is projected to be worth nearly $700 billion by 2026—up from $339 billion in 2022. Meanwhile, the green economy is forecast to be worth $10.3 trillion by 2050, as new industries are born. So, as a leader, managers have a choice not about whether to pursue sustainable policies (because there are regulations requiring managers to do so) but rather about how, and how far, to pursue them.

Technology

Technology is seen by many as a "silver bullet" solution to all our problems. As discussed above, it can certainly make a big difference in the quest for innovation, the optimization of supply chains, and the achieving of sustainability goals. It is therefore crucial that managers make the application of technology across the company one of managers leadership imperatives. Managers cannot afford to delegate this task to the chief technology officer, chief information officer, or chief data officer. These technology experts can

help managers select the best package of systems and tools. A study by BCG and *MIT Sloan Management Review* found that only one out of ten companies enjoy significant benefits from AI. Why is this? The problem lies in the way technology is embedded in the everyday operation of the company. To address this, BCG uses what we call the 10–20–70 rule. To embed the technology successfully, companies typically devote 10% of their effort to designing the algorithms and 20% to developing the underlying technology and data. The lion's share of the effort—70%—should be devoted to supporting people and changing the organizational processes and culture through the program(Kumar, S., 2023).There are understandable fears about the new technologies; they will certainly have a profound impact on all of our lives. But as a leader, managers need to need to make the case for why they are not so much a threat as a powerful lever to build a stronger organization and a better future.

Capital and Liquidity

"A rising tide floats all boats," the investor Warren Buffett famously said, and "only when the tide goes out do you discover who's been swimming naked." For much of the past decade and a half, many companies have been kept afloat by the massive injection of funds from central banks anxious to avoid a deep global recession in the wake of the financial crisis of 2008. All kinds of companies secured capital very easily and enjoyed historically low interest rates. As a result, corporate valuations went through the roof and the world abounded with paper billionaires.Eventually, however, the tide went out(Kumar, S., 2024). When inflation started to rise and then to accelerate with the energy crisis that followed Russia's invasion of Ukraine, central banks reacted by increasing interest rates and tightening markets. Many companies, whose leaders convinced themselves that low interest rates were the new normal and neglected prudent risk management, were found to be massively overleveraged, and some were forced to close down. In the US, for example, Silicon Valley Bank collapsed in the space of 36 hours after higher interest rates triggered a liquidity crisis which caused its stock price to plummet by 60% and its angry customers to hurriedly attempt to withdraw a total of $42 billion.Such corporate failures need never have happened. If, in the wake of the financial crisis, companies had opted to maintain a solid capital base with sufficient liquidity to support them through any turmoil in the financial markets, then they would still be a going concern.A more prudent approach will require you to evaluate your company's real funding needs and to run risk models even those with extreme scenarios on a continuous basis so managers can better understand the impact of any changes in the financial markets on the viability of managers capital base and on managers liquidity.

Talent

Today, we like to lament the lack of digital savvy people, and of AI experts in particular. But the reality is that there are acute talent shortages in all sectors and at every skill level. While the so-called "Great Resignation" may have been overhyped, it is a fact that there is an aging workforce around the world, and millions of people are poised to retire. When they do, they will leave companies with an enormous recruitment challenge(Kumar, S., 2023).In Japan and South Korea, the two countries projected to have the oldest populations of the OECD countries by 2040, many companies will see up to 30% of their employees retire over the next ten years. Meanwhile, across Europe, and even in China and the US—two of the three most populous nations—there will be major challenges, as the last of the Baby Boomer generation leaves the workforce.Of course, the big difference is that a "people P&L" is about people, not numbers. It's about human relationships, not cash transactions. It is therefore essential that managers develop a talent strategy that focuses.

A new skillset: Innovative, adaptive and collaborative

The changing landscape means business leaders need to adapt their own skills and those of their teams if they are to both remain competitive and take advantage of new opportunities in the marketplace.According to the IBR data, current global mid-market executives believe that the most important attribute for a business leader in 2030 will be to be innovative – cited by 20% of respondents; compared to the 16% who believe this is required today. Meanwhile, 18% say being adaptive to change will be essential, compared to just 14% who see this as a key requirement in 2019. Being collaborative is also viewed as important, with 9% of respondents highlighting this, while Future and a specialist advisor on business transformation, disruptive strategies and radical innovation, says "the ability to adapt requires a number of leadership skills which may previously have been less important.""Digital literacy; the personal capabilities to manage themselves and manage their own emotions; and then the workplace competencies that help them do the job, so problem-solving, collaboration, big picture thinking, scenario thinking, making decisions. There's a whole set of those skills that are all critical to helping us prepare for the future," he says.Future leaders will need to be both more open to new ideas and aware of their own limitations, believes Dlamini. "Creating the best culture to cope with disruption requires that leaders be the students of change and invite their teams to be curious with them," he says."This means that leaders need to create a safe space and be willing to be vulnerable. Celebrate curiosity and experimentation and encourage teams to think beyond what is currently out there. This means leaving room for the new and even celebrating those who make exceptional mistakes in pursuit of something new and unique."This is not easy to achieve as organisations are living organisms that are creatures of habit, so to achieve it will require an ongoing shake-up."

Sharing a vision: Strategy, direction and engagement

They must also be willing and agile enough to break down obstacles and processes which have traditionally slowed down transformation, she adds. "Structure can cause additional red tape and slow the ability to change direction. Having less structure allows ideas to be easily adapted to the changing environment. Organisations need to be willing to trial ideas with low cost and take these options to market."Softer skills will also be essential in such an environment, particularly in the ability to engage staff and persuade them to follow a new vision. Gaurav Chaubey, a director in the advisory practice at Grant Thornton India, points to the need for more authentic, honest and direct conversations – which will be essential for designing a unique customer and talent experience(Kumar, S., 2024)."It also helps ensure one is able to have frequent conversations, and give and accept feedback graciously." Resilience is another important attribute, he adds, with leaders required to demonstrate emotional strength, courage and responsiveness at the most trying times.

Building tomorrow's talent: Training, development and recruitment

Alongside the skills that future leaders will themselves require, they will also have to build up the surrounding talent in the organisation to help them meet the challenges of tomorrow."People will be even more critical," says Rix. "The ability to develop new skills quickly in order to keep up with the pace of change in the market is increasingly important. Recruit people who are comfortable working in ambiguous environments and who thrive on change."In order to obtain and retain this talent, businesses, especially in the hyper-competitive worlds of scale-ups and mid-market players, will need to refocus and perhaps restructure their recruitment processes. Successfully targeting change makers, and appealing to their more fluid approach to their careers, will require the use of specific advertising language, intelligent candidate identification, and flexible working opportunities.A workforce that embraces change is going to be particularly

important when it comes to grappling with the disruption that will come from more AI, automation and robotics entering the workplace, says Dlamini.“Those who will thrive in this era are the ones that understand that these technologies alone cannot replace an entire workforce, but that they will greatly increase the efficiency of the tasks that the organisations perform going forward,” he points out.“The key to success is going to be equipping existing and future talent to understand new technology and leverage it by doing what only humans can do. This requires an increase in the 'high touch’ human skills that are needed to connect with the human customers in the highly digitised world.”Organisations will need to train people to help prepare them for when parts of their roles are taken over by machines or AI, both in using the technology itself and in being equipped for the higher-value activities that may come their way as a result – and also the potential emotional challenge of being ‘replaced’ by a machine.“Departments such as marketing have already gone through this; for the last eight years growth hacking, which is how to create one-to-one campaigns using ads and real-time bidding, have been using AI,” says Martinez. “Companies have already started to put AI tools in the hands of individuals, and what has happened is that new jobs have emerged.”

Learning to think: Adapting, engaging and evolving

Talwar, though, points out that many people actually enjoy the less demanding elements of their roles, and will take time to adapt to the new reality of tackling more creative or higher-value activities. “You only have to look at how tired people are after a one-day workshop of using their brains and having to think,” he says.“Most people aren’t trained or ready to do that. But there will be more of that kind of work, and that will be fine for a while, but then organisations will start to look to differentiate themselves so they will go back to injecting people into roles.“We will go through some very messy cycles in the coming years. From an organisational perspective we need to train people to work with this technology, but we also need to be teaching them how to use their time well and how to pace their time when it’s on free tasks,” he says.

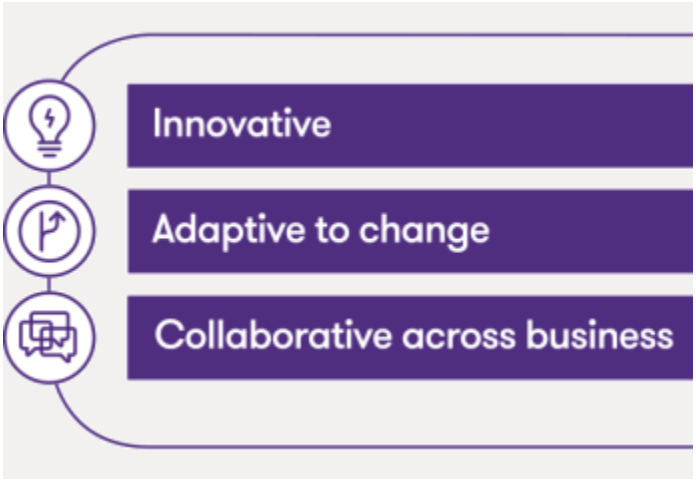
Strength through diversity: Inclusion, innovation and culture

Diverse teams and inclusive cultures are vital for future business success. A study by Forbes found that inclusive teams make better business decisions 87% of the time, with diverse teams delivering 60% better results. Those results come, in part, from increased innovation, which is a proven result of a more diverse workforce(Kumar, S., 2023). A study by Boston Consulting Group of 171 German, Swiss and Austrian businesses, for example, showed a clear relationship between diverse management teams and revenues from innovative products and services – and also that innovation performance only increased significantly when more than 20% of management positions were held by women.Having tracked gender diversity data over 15 years of women in business reporting, Grant Thornton research confirms these findings. CJ Bedford, associate director, people advisory, at Grant Thornton UK, believes it will be increasingly important for firms to build inclusive cultures and a diverse workforce to mirror their consumer base and enable them to innovate. “Diversity is essential, but inclusive cultures are the enabler to bring diversity to bear,” she points out. They also need to balance this understanding with enabling challenge in their decision making, she adds.There are signs that organisations are becoming more inclusive; according to Grant Thornton’s 2019 ‘Women in business: building a blueprint for action’ report, some 34% of businesses now ensure there is equal access to developmental work opportunities, and 31% claim to have created an inclusive culture. Through its ‘Blueprint for action’, Grant Thornton has identified targeted, deliberate actions that businesses can take to improve gender diversity.

Result & Findings

"Not only is the average company lifespan decreasing and economic power shifting to newer cultures, but with the advent of the gig economy even the greatest talent could be anywhere around the world. The challenges organisations and leaders face over the coming years are considerable, and will likely require fundamental changes to both leadership behaviours and business operating models. Organisations will benefit from nurturing a culture and building systems that decentralise control, encourage people to constantly learn, and empower people to take charge and be responsive to changing circumstances."

Figure 1 : Conceptual Model showcasing the 3 mindset attributes for business leaders in Industry 6.0



Conclusion

If CEOs follow a roadmap for continuous and rapid change—building their future-ready company with a streamlined corporate portfolio, breakthrough innovation, resilient supply chains, a clear sustainability strategy, properly embedded technology, a solid capital base with sufficient liquidity, and a "people P&L" that recognizes talent as the company's most important asset they can navigate their way to a promising future.Of course, no one knows what tomorrow will be like. But every business leader should begin each new day with a sense of optimism. A mood of doom and gloom can all too easily become a self-fulfilling prophecy. As the *Financial Times* has reported, there is evidence to suggest that "the west [is] talking itself into decline." In England in the seventeenth century on the eve of the industrial revolution there was "a marked increase in the use of terms related to progress and innovation." By contrast, "over the past 60 years, the west has begun to shift away from the culture of progress, and towards one of caution, worry, and risk-aversion, with economic growth slowing over the same period." This is reflected by the fact that "the frequency of terms related to progress, improvement, and the future has dropped by about 25% since the 1960s, while those related to threats, risks, and worries have become several times more common.In so many ways, the future is an attitude, a state of mind. So, as CEO, managers should talk up your company's chances and, if things go well, managers should keep going.

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PROSPECTS FOR DEVELOPMENT THROUGH IMPROVING THE MECHANISM OF POSTAL AND COURIER SERVICE PROVISION

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ABSTRACT

This scientific article examines the theoretical and methodological foundations as well as the practical aspects of improving postal and courier service mechanisms. The role and significance of these services in the global economy under the conditions of globalization and the transition to a digital economy are highlighted. At the same time, advanced foreign experiences are analyzed, and the current state, development trends, and prospects of the postal and courier service system in Uzbekistan are scientifically substantiated. The organizational and economic mechanisms for the development of postal and courier services have been improved.

Keywords: *postal service, courier service, digitalization, logistics infrastructure, e-commerce, organizational and economic mechanism, Uzbekistan Post, modernization, technology.*

Introduction.

In the era of globalization and the digital economy, postal and courier services have become an important component of the global economy. According to reports from the Universal Postal Union, in recent years the volume of postal and courier services worldwide has more than doubled, playing a direct role in the development of international trade, e-commerce, and social relations. Digitalization, modernization of logistics infrastructure, and the introduction of new technologies contribute to improving efficiency in the sector. The main problems of postal and courier services include weak infrastructure, insufficient use of modern technologies, and a shortage of qualified personnel, which lead to low service quality. In particular, in rural and remote areas, the quality of postal services is significantly lower, delivery times are long, parcel tracking systems are underdeveloped, and customer communication quality does not meet standards. In addition, the obsolescence of transport vehicles, the lack of modern sorting centers, and the limited knowledge of employees regarding modern service standards also create significant obstacles.

In Uzbekistan today, postal and courier services are among the most important parts of the logistics system, and due to the rapid development of e-commerce and online trade, the demand for this sector is steadily increasing. Modernizing postal and courier services in Uzbekistan and improving their quality and efficiency are pressing issues, as the development of the economy and the improvement of the population's living standards are directly linked to the effective functioning of these services. In particular, in accordance with the Resolution of the President of the Republic of Uzbekistan Sh. M. Mirziyoyev dated December 14, 2020, No. PQ-4921, "On measures for the radical improvement of the postal communication service system," the priority goal was defined as "improving the quality of provided services and enhancing the delivery of postal items, periodicals, and courier shipments in a short time frame" [1]. Based on this, the introduction of the "bundle-client" delivery scheme, providing 500 electric scooters for postal workers serving regional and district centers from central sorting units, was initiated. These measures show that further

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improvement of the sector's activities remains one of the urgent issues of the present time. Moreover, to further develop postal and courier services, there is an increasing need to improve their organizational and economic mechanisms.

Analysis of literature related to the topic.

Numerous foreign and domestic sources related to the topic have been analyzed. In particular, in the article by Sikora M. titled "Competition on the courier, express and postal services market" [2], the following conclusions regarding postal and courier services were reached:

- During the COVID-19 pandemic, the level of use of courier services increased, and the current leading service providers' high level of customer satisfaction is associated with innovative parcel lockers, fast delivery, and convenient tracking systems;
- Since courier company clients value timely delivery, efficiency, and modern solutions such as parcel lockers, these factors are important directions for improving customer satisfaction and loyalty;
- The increase in the use of courier services during the pandemic reflected changes in purchasing behavior. It was also found that older people use courier services less for online purchases, indicating the need for educational work and tailored offers for this group of customers. Therefore, courier companies should focus on improving service quality, offering innovative delivery solutions, adapting to customer preferences, and responding flexibly to changing market conditions.

European economists Lorenzo-Espejo A., Munuzuri J., Onieva L., and Rojas A. in their scientific article "Exploring the correlation between courier workload, service density and distance with the success of last-mile and first-mile reverse logistics" [3] deeply study the key factors determining the efficiency of postal and courier service processes. The authors analyze large volumes of real data from courier operations in various cities using statistical modeling. The results show that excessive courier workload significantly reduces delivery quality and timeliness, while service density (i.e., the number of customers in a given area) increases service efficiency. At the same time, longer distances sharply increase transportation costs and reduce delivery speed.

In his article "Appraisal of the Nigerian Postal Service's compliance with the Universal Postal Convention: Challenges and prospects" [4], Godswill O. A. stated that "International postal services, especially those guaranteed within the framework of the Universal Postal Convention, are considered universal social goods serving the interests of all countries and peoples."

According to the opinions of the aforementioned scholars, international postal service, as a process of exchanging letters and parcels across borders between all countries, contributes to trade development, strengthens social relations, and ensures information exchange.

In the article "What Makes Courier Service Creative? — From Managing Logistics to Managing Knowledge" [5], written by Yao L., Nurul I., and Mohd Sh. Kabi, courier services are viewed not only as logistical processes but also as knowledge management processes. The main idea of the research is that innovative solutions and creative approaches in courier services are generated not only through technology but also through the effective management of employees' knowledge and experience. The authors, based

on qualitative analysis of experiences from various courier companies (mainly operating in the Asian region), demonstrate which knowledge-sharing and motivation mechanisms function in shaping creative services.

In the article by Galina F. and Oleksiy T. titled “Моделированиевлияниядеятельности почтовыхикурье рскихслужбнаэкономическийростстранЕС” [6], it was determined that under the available information base, using a single-factor model is advisable for building a regression assessing the impact of postal and courier service activities on macroeconomic growth in EU countries. The results of estimating the parameters of single-factor panel regression models assessing the influence of postal and courier service activity on the macroeconomic growth of EU countries show that such activities have a positive impact on macroeconomic growth.

If we analyze domestic literature: a courier service is a service that accepts postal items from the sender’s address and delivers them to the recipient’s address. Since courier postal deliveries are carried out directly by courier delivery, recipients receive high-quality and fast delivery of courier parcels. After courier postal items are delivered to the address, the sender is provided with information confirming delivery[7].

Research methodology.

The research employed comparative and systematic analysis methods. Based on foreign and domestic scientific literature, international experience, and ongoing reforms in Uzbekistan, the development trends of the sector were studied. Advanced studies utilizing panel regression models were analyzed, substantiating the positive impact of courier and postal services on macroeconomic growth. In addition, legal and regulatory documents, Presidential decrees, and practical statistical data were used as research sources.

Analysis and results. In today’s era of globalization and the digital economy, postal and courier services are gaining particular importance as an integral part of international trade, e-commerce, and logistics systems. The annual growth of global e-commerce volume has sharply increased the demand for delivery services, turning courier services into one of the strategic sectors of the economy. According to the 2024 reports of the Universal Postal Union (UPU) [8], over the past decade, the global volume of postal and courier services has more than doubled, indicating the need to improve their management and operational mechanisms.

In this regard, it can also be observed that the share of postal and courier services in Uzbekistan has been increasing year by year. In particular, by the end of January–November 2023, the volume of postal and courier services reached 1,022.9 billion soums, with Tashkent city accounting for 67.8% or 693.9 billion soums of the total service volume, reflecting a continuous increase in service activity [9]. At the same time, in recent years, the main indicators of postal communication in the country — including the number of letters, postcards, and parcels — have shown a rising trend. Specifically, while in 2015 the number of postal items amounted to 15 million units, by 2024 this figure reached 5.4 million units (Table 1). One of the main reasons for this is the ongoing modernization of postal services, as technological updates have led to corresponding changes in performance indicators.

Table 1 : Main indicators of postal communication: letters, postcards, parcels (million units)[10].

Code	Classifier	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
1700	Republic of Uzbekistan	15	15,9	16,6	14,7	15,2	14,1	13,4	10,8	7,1	5,4

In Uzbekistan, the importance of this sector is also steadily increasing. The expansion of the e-commerce market, along with the growing demand from the population and business entities for fast delivery services, necessitates the modernization of national postal and courier services. At the same time, the development of logistics infrastructure, the widespread use of digital technologies in services, and the introduction of mechanisms that meet international standards play a crucial role in enhancing Uzbekistan's competitiveness in the global market.

In the Republic of Uzbekistan, the modernization of postal and courier services has been recognized as one of the priority areas of state policy. The regulation "On the procedure for customs control and clearance of international postal and courier shipments" [11] established new legal frameworks in the sector. In addition, consistent efforts are being made by "UzbekistonPochtasi" JSC and major private courier companies to expand the provision of fast, reliable, and high-quality services to the population. Furthermore, the rapid development of e-commerce in Uzbekistan and the growing habit of online shopping among the population and business entities have significantly increased the demand for postal and courier services. The pandemic period has clearly demonstrated the essential role of postal and courier services, elevating the sector to a new stage of development and leading to improved service efficiency. Therefore, improving postal and courier service mechanisms, developing modern logistics infrastructure, simplifying and digitalizing customs procedures, and introducing international standards remain pressing issues today.

Global experience shows that postal and courier services are not only an important part of the economy but also a key factor in employment. For example, in the European Union, 1.8–2 million people work in this sector, averaging 42 employees per 10,000 inhabitants. In some countries, this figure is much higher — 61 in the United Kingdom, 60 in the Czech Republic, and 58 in Slovakia. Meanwhile, in Portugal, Greece, and Cyprus, the figure is much lower — around 16–17 employees [12]. These differences highlight the crucial role of infrastructure, economic capacity, and the level of digitalization in the development of the sector.

In addition, many effective measures have been implemented in this field in Uzbekistan. In particular, the Presidential Decree of the Republic of Uzbekistan "On measures for the radical improvement of the postal communication service system" [9] was adopted. This decree outlines:

- The "Roadmap" for the development of postal communications for 2021–2023;
- The target indicators for postal service development for 2021–2025;
- The approval of "Roadmaps" for transformation projects in 42 model districts (cities) in 2021, identifying key priority tasks.

To ensure the implementation of this decree, in 2022, significant work was carried out to transform the activities of "UzbekistonPochtasi" JSC, improve its material and technical base, digitalize its operations, expand the scope of postal and courier services, and introduce electronic commerce, banking, and public services. In particular, the company's existing information systems were upgraded, the automated system for payments and money transfers was modernized and launched under the "AVVAL" brand, and its mobile application was also developed.

Currently, the system has been equipped to accept more than 95 types of payments. In addition, postal facilities and postmen have been provided with 2,800 mobile devices. Now postmen can accept various payments from the population online within their service areas, while citizens can make payments online without leaving their homes.

In order to improve traditional postal services, digitize them, and introduce information technologies and systems into the processes of accepting, sorting, tracking online, and delivering postal items, the “Postal Service Process Automation System” was developed and launched. In more than 1,970 postal facilities located in remote areas, banking services, including replenishment of bank cards with funds and cash withdrawals, have been introduced. As a result, residents of remote areas have been provided with convenient access to banking services.

It should also be especially noted that today, for the population living in remote areas of our republic, more than 1,055 postal facilities provide over 60 types of public services. In addition, the “Hybrid Mail” system has been improved, and a Unified National System has been introduced. The advantage of the hybrid mail service is that government bodies and organizations are freed from the need to put postal items into envelopes, attach stamps, write recipient addresses, and bring them to the post office. The postal communication system of the Republic of Uzbekistan includes postal facilities and routes that are interconnected to ensure the continuous acceptance, processing, and delivery of postal items and periodicals. The national postal system is organized by the joint-stock company “Uzbekistan Post” based on a geographical principle and includes the following:

- 165 district and city networks, 14 regional branches consisting of 1,732 communication offices, as well as 4 specialized branches;
- 1 railway, 34 air, and 230 automobile routes ensuring the regular transportation of postal items.
- Postal enterprises have 3,688 delivery sections, of which 1,414 are located in cities and urban-type settlements, and 2,274 in rural areas. To collect letters and messages across the republic, 2,519 mailboxes have been installed, of which 1,619 are located in rural areas.
- In the context of Uzbekistan, in order for the development of postal and courier services to produce significant economic results, it is first necessary to identify the advantages and disadvantages that arise in improving postal and courier services (Table 2).

Table 2 : Advantages and disadvantages of postal and courier services [13].

Advantages	Disadvantages
The speed and quality of service will increase.	Modernizing logistics infrastructure requires significant financial resources
New jobs will be created and staff skills will be improved.	Implementation is difficult in rural areas due to lack of internet and technical infrastructure
Regional branches and transport networks will expand, bringing them closer to the population.	Branch expansion incurs high operating costs
The opportunity to attract investments based on public-private partnerships will increase.	The underdeveloped insurance system may not fully cover risks and losses.
Foreign exchange earnings increase through the export of services	Customs and legal issues may arise in the process of international integration.

Among the advantages are the increase in service speed and quality, the creation of new jobs, the improvement of employee qualifications, the expansion of regional branches and transport networks, the widening of opportunities to attract investments through public-private partnerships, and the growth of foreign exchange earnings through the export of services. However, there are also disadvantages, such as the large financial resources required to modernize the logistics infrastructure, the difficulty of implementing services in rural areas due to the lack of internet and technical infrastructure, the high operating costs associated with branch expansion, the incomplete coverage of risks and losses due to an underdeveloped insurance system, the lack of public awareness and skills in using postal and courier services, and the emergence of customs and legal regulation problems in the process of international integration. Therefore, the development of these services, while providing economic and social benefits on one hand, also demonstrates the need for systemic reforms and substantial investments on the other.

It should also be emphasized that despite the introduction of new technologies into courier services aimed at improving customer convenience and work quality, service quality may not always improve. This is because the digitalization of postal services allows shipments to be scanned at every stage, enabling customers to track their parcels online in real time. In addition, all branches are equipped with “fitting rooms,” which, in turn, provide great opportunities for online stores engaged in “fashion sales” to increase their sales. Therefore, adapting work mechanisms for rapid mastering and creating user convenience remain among the key issues in this process.

Furthermore, an effective way to develop postal and courier services in our republic is to improve their organizational and economic mechanisms. First of all, it is necessary to substantiate the need for such services. Postal and courier services represent infrastructure that ensures the functioning of society and the economy by delivering information, documents, and goods from one place to another. Although digital communication is increasing, the demand for the delivery of physical packages, documents, e-commerce orders, and legal document exchanges demonstrates the necessity of these services, which can be reflected as follows:

Firstly, the reliable physical delivery of official documents, contracts, and banking papers ensures information and document exchange within society.

Secondly, the delivery of online orders to customers supports economic exchange and satisfies consumer demand, thereby contributing to the growth of trade turnover.

Thirdly, the fast and controlled delivery of export-import documents, samples, and small packages improves the country’s foreign trade and logistics chain systems.

Fourthly, in rural areas, postal systems play a vital role in delivering services, medicines, and essential goods, thereby improving the standard and quality of life and ensuring local and regional integration.

Fifthly, the delivery of pensions, benefits, assistance payments, and official notifications supports social stability.

Sixthly, the prompt delivery of documents and the provision of courier services for urgent items enhance business efficiency, thereby ensuring business activity and prompt services.

Thus, postal and courier services in our country form an integral part of the modern socio-economic system. They ensure not only information and document exchange but also “e-commerce,” and the

functioning of local and international logistics chains. Modernization, digitalization, and expansion of territorial coverage will strengthen the economic and social stability of the country.

Based on the above-mentioned advantages, disadvantages, and the practical necessity of developing postal and courier services, it can be concluded that using an organizational and economic mechanism to develop these services is expedient (Table 3).

Table 3 : Supporting mechanisms for the organizational and economic mechanism for the development of postal and courier services [13].

Organizational mechanisms	Economic mechanisms
Management and coordination of services based on a single national system.	Adjusting prices and improving tariff policy based on market demand.
Expanding the activities of regional branches and offices, establishing logistics centers.	Optimize costs and increase profitability in the service process.
Widespread implementation of digital technologies (mobile applications, online tracking, electronic documents).	Attracting innovative investments and expanding private sector participation.
Staff training and service culture improvement.	Introduction of value-added services in a competitive environment (express, premium services).
Quality control of services and compliance with international standards.	Diversify revenue from services (international, domestic, business and personal shipments).
Modernization of transport and logistics infrastructure.	Financial incentive mechanisms (tax breaks, subsidies and grants).
Expanding cooperation based on public-private partnerships.	Attracting foreign investment and establishing joint ventures.
Strengthening security systems (shipment insurance, monitoring).	Increasing foreign exchange earnings by developing services exports.

Based on the data presented in Table 3 above, it can be concluded that these findings can be utilized in improving the organizational and economic mechanism of postal and courier service delivery in our republic. In particular, if we turn to foreign experiences, it can be observed that special emphasis is placed on corporatizing postal operators or transforming them into state-owned holdings, opening the market and promoting competition while maintaining the obligation of universal service, as well as diversifying postal operations into logistics and e-commerce services. These approaches are implemented through various models, in particular in the form of public-private partnerships, mixed ownership, and private ownership structures.

In our opinion, based on the above considerations, in order to develop the organizational and economic mechanism of postal and courier service delivery, it is necessary to define the directions required for implementing activities such as setting prices, network access, and quality standards through an independent regulator, as well as conducting training in logistics, IT, and customer service, and preparing specialized courier and fulfillment personnel (see Figure 1).

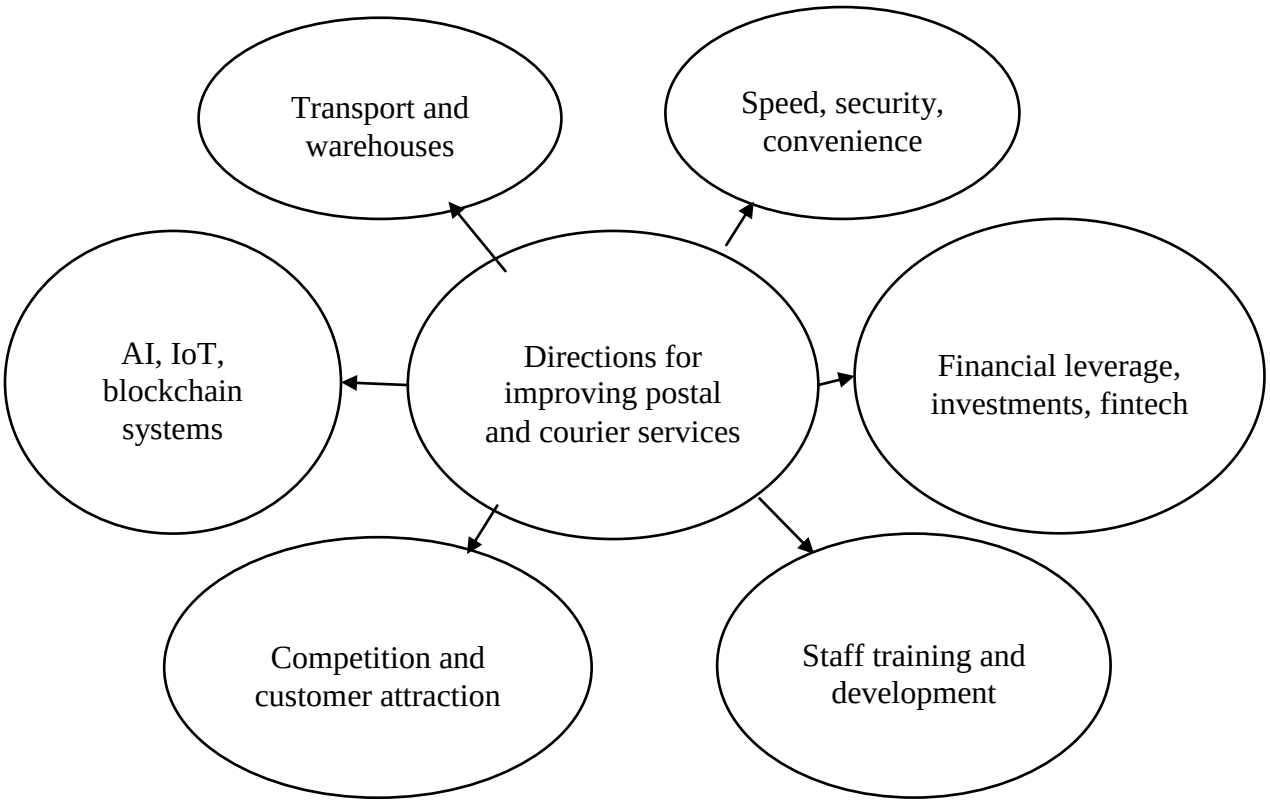

Figure 1. Directions for improving postal and courier services [13].

In order to improve the organizational and economic mechanism of postal and courier services in our republic, we have effectively used the directions presented in Figure 1 to form an improved view of the organizational and economic mechanism (Figure 2).

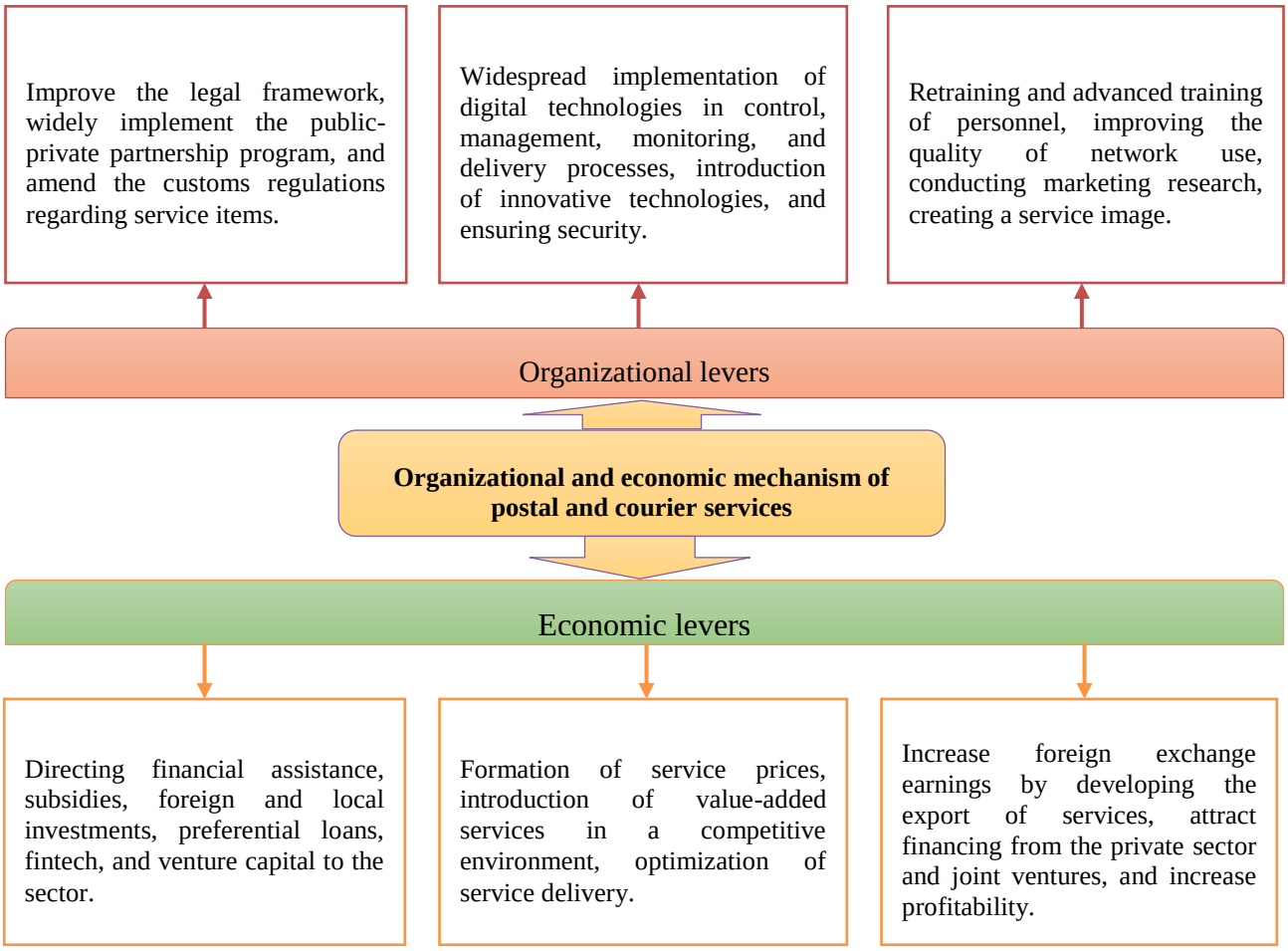

Figure 2.An improved view of the organizational and economic mechanism for postal and courier services [13].

In our opinion, as a result of improving the organizational and economic mechanism of postal and courier service delivery, it will contribute to the increase in the volume and quality of services in the republic, as well as to the improvement of the circular flow of reproduction phases. In addition, delivery times will be reduced, costs will decrease, errors and losses will be minimized, customer satisfaction will increase, complaints will decline, brand reliability will be strengthened, and service provision in rural and remote areas will improve, ensuring the fulfillment of universal service obligations.

As a result of implementing this organizational and economic mechanism in practice, first of all, it will increase the efficiency of postal offices located in rural areas, ensuring greater attention is given to providing state services, banking services, and other types of services to the population living there.

Secondly, the quality and variety of postal and courier services will be improved and expanded, and the necessary logistical infrastructure for the development of e-commerce will be enhanced.

Conclusion and suggestions.

In conclusion, under the conditions of Uzbekistan, the organizational and economic mechanisms for the development of postal and courier services have been developed. Based on the analysis of the current state of the sector, digitalization, modernization of logistics infrastructure, and improvement of service quality have been identified as priority directions. The reforms being implemented in our country — such as the transformation of “Uzbekistan Post” JSC, digital payment systems, automated postal systems, and innovative solutions like hybrid mail — have proven to be effective tools for improving service quality, as demonstrated by our research findings.

Based on the results of the study, it has become clear that to further develop postal and courier services, it is necessary to widely introduce modern information and communication technologies, expand service coverage in remote areas, continuously improve personnel qualifications, simplify customs procedures, and enhance the service system in line with international standards. Accordingly, in order to improve the performance of the sector, the following proposals and recommendations have been developed:

First, to accelerate digitalization processes in order to develop postal and courier services, make extensive use of technologies such as GPS, RFID (radio-frequency identification), and blockchain, as well as expand the network of automated sorting centers and parcel lockers to increase service speed and convenience.

Second, to expand service coverage in rural and remote areas of the republic, introduce mobile postal points and electric scooters.

Third, to improve postal and courier service delivery in our country, simplify international customs procedures and widely implement the electronic declaration system.

Fourth, to enhance communication with customers in delivery, verification, and payment processes by improving employee qualifications, developing CRM (Customer Relationship Management) systems, and expanding online service platforms.

Fifth, to improve the quality control and monitoring system in the service process by introducing real-time evaluation based on key performance indicators.

The implementation of these proposals primarily depends on the effectiveness of its organizational and economic mechanism. If applied in practice, these measures will lead to an increase in the quality, volume, and scale of postal and courier services in our country. Favorable conditions will be created for the population, and this process will also be beneficial for entrepreneurs and the state, contributing to the growth of foreign trade turnover on an international scale.

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CLINICAL AND ECONOMIC BURDEN OF TUBERCULOSIS IN INPATIENT FACILITIES IN UZBEKISTAN: AN ICD-10-BASED ANALYSIS

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ABSTRACT

This study presents a quantitative assessment of the inpatient cost and hospitalization duration associated with various forms of tuberculosis in selected healthcare facilities in Uzbekistan. The analysis is based on aggregated data across main diagnostic categories according to ICD-10. The average cost per case was calculated using the step-down costing method. It was found that the mean cost per inpatient episode ranged from 3,740 thousand Uzbek sum (≈331 USD) to 21,378 thousand sum (≈1,891 USD), with an average length of stay between 17 and 72 days. The most resource-intensive and expensive forms included bacteriologically confirmed pulmonary TB, TB of the ear, adrenal TB, and generalized TB. Less costly forms included cases without laboratory confirmation and skeletal TB. Currency conversion was performed using the official exchange rate of the Central Bank of Uzbekistan as of January 1, 2023 (1 USD = 11,300 sum). The results may be used to inform tariff development and the implementation of case-based payment systems for tuberculosis under Uzbekistan's strategic purchasing framework.

Keywords: *Tuberculosis, ICD-10, Inpatient Care, Average Cost, Length Of Stay, Clinical And Economic Analysis, Step-Down Costing, Health Financing*

Tuberculosis (TB) remains one of the leading causes of death from infectious diseases worldwide. According to the WHO Global Tuberculosis Report 2024, an estimated 10.8 million new cases and 1.25 million TB-related deaths occurred in 2023, making TB the deadliest bacterial infection globally (WHO, 2024). Despite notable advances in pharmaceuticals and diagnostics, the financing of TB inpatient care in many countries remains inefficient and fragmented.

This challenge is especially pronounced in countries with transitional economies, where hospital payments are typically based on bed-days. Such financing models fail to account for clinical complexity, encourage unnecessarily long hospitalizations, and do not incentivize efficiency (Langenbrunner et al., 2009). In response, many countries in Eastern Europe and Central Asia have adopted diagnosis-related group (DRG) models, customized for tuberculosis and pulmonary care systems (Jakab et al., 2020).

In Uzbekistan, TB care represents a significant portion of inpatient services, and the introduction of case-based groups (CBGs) has been recognized as a key priority in health sector reforms. This direction is formally outlined in the Presidential Decree No. PP-12 dated January 20, 2023, "On measures for the further development of phthisiology and pulmonology services for 2023–2026." However, to date, no systematic analysis has been conducted to accurately classify TB cases by cost and treatment duration depending on the specific clinical form.

The heterogeneous nature of TB — including pulmonary, extrapulmonary, and generalized forms — necessitates a differentiated approach to tariff setting. Studies evaluating DRG application in TB care have shown that precise cost estimation for each form of TB significantly improves transparency and equity in resource allocation (Friedrich et al., 2022).

This study seeks to fill that gap. Its objective is to quantify diagnosis-related variation in the economic burden of tuberculosis care using ICD-10-based classification. The findings aim to provide an empirical foundation for the implementation of case-based groups and for optimizing the financing of inpatient TB care in Uzbekistan.

Materials and Methods

This study analyzed data from 85,776 inpatient episodes under the clinical specialty of “phthisiology” registered across healthcare facilities in Uzbekistan during 2022 and 2023. The dataset included 59 institutions of various levels, ranging from national and regional specialized centers to district tuberculosis dispensaries. For the purposes of this article, the focus is on a subset of cases reflecting different clinical forms of tuberculosis, categorized according to ICD-10 codes, as presented in Table 1 and Figure 1.

The cost per inpatient case was calculated using the step-down costing methodology, as recommended by the Joint Learning Network for Universal Health Coverage (JLN, 2014) and adapted to the healthcare context of Uzbekistan. This method involves sequential allocation of overhead costs from administrative and support departments to clinical units, based on factors such as patient volumes, bed-days, staff numbers, facility area, and others. The methodology was validated in collaboration with the working group of the Ministry of Health, the State Health Insurance Fund, and was based on the national accounting system (UzASBO), as well as standardized reporting templates used during the pilot phase.

Data sources included financial records from healthcare institutions, clinical and statistical reporting forms, standardized Excel templates, and aggregated tables from analytical dashboards. All data were anonymized, cleaned, and harmonized prior to analysis. Cost figures are presented in thousands of Uzbek sum and were converted into USD at the official exchange rate as of January 1, 2023 (1 USD = 11,300 sum).

The legal and organizational basis for this study is provided by regulatory documents of the Republic of Uzbekistan, including Presidential Decree No. PP-12 (January 20, 2023) “On measures for further development of phthisiology and pulmonology services for 2023–2026” (lex.uz), as well as Ministerial Orders No. 324 (December 14, 2023) and No. 186 (June 7, 2024). All calculations and summaries were carried out within the framework of implementing strategic purchasing mechanisms and the development of case-based payment models in the national tuberculosis care system.

Results

The analysis summarized in Table 1 focuses on the most common clinical forms of tuberculosis, recorded in 13 selected facilities participating in the development of case-based groups (CBGs). Rare and outlier cases were excluded from the dataset to ensure the reliability and representativeness of the findings.

The most frequent diagnosis was bacteriologically or histologically confirmed pulmonary TB (A15.0), accounting for 3,560 cases. The average inpatient treatment cost for this group was 19,173 thousand sum (≈1,696 USD), with an average length of stay of 72 days. The second and third most common diagnoses were A16.0 (bacteriologically/histologically negative pulmonary TB) with 1,512 cases and A18.0 (TB of bones and joints) with 776 cases, having average costs of 13,177 thousand sum (1,166 USD) and 9,916 thousand sum (878 USD), respectively.

Table 1. Key indicators for hospitalized TB patients in the selected facilities.

Among the less common forms of tuberculosis, several diagnoses were associated with particularly high treatment costs. A18.6 – Tuberculosis of the ear reached the highest average cost at 21,378 thousand sum (1,891 USD) with a mean hospital stay of 57 days. A15.4 – Confirmed intrathoracic lymph node TB had an average cost of 18,810 thousand sum (1,664 USD) and 61 days of hospitalization. A18.5 – Ocular tuberculosis amounted to 17,864 thousand sum (1,581 USD) with an average stay of 48 days, while A19.0 – Acute miliary TB affecting a single organ incurred 16,311 thousand sum (1,443 USD) over a prolonged stay of 69 days, making it one of the most extended forms of inpatient care.

Conversely, the least expensive and shortest hospital stays were observed in the following diagnoses: M90.0 – TB of bones (non-spinal) with 3,740 thousand sum (331 USD) and 17 days, A16.2 – Pulmonary TB without specified confirmation at 5,758 thousand sum (510 USD) and 25 days, and A18.8 – TB of other specified organs with 5,421 thousand sum (480 USD) and 24 days.

These findings are visually presented in Figure 1, where the X-axis displays specific TB forms, and the two Y-axes represent the average cost of treatment (in thousand sum) and the average length of stay (ALOS, days), respectively. The chart highlights diagnoses characterized by both high cost and long duration (e.g., A15.0, A15.4, A19.0), as well as forms with high costs but relatively short hospital stays (e.g., A18.5, A15.5).

Figure 1. Correlation between Average Length of Hospital Stay and Average Cost of TB Treatment

To evaluate the significance of differences between diagnostic forms, a one-way analysis of variance (ANOVA) was conducted, confirming statistically significant differences in both treatment costs ($p < 0.01$) and length of hospital stay ($p < 0.01$) across ICD-10 groups.

A correlation analysis between the average treatment cost and average length of hospitalization (based on the 21 most represented TB forms) revealed a moderate positive correlation: $r = 0.57$, $p < 0.05$. This indicates that, on average, longer hospitalization is associated with higher costs, although the relationship is not linear and contains notable exceptions.

For example, A16.3 (Intrathoracic lymph node TB, not confirmed) and A18.3 (Abdominal TB) are associated with relatively long hospital stays (58 and 43 days, respectively), but moderate treatment costs—12,797 thousand sum (≈1,132 USD) and 8,800 thousand sum (≈779 USD). Conversely, A18.4 (Skin and subcutaneous TB) and A18.6 (Ear TB) are characterized by relatively shorter hospital stays (52 and 57 days), yet exhibit high treatment costs—16,414 thousand sum (≈1,452 USD) and 21,378 thousand sum (≈1,891 USD).

Discussion

The results demonstrate pronounced heterogeneity in both treatment costs and hospitalization duration among patients with various forms of tuberculosis. A15.0 (bacteriologically or histologically confirmed pulmonary TB) was not only the most common form but also associated with a high average cost (≈1,696 USD) and the longest average hospital stay (72 days). These indicators reflect the clinical complexity, need for multi-step diagnosis, and potentially delayed transition to outpatient care due to prolonged inpatient treatment.

Special attention should be given to TB forms such as A18.6 (ear TB), A15.4 (confirmed intrathoracic lymph node TB), and A18.5 (ocular TB), where treatment costs exceeded 1,500–1,800 USD, although the length of hospitalization was not always the longest. This confirms the hypothesis that high costs may be driven not only by duration of care but also by the need for expensive diagnostic and therapeutic interventions, including surgical procedures, specialized drug regimens, and consultations with narrow-profile specialists.

The presence of statistically significant differences ($p < 0.01$) in both cost and length of stay across TB forms confirms the need for granular cost assessments in tariff formation under the Case-Based Group (CBG) model. The moderate positive correlation ($r = 0.57$) between cost and length of hospitalization indicates that while treatment duration is a key cost driver, it is not the only factor influencing resource intensity.

International evidence reinforces the importance of differentiated inpatient payment models for tuberculosis. The World Health Organization (2023) emphasizes that strategic payment mechanisms like DRGs or CBGs can improve efficiency and transparency in resource allocation, especially in settings with limited funding. At the same time, evidence from Southeast Asia highlights the risk of underfunding complex TB forms when flat-rate tariffs are applied without considering clinical heterogeneity (WHO, 2023).

In the case of Uzbekistan, the findings from this study were used to inform the design of case-based groups grounded in real treatment costs for both common and high-cost TB forms. These results supported the justification of tariffs under the strategic purchasing system, development of patient care pathways, and transition to outpatient care for forms associated with short hospital stays and low costs.

The main limitations of the present analysis include the fact that the data covers only 13 healthcare facilities involved in the pilot phase of CBG development, which limits the generalizability of the results to the entire country. Additionally, rare and atypical TB cases were excluded, preventing comprehensive analysis of severe and infrequent forms. Moreover, the study focuses exclusively on inpatient care, without incorporating the costs of outpatient or follow-up treatment.

Despite these limitations, the study provides a critical empirical foundation for the continued implementation of strategic payment mechanisms and for enhancing the economic rationale behind TB tariff policy in Uzbekistan.

Conclusion

The clinical and economic analysis of tuberculosis forms, based on data from 13 pilot inpatient facilities in Uzbekistan, revealed significant differences in the cost and duration of treatment across various diagnostic categories. The findings highlight the necessity of a flexible and evidence-based approach to tariff setting within the implementation of the Case-Based Group (CBG) payment model. Special attention should be given to high-cost and high-prevalence forms of TB when determining financing priorities. The presented data can serve as a practical foundation for tariff policy development, resource planning, and improving the efficiency of inpatient tuberculosis care in the country.

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THE MAHALLA-BASED WORKING SYSTEM IN UZBEKISTAN: AN INSTITUTIONAL MANAGEMENT AND DECENTRALIZATION ANALYSIS

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Key words: MBWS - Mahalla-Based Working System, Decentralization, Institutional, Hokim Assistant - HA, Normative,Mahalla Committees (*Kengash*).

I. Introduction: Framing MBWS in Contemporary Public Administration

The efficiency and democratic legitimacy of modern public administration increasingly depend on effective decentralization—the delegation of executive functions to grassroots institutions. Uzbekistan’s Mahalla institution, a historical and cultural structure of local self-governance, provides a unique framework for exploring this dynamic.[1] Traditionally acting as autonomous, neighborhood-level mechanisms for dispute resolution, social cohesion, and informal welfare provision, Mahallas possess deep knowledge of local conditions and household dynamics.[1]

Post-independence reforms aimed to integrate these structures into the formal public administration system. This process, however, has been subject to continuous academic scrutiny, questioning whether the transformation genuinely facilitates democratic decentralization or, rather, serves as a sophisticated state apparatus for comprehensive social control and micro-level management.[3] This crucial ambiguity forms the theoretical backdrop for analyzing the recent shift toward the Mahalla-Based Working System (MBWS).

MBWS is defined broadly as a governance mechanism designed to ensure the active socio-economic participation of local communities, effectively acting as an institutional bridge between the centralized state and individual citizens. Its fundamental purpose is to integrate local citizen needs and demands into broader state policy implementation.[5]

At its core, MBWS represents a complex set of activities aimed at addressing the socio-economic needs of residents, improving living standards, and elevating overall community welfare.[5] The necessity of this system is emphasized by key presidential strategic documents (such as PF-4947, PF-60, and PF-158), which formally mandate the enhancement of the Mahalla institution's efficiency, transforming it into the "basic link of public administration and control" for solving pressing socio-economic problems at the local level.[5] This legal instrumentalization formally delegates executive and economic management functions to the micro-level, moving beyond purely ceremonial or welfare roles.

The focus of this analysis is the theoretical framework underpinning MBWS, particularly its organizational architecture and performance management systems, as outlined in the theoretical chapter of the dissertation. The central contribution is an evaluation of how a traditionally centralized state strategically utilizes a deeply embedded social institution to achieve rapid, measurable, and decentralized economic outcomes.

The state’s reliance on formal legal frameworks to define and operationalize traditional Mahalla roles suggests a strategic legal instrumentalization of pre-existing social capital.[5] Critics argue that while pre-

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Soviet Mahallas relied on voluntary social insurance and dispute resolution, subsequent reforms, particularly the introduction of salaried, state-integrated positions, shifted the primary managerial dynamic from **community solidarity** to **vertical bureaucratic accountability**.[3] This structural observation indicates that the system's overall effectiveness hinges less on spontaneous local initiative and more on the state's capacity to efficiently delegate and monitor authority down to the lowest administrative tier.

II. MBWS Conceptualization and Organizational Architecture

MBWS's conceptual foundation rests upon integrating top-down state policy delivery with existing localized communal networks. The institutional architecture defines how resources and mandates flow:

1. **Mahalla Committees (*Kengash*):** These are the formal management bodies responsible for local administration. Their duties involve registering citizens' needs, problem identification, and implementing solutions.[5]
2. **Citizen Gatherings (*FuqarolarYig'ini*):** These gatherings serve as essential components for participatory governance, providing a mechanism for gathering feedback, articulating community demands, and generating local input for policy adjustments.[5]
3. **State and Public Bodies:** These entities function as the resource backbone, providing the necessary financial support and programmatic mandates for implementing social, economic, and cultural development programs locally.[5]

The ultimate managerial objective is not merely the passive distribution of welfare benefits, but active socio-economic empowerment, which directly links citizens to state resources for entrepreneurship and job creation programs.[5]

The MBWS system requires a multi-functional management approach, blending social security roles with aggressive economic development mandates [5]:

- **Socio-Economic Development:** This function focuses on enhancing local economic potential by identifying *mahalla* specializations, supporting small businesses and entrepreneurship, stimulating job creation, and improving vital local infrastructure such as roads and utilities.[5] Economic management requires defining growth points and developing "driver projects" tailored to the local resource base.[5]
- **Social Protection and Welfare:** This involves the identification of vulnerable populations (low-income families, the disabled, the elderly) and the distribution of material aid and social services.[5] The function is now professionally supported by dedicated Social Workers, integrated at the Mahalla level under the National Social Protection Agency, indicating a shift towards formalized, professionalized welfare management beyond traditional communal support.[5]
- **Community Dialogue and Accountability:** MBWS aims to institutionalize effective communication channels between local residents and governmental bodies, ensuring that feedback is collected and policy implementation is monitored.[5]
- **Cultural and Educational Development:** Roles include promoting public health, organizing cultural events, and expanding access to education and vocational training.[5]

The operational core of MBWS is the 'Mahalla Seven' (*Mahalla Yettiligi*), a specialized, multi-disciplinary management team assigned to each local administrative unit.[5] This structure is designed to deploy the full range of state administrative capacity directly to the community level, formalizing policy execution through specialized personnel.

The structure intentionally separates key managerial domains. Economic functions are assigned to the Hokim Assistant (HA), social welfare is handled by the Social Worker and Women's Activist, and security and overall governance are maintained by the Mahalla Rais (Chairperson) and Prevention Inspector.[5]

The **Hokim Assistant (HA)** is pivotal in the MBWS economic model. HAs are responsible for developing micro-projects, coordinating business foundations training, and facilitating preferential credit and subsidy allocation. They manage the strategic deployment of low-interest loans (up to 2 billion UZS per Mahalla) to identified entrepreneurs and must create individualized development programs for poor families to increase income and achieve sustainable poverty exit.[5]

The move to the Mahalla Seven structure represents a fundamental organizational pivot. Instead of solely relying on the voluntarily-led *Rais* and Elders, MBWS utilizes a professionalized, bureaucratic management unit at the micro-level. By institutionalizing specialized roles with defined reporting lines, the state ensures disciplined policy execution across economic, welfare, and security sectors. However, this level of state integration, while guaranteeing policy delivery, carries the organizational risk of **crowding out** genuine civil society participation and reinforcing the propensity for "absolutist micromanagement" observed in previous administrative analyses of the Mahalla system.[3]

Conclusion

The Mahalla-Based Working System (MBWS) in Uzbekistan is established as a critical, multi-functional management system vital for socio-economic development, social protection, and citizen participation.[5] The theoretical framework defines MBWS as a hybrid institutional form, simultaneously relying on historical social capital and sophisticated modern administrative tools, such as the specialized Mahalla Seven structure and the *Online Mahalla* platform. The resulting system demonstrates remarkable capability for rapid execution and measurable performance improvement in job creation and targeted lending, particularly the strategic shift toward supporting high-value service and manufacturing sectors.[5]

However, the analysis of MBWS's theoretical foundations and operational structure reveals a central managerial tension. To achieve sustainable local development and avoid merely functioning as an instrument of state micromanagement, MBWS must overcome core structural deficiencies. Specifically, fixing the ambiguous accountability structure of the Hokim Assistant and consolidating fragmented fiscal mechanisms into a powerful, unified poverty reduction fund are necessary organizational reforms. By refining its institutional architecture based on rigorous performance evaluation and comparative management insights, Uzbekistan can enhance the operational efficiency and long-term sustainability of MBWS, solidifying its role as a distinctive and effective paradigm in decentralized development management.

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PROBLEMS OF SELLING HANDICRAFTS PRODUCTS ELECTRONIC PLATFORMS IN UZBEKISTAN

Safarova Dilshoda Farrukhovna[1]

ABSTRACT

The article separately analyzes the issues of export of national products of Uzbekistan through e-commerce, prospects for the development of the industry, the legal basis, the role of our economy in the field of e-commerce services, problems in the field of increasing exports of national products in Uzbekistan and proposals for its solution.

Keywords: *Trade, Product, National Products, Services, E-Commerce, Marketplace, Infrastructure, Competitiveness, Digital Economy, Export, Currency, Marketing, Etc.*

INTRODUCTION

Relevance of the topic. The development of the digital economy worldwide allows for the expansion of innovative services based on information and communication technologies in the service sector, particularly e-commerce. Population growth, expanding needs, and the growing demand for high-quality and convenient services are contributing to the rapid development of e-commerce.

In this regard, regulation of the e-commerce sector, the implementation of the most convenient organizational and managerial structure of e-commerce, ensuring the security of the payment system, assessing the effectiveness of the development of the e-commerce system, improving the innovation management system, the conditions for the formation of an e-commerce system in retail enterprises, and the study of scientific problems in the field of e-marketing are becoming increasingly important.

Research Methodology. The methodological basis of the study is based on regulatory documents in the field of tourism development, as well as proposals and recommendations for implementing the objectives outlined in these decrees and decisions, as well as modern statistical methods of observation, analysis, and synthesis. These methods are widely used in collecting and processing relevant statistical data.

Statistical background. The scientific and methodological aspects of the development of the service sector and the service industry were discussed by Pardaev M.K., Polatov M.E., Mukhammedov M.M., Zainalov D.R., Mirzaev K.J., Tukhliev I.S., and AslanovaD.. Other scientific works are devoted to this topic.[2]

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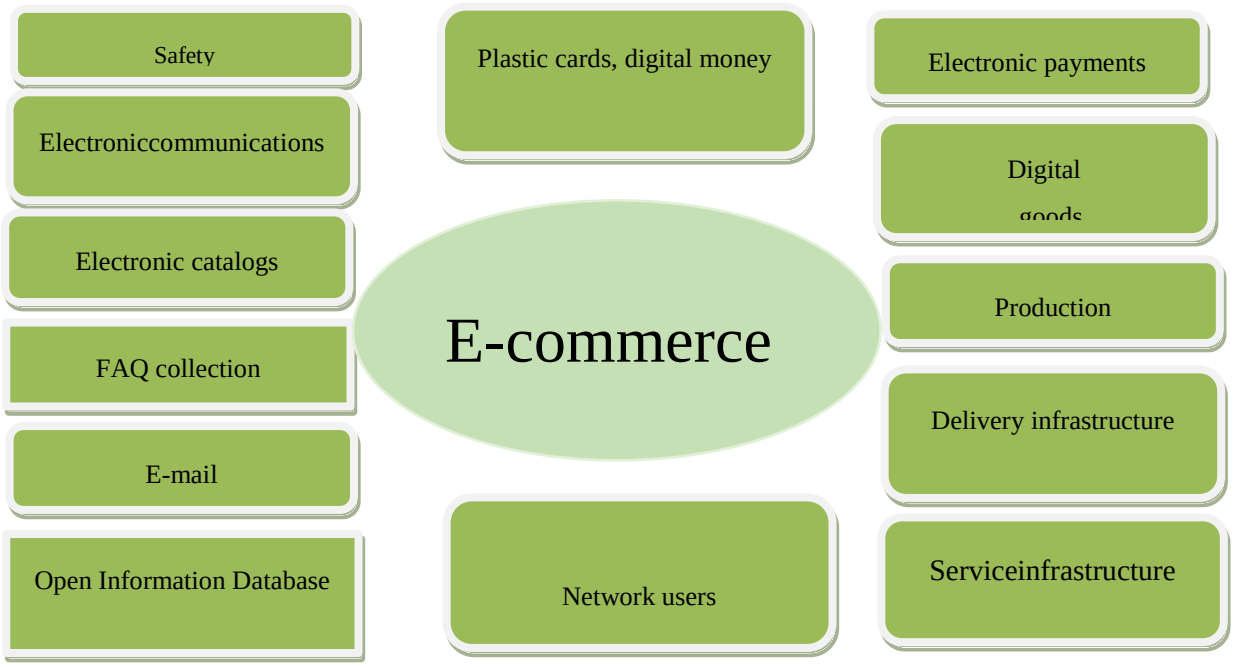
[2] Pardaev M.K., Isroilov Z.I., Gapparov A.K. Problems of improving economic analysis in the service sector. Treatise. Samarkand. "Zarafshon", 2009. - 66 p. - 4.1 pp.; Pulatov M.E., Mirzaev K.Zh., Sultonov Sh.A., Shavkiev E. Global economic development (tourism economy). Textbook. T.: Science and technology, 2018. - 296 p.; Muhammedov M.M. et al. Economics of trade. Samarkand. 1998. p. 282; Zaynalov D.R. Services and service as an economic category. // "Service" magazine. Samarkand: 2009, issue 1. pp. 70-77. - 0.6 pp.; Tukhliev I.S., Hayitboev R., Safarov B.Sh., Tursunova G.R. Basics of tourism. Textbook. - T.: Science and technology, 2014. - 332 p.; Aslanova D.Kh. Labor intensity of public catering products and reserves for its reduction: abstract of a dissertation for the degree of candidate of economic sciences. – Kyiv. 1992. – P. 20.

In our opinion, "E-commerce is the process of buying and selling goods and services electronically. As a result of the transaction, ownership of the goods and services transfers from one person to another. E-commerce easily integrates with marketing systems based on electronic tools, electronic payments, and logistics."

E-commerce technically has three main components: a server, a database, and a delivery system. The first component is considered to be of high quality, while a fast server is considered the most important.

Furthermore, e-commerce, which uses open electronic data via internet access, requires ensuring the security, confidentiality, and integrity of all participants.

Global e-commerce requires global certification systems, as the adopted security mechanisms are based on third-party certification.



Structural Elements of E-Commerce Figure 1.1.[1]

E-commerce consists of system elements formed by multifaceted relationships, which are classified as follows: network users, open database, email, FAQ, electronic catalogs, electronic communication,

security, bank cards or digital money, electronic payments, electronic products, production, delivery infrastructure, and service infrastructure (Figure 1.1).

[1]Developed by the author. Makhmudov L., "Classification of the structural elements of electronic commerce formed by multilateral connections", Collection of materials of the international scientific and practical conference "Development of the export of local products based on international marketing strategies". 19-20.11.2021., 261 p.

Handicrafts in Uzbekistan are a key part of cultural heritage and the national economy, encompassing such activities as ceramics, carpet weaving, embroidery, wood carving, jewelry making, and gold embroidery. The state actively supports artisans by providing incentives and establishing folk crafts centers, as well as developing the "ustoz-shogird" training system to pass on skills to new generations and attract tourists.

Handicrafts are an important part of cultural tourism, attracting visitors to the regions and creating new jobs.

To promote Uzbek handicrafts in international markets, it is necessary to focus on online platforms, participate in international exhibitions, develop cooperation with foreign tour operators, and maintain quality standards for competitive products. Government initiatives and the support of international organizations such as UNESCO play a crucial role in preserving traditions and creating conditions for exports.

Basic areas of promotion:

1. Online presence:

Create and promote websites and social media accounts showcasing products and explaining the production process.

Use international marketplaces for selling handmade goods, such as Etsy.

2. International exhibitions and fairs:

Actively participate in international exhibitions and folk craft fairs to present products and find buyers.

Participate in export support programs that help find foreign partners.

3. Tourism and cooperation:

Develop cooperation with foreign tour operators to include visits to craft workshops in their tours of Uzbekistan.

Create master classes and interactive programs for tourists to learn about craft traditions.

4. Quality improvement and standardization:

Ensure high-quality products in accordance with international standards to ensure they are competitive in foreign markets.

Develop innovative solutions in traditional crafts to make them more appealing to a modern audience.

5. Government Support and International Cooperation:

Using support from government agencies and international organizations, such as UNESCO, to preserve craft traditions and develop artisanship.

Based on a study of international experience:

One popular marketplace focused on selling handmade goods is Etsy.

Etsy is an American online platform for selling handmade goods. The service is widely popular in the United States, and currently has over 20 million registered users.

It allows creative people to sell handmade goods. Currently, the platform has over 800,000 established online stores, and its product range includes over 15 million items.

The project was created in 2005 by artist and photographer Rob Kalin.

Etsy charges a fee of $0.20 for each item listed on the site. If an item doesn't sell within four months, the fee is reissued. Additionally, each seller pays a 3.5% commission on each item sold.

Etsy Development Facts

• In 2007, the site sold its millionth item. Total sales on the site reached $4.3 million.

• In 2008, the site's growth accelerated significantly, attracting the attention of investors, who invested $27 million in the company's development. The project became independent and began to develop into a familiar e-commerce platform.

• In 2009, average monthly sales reached $13 million, and its audience continued to grow.

• In 2010, turnover exceeded $314 million, and a year later, this figure had already surpassed half a billion.

• In 2011, the site added a new feature—a seller search system with the ability to add sellers to "Favorites."

• In 2012, 600,000 users registered on the site per month.

• In 2015, Etsy went public, raising $267 million and valuing the company at $3 billion.

The project's main advantage is its narrow niche and unique products.

Table : Etsy's financial statements by year.[1]

Indicators	2019	2020	2021	2022	2023	2024
Capitalization	5.3 mlrd	21.6 mlrd	27.9 mlrd	9.23 mlrd	9.03 mlrd	5.99 mlrd
Net Profit	95.9 mln	349 mln	494 mln	-694mln	308 mln	303mln
Revenue	818 mln	1.73 mlrd	2.33 mlrd	2.57 mlrd	2.75 mlrd	2.81 mlrd
Sales cost	271 mln	465 mln	655 mln	745 mln	829 mln	775 mln
Gross Profit	547 mln	1.26 mlrd	1.67mlrd	1.82 mlrd	1.92mlrd	2.03 mlr

[1]https://marketcap.ru/stocks/ETSY/financial-statements/cash-flow

Table 2 : Etsy's Cash Flow by Year[1]

Indicators	2019	2020	2021	2022	2023	2024
Operating cash flow	207 mln	679 mln	652 mln	684 mln	706 mln	752 mln
Depreciation and amortization	48 mln	58.2 mln	74.3 mln	96.7 mln	91.3 mln	108 mln
Accounts payable	26.3 mln	40.9 mln	28 mln	28.8 mln	29.9 mln	26 mln
Accounts receivable	15.4 mln	22.6 mln	27.3 mln	-	24.7 mln	8.7 mln

Based on the year-on-year growth of Etsy, a marketplace focused on selling handmade goods in the US, we can confidently say that this is precisely the kind of marketplace Uzbekistan's artisans need.

CONCLUSIONS AND SUGGESTIONS

Uzbekistan has developed proposals and recommendations on all factors influencing the development of e-commerce. However, a number of issues need to be addressed to create an Etsy prototype in Uzbekistan.

These can be divided into several categories:

- Developing logistics and fast delivery systems
- Improving the quality of communication services and expanding coverage
- Expanding payment systems. Joining international payment systems such as PayPal
- Implementing voice search functionality in online stores

To prevent problems that may arise in Uzbekistan as a result of e-commerce development, the following tasks should be addressed immediately:

- First and foremost, ensure equal growth in real incomes of the population in all regions, ensure the opening of large and small logistics companies, and ensure full coverage of all regions with communication services;
- The issue of legal control over the system, a problem that has already arisen in developed e-commerce countries. Product quality issues. Because both seller and buyer are anonymous online and cannot see the product directly, the actual product quality may differ from what is shown online.

At the same time, our republic is currently characterized by a low level of market culture in commodity markets, underdeveloped regulatory frameworks, an underdeveloped information structure for commodity markets, a high level of economic monopolization, and an underdeveloped financial and credit system.

[1]https://marketcap.ru/stocks/ETSY/financial-statements/cash-flow

In Uzbekistan, the following measures have been taken to develop e-commerce.

A comparative analysis of the share of e-commerce in retail turnover in countries with developed e-commerce worldwide and trends in this area was conducted, as well as the share of e-commerce in retail turnover in Uzbekistan.

A classification of factors influencing the development of e-commerce, directly and indirectly related to the market situation, and hindering its development was developed.

Based on the goals of implementing e-commerce by type, criteria for assessing various aspects of e-commerce system use were developed, aimed at identifying its objectives, choosing the type of business, resolving organizational issues, and determining economic efficiency.

A service strategy for online store logistics was developed for enterprises focused on outsourcing online stores, transitioning operations to a mixed business model, creating a unified sales platform, developing a software suite, and fostering cooperation through virtual stores.

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THE APPLICATION OF MARKOV CHAIN MONTE CARLO MODELS (MCMC) TO FORECAST INBOUND TOURISM IN UZBEKISTAN

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ABSTRACT

This research applies the Markov Chain Monte Carlo (MCMC) modeling framework within a Bayesian statistical paradigm to forecast inbound tourism demand in Uzbekistan for the period 2025–2028. Inbound tourism is a vital indicator of a nation's economic competitiveness and international attractiveness, yet its prediction is complicated by the inherent uncertainty of global travel trends and political dynamics. Using annual data from 2000 to 2024, a Bayesian local-level state-space model was estimated on the logarithmic scale, capturing both latent growth dynamics and stochastic volatility. The MCMC algorithm generated thousands of posterior draws, providing full predictive distributions rather than point forecasts. Results show that the mean forecast of inbound arrivals is expected to increase from approximately 8.07 million visitors in 2025 to 11.08 million in 2028, implying an average annual growth rate of 10–12%. The model also reveals considerable uncertainty, with 95% credible intervals ranging widely to reflect potential structural shocks or exceptional growth episodes. The probabilistic nature of the MCMC approach offers a richer, risk-aware alternative to deterministic methods such as ARIMA, allowing policymakers to base tourism strategies on realistic credible ranges. Overall, the findings confirm that Bayesian simulation-based forecasting is a powerful tool for planning and decision-making in the tourism sector, particularly in volatile and data-limited environments such as Uzbekistan.

Keywords*: MCMC, Forecast, Baseline, Bayesian Approach, Probability Distribution*

Introduction

Inbound tourism is an important indicator demonstrating how tourism destination is doing in terms of economic performance and competitiveness. Forecasting it can be challenging due to uncertainty in global tourism markets and political tensions among countries. However, Bayesian approach gives a researcher tools to assess probability of an event, or in this case, the probability distribution of inbound tourism of Uzbekistan. Assuming that inbound tourism dynamics will follow normal distribution and other fundamental assumptions we can generate resilient forecasts for several years.

An important attraction of the Bayesian framework rests on more pragmatic considerations. In recent decades, the advent of cheap, fast computing power has seen simulation-based approaches to statistical inference become feasible for the typical social scientist. In particular, throughout the 1990s, there was something of an explosion of interest in Bayesian approaches, almost entirely driven by the fact that cheap computing power makes it feasible to do simulation-based, Bayesian statistical data analysis. A suite of algorithms known as Markov chain Monte Carlo (MCMC) makes the Bayesian approach not just a theoretical curiosity, but a practical reality for applied researchers.

The origins of Markov Chain Monte Carlo (MCMC) trace back to the early 1950s, following the advent of classical Monte Carlo methods at Los Alamos National Laboratory—one of the few facilities equipped with

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electronic computers at the time. In their seminal work, Metropolis et al. (1953) developed a computational scheme to simulate a liquid in thermodynamic equilibrium with its vapor phase. Instead of reproducing the full physical dynamics of molecular motion, they discovered that it was sufficient to construct and simulate a Markov chain whose stationary (equilibrium) distribution matched the desired physical distribution. This insight marked a fundamental conceptual shift, giving rise to what is now known as the Metropolis algorithm.

Initially, the method gained substantial traction in physics and chemistry, where it was applied to problems in statistical mechanics and thermodynamics. However, the approach remained largely confined to those disciplines for several decades and only began to penetrate statistical research communities in the late 1980s and early 1990s, coinciding with advances in computing accessibility.

Literature review

A significant theoretical extension was later introduced by Hastings (1970), who generalized the Metropolis scheme to accommodate asymmetric proposal distributions. The resulting Metropolis–Hastings algorithm provided a much broader and more flexible framework for constructing Markov chains with specified target distributions. In parallel, Geman and Geman (1984) proposed a related approach, apparently independent of the earlier work, while studying Bayesian image restoration. Their technique, known as the Gibbs sampler, represents a special case of the Metropolis–Hastings algorithm in which parameters are sampled sequentially from their full conditional distributions.

Although Geman and Geman initially emphasized optimization rather than simulation—focusing on the search for the posterior mode—it was later recognized within spatial statistics that the Gibbs sampler could be used to generate random draws from the full posterior distribution. This realization opened the door to performing complete Bayesian inference rather than point estimation alone. Around the same period, Tanner and Wong (1987) independently developed a similar concept termed data augmentation, unaware of the connection to the Gibbs sampler. Subsequently, Gelfand and Smith (1990) played a pivotal role in popularizing the Gibbs sampler within the broader Bayesian community, transforming MCMC into a central computational paradigm in modern statistics.

By the early 1990s, researchers had come to appreciate that most Bayesian analyses previously deemed intractable could now be carried out using MCMC simulation. Foundational theoretical work by Geyer (1992) and Tierney (1994) formalized the mathematical underpinnings of MCMC, establishing that the earlier methods—including those of Metropolis, Hastings, and Geman—were all special cases of a unified stochastic simulation framework. Subsequently, Green (1995) introduced a far-reaching extension of the Metropolis–Hastings algorithm, now referred to as the Metropolis–Hastings–Green algorithm, which enabled variable-dimension parameter spaces and underlies modern Reversible Jump MCMC.

Although MCMC revolutionized Bayesian computation, its utility extends beyond Bayesian contexts. It has also become an indispensable tool for likelihood-based inference in situations where analytical likelihoods are unavailable—such as models with missing data or complex dependency structures (Geyer, 1994, 1999).

Today, MCMC is recognized as a cornerstone of computational statistics, providing a flexible, general-purpose method for approximating probability distributions that are analytically intractable but fundamental to inference and decision-making.

Methodology.

The study employs the Markov Chain Monte Carlo (MCMC)approach to estimate and forecast inbound tourism demand within a Bayesian statistical framework. MCMC provides a powerful computational mechanism for approximating complex posterior distributions that are analytically intractable. In Bayesian inference, the goal is to obtain the posterior distribution of model parameters conditional on observed data. Given the joint probability structure of parameters θ and data y, Bayes' theorem defines this posterior as:

$$p(\theta|y) = \frac{p(y|\,\theta)\,p(\theta)}{p(y)}$$

Where:

$p(\theta)$ –represents the prior distribution encapsulating pre-sample beliefs about the parameters;

$p(y|\theta)$ –denotes the likelihood function;

$p(y) - \int p(y|\theta)\ p(\theta)d\theta$is the marginal likelihood or normalizing constant.

In most practical applications, including time series models of tourism demand, the denominator $p(y)$ is analytically intractable due to its high-dimensional integration.MCMC circumvents this challenge by constructing a Markov chain that generates dependent random samples whose long-run distribution converges to the true posterior $p(\theta|y)$.These simulated draws are then used to approximate posterior expectations, parameter estimates, and predictive distributions.

Let the observed data on inbound tourism be represented by the series $y_{1:T} = (y_1, y_2, \dots, y_T)$where y_t denotes the (logged) number of tourist arrivals at time t.

We assume an underlying latent process μ_t capturing the true, unobserved level of tourism demand, governed by a state-space (local-level) model:

$y_t = \mu_t + \epsilon_t$, where $\epsilon_t \sim N(0, \sigma^2) = \frac{1}{\sqrt{2\pi\sigma^2}} e^{-\frac{x^2}{2\sigma^2}}$, $x -$ a random variable

$\mu_t = \mu_{t-1} + \eta_t$, $\eta_t \sim N(0, \tau^2)$, $t = 1,2, \dots, T$, τ^2 –the variance of the state evolution — controls how volatile or flexible the trend is

$$\mu_1 \sim N(y_1, 1)$$

where:

σ^2denotes the observation variance, representing short-term fluctuations around the underlying trend;

τ^2 denotes the state evolution variance, controlling the smoothness or volatility of the long-term trend.

The joint posterior distribution of all unknown quantities is therefore:

$$p(\mu_{1:T}, \sigma, \tau\,|y_{1:T}) \propto p(\mu_1)p(\sigma)p(\tau)\prod_{t=2}^{T} p(\mu_t|\mu_{t-1}, \tau)\prod_{t=1}^{T} p(y_t|\mu_t, \sigma)$$

This expression forms the target distribution for MCMC sampling.Because the normalizing constant is not required, the algorithm can draw directly from the conditional densities.

The MCMC approach is a computational implementation of Bayesian updating.In essence, Bayes' theorem combines prior knowledge about parameters $p(\theta)$ with new information from the observed data

$p(y|\theta)$to yield a posterior distribution $p(\theta|y)$. MCMC approximates this posterior not by integration but through simulation — constructing a Markov chain that explores the parameter space according to transition rules satisfying detailed balance:

$$p(\theta'|\theta)p(\theta) = p(\theta|\theta')p(\theta')$$

Under appropriate regularity conditions, the stationary distribution of this chain is exactly the desired posterior $p(\theta|y)$ .Consequently, after a sufficiently long "burn-in" period, simulated draws $\{\theta^{(m)}\}_{m=1}^{M}$approximate samples from the true posterior, enabling estimation of posterior means, variances, and predictive quantities.

The model is estimated via the Metropolis–Hastings algorithm, a general MCMC scheme that iteratively:

1. Proposes new candidate values for parameters from a proposal distribution$q(\theta'|\theta)$,
2. Computes the acceptance probability:

$$\alpha = \min(1, \frac{p(y|\theta')p(\theta')\, q(\theta|\theta')}{p(y|\theta)p(\theta)\, q(\theta'|\theta)})$$

3. Accepts the proposed move with probability α\alphaα, otherwise retains the previous value.

When the proposal distribution is symmetric ($q(\theta'|\theta) = q(\theta|\theta')$), the scheme reduces to the Metropolis algorithm. Alternatively, when each parameter can be sampled directly from its full conditional distribution, the method becomes equivalent to the Gibbs sampler—a special case of Metropolis–Hastings.

To ensure non-negativity and regularization of variance parameters, the following weakly informative priors are adopted:

$$\sigma \sim HalfNormal(1), \qquad \tau \sim HalfNormal(1),$$

If $X \sim N(0, \sigma_0^2)$ and we take $Y = |X|$, then Y has a half normal distribution with scale $\sigma_0 = 1$, the probability distribution function is:

$$f(y|\sigma_0 = 1) = \begin{cases} \sqrt{\frac{2}{\pi}} e^{-\frac{y^2}{2}}, & y \geq 0 \\ 0 \end{cases}$$

For $\sigma_0 = 1$, the 95% prior quantile is about 1.96. So a $HalfNormal(1)$ says "we expect the standard deviation to be modest, but values up to 2 are quite plausible."

Putting it together we can get following model:

$$\mu_1 \sim N(y_1, 1),$$
$$\eta_t \sim N(0, \tau^2), \qquad t = 2, \ldots, T,$$
$$\mu_t | \mu_{t-1}, \tau = \mu_{t-1} + \eta_t,$$
$$\epsilon_t \sim N(0, \sigma^2),$$
$$y_t | \mu_t, \sigma = \mu_t + \epsilon_t$$

This is a Gaussian state-space model on the log scale. On the original scale e^{y_t} is log normal which is appropriate for positive, right skewed demand.

The MCMC analysis rests on the following core assumptions:

1. Gaussian errors: Both observation and state innovations (ϵ_t and η_t) are normally distributed with zero mean and constant variance. This implies symmetric shocks and absence of systematic bias in the error structure.
2. Markov property: The latent level μ_t depends only on its immediate predecessor $\mu_{t-1}$and not on earlier states, consistent with the Markov chain assumption.
3. Parameter stationarity**:** The variances σ^2 and τ^2 remain constant over time, implying stable noise processes during the analyzed period.
4. Conditional independence: Given the latent state μ_t, the observations $y_t$are independent of all other states and data points.
5. Posterior convergence: The Markov chain generated by the MCMC sampler converges to the true posterior distribution after a sufficient number of iterations.

Under these assumptions, the posterior draws $\{\mu_{1:T}^{(m)}, \sigma^{(m)}, \tau^{(m)}\}_{m=1}^{M}$ provide consistent estimates of the posterior mean and variance of all parameters, as well as predictive distributions for future tourism demand.

Results and analysis.

We forecasted the inbound tourism based on the actual data from year 2000 to 2024. First, we took the log of inbound tourism dynamics:

$$y_t = \log(Inbound_t), t = 1,2, \dots, T.$$

On the log scale, the model assumes each observation is a noisy snapshot of a latent variable μ_t that drifts over time.PyMC module draws many samples from the posterior distribution of all unknowns, namely:

$$p(\mu_{1:T}, \sigma, \tau \,|y_{1:T}) \propto p(\mu_1)p(\sigma)p(\tau)\prod_{t=2}^{T} p(\mu_t|\mu_{t-1}, \tau)\prod_{t=1}^{T} p(y_t|\mu_t, \sigma)$$

Practically, the above sampler learns a smoothed latent trajectory $\mu_1, \mu_2, \dots \mu_T$, how volatile is the state-evolution τ and how noisy are the observations (σ). So we get thousands of posterior draws $\{\mu_{1:T}^{(m)}, \sigma^{(m)}, \tau^{(m)}\}_{m=1}^{M}$The posterior distribution factorizes into the product of the prior densities for the initial latent state and variance parameters, the state transition densities linking μ_t to μ_{t-1} and the observation likelihood terms. This structure reflects the dynamic Bayesian updating process whereby latent tourism demand evolves as a random walk, and observed arrivals are treated as noisy realizations of this underlying level. The proportionality notation indicates that the expression omits the marginal likelihood, which is treated as a constant during Markov chain Monte Carlo sampling.

In the h-step ahead forecasts ($h = 4$ in our case) for each posterior draw m to evolve the latent level forward, we use following formula to make draws (Geyer, 1992):

$$\mu_{T+1}^{(m)} = \mu_T^{(m)} + \eta_{T+1}^{(m)}, \;\; \eta_{T+1}^{(m)} \sim N(0, [\tau^{(m)}]^2)$$

Repeat recursively for $T + 2, \dots, T + h$:

$$\mu_{T+k}^{(m)} = \mu_{T+k-1}^{(m)} + \eta_{T+k}^{(m)},\ \ \eta_{T+k}^{(m)} \sim N(0, \left[\tau^{(m)}\right]^2)$$

Then we generate future observations around that level:

$$y_{T+k}^{(m)} = \mu_{T+k}^{(m)} + \epsilon_{T+k}^{(m)},\ \ \epsilon_{T+k}^{(m)} \sim N(0, \left[\sigma^{(m)}\right]^2)$$

After getting the values for future observations we transform back values from log scale to original units:

$$Inbound_{T+k}^{(m)} = e^{y_{T+k}^{(m)}}$$

So, we do it for alldraws $m = 1,2, \dots, M$. The cloud of $\{Inbound_{T+k}^{(m)}\}$ is the posterior predictive distribution for year $T + k$.

Overall, μ_t – random walk level captures smooth long run growth, while evolution noise τ lets the level jump when the system changes, the larger τ means more agile adaptation. The observation noise σ soaks up year-specific deviations around the trend. In simpler words, μ_t is the best estimate of the current log trend, it anchors the forecast path. State volatility τ controls how wide forecasts spread as the horizon increases.

We used following Python code excerpt to do the forecast:

```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import pymc as pm
import arviz as az

# 1) Data
raw = {
    2000: "302",
    2001: "345",
    2002: "332",
    2003: "231",
    2004: "262",
    2005: "242",
    2006: "560",
    2007: "903",
    2008: "1069",
    2009: "1215",
```

```
    2010: "975",
    2011: "1500",
    2012: "1975",
    2013: "1969",
    2014: "1862",
    2015: "1918",
    2016: "2027,035",
    2017: "2690,074",
    2018: "5346,219",
    2019: "6748,512",
    2020: "1504,126",
    2021: "1881,345",
    2022: "5232,78",
    2023: "6626,331",
    2024: "7288,316",
}
years = np.array(sorted(raw.keys()))
vals_thousands = np.array([float(str(raw[y]).replace(",", ".")) for y in years], dtype=float)

# Log-transform
y = np.log(vals_thousands)
T = len(y)

# 2) Local-level state-space model
with pm.Model() as model:
    sigma = pm.HalfNormal("sigma", sigma=1.0)     # obs noise SD
    tau   = pm.HalfNormal("tau",   sigma=1.0)     # state evolution SD

    # Latent level: random walk on the log scale
    mu0 = pm.Normal("mu0", mu=y[0], sigma=1.0)
eps_state = pm.Normal("eps_state", mu=0.0, sigma=tau, shape=T-1)
```

```
    # mu_vec[0]=mu0; mu_vec[t]=mu_vec[t-1]+eps_state[t-1]
mu_vec = pm.Deterministic("mu_vec", pm.math.concatenate([[mu0], mu0 + pm.math.cumsum(eps_state)]))

    # Observation model
y_obs = pm.Normal("y_obs", mu=mu_vec, sigma=sigma, observed=y)

idata = pm.sample(draws=3000, tune=2000, chains=4, target_accept=0.9, random_seed=42, progressbar=True)

# 3) Forecast 2025–2028 on the log scale, then back-transform
h = 4
future_years = np.arange(years[-1]+1, years[-1]+1+h)

mu_T = idata.posterior["mu_vec"].sel(mu_vec_dim_0=T-1).values.reshape(-1)
tau_draws   = idata.posterior["tau"].values.reshape(-1)
sigma_draws = idata.posterior["sigma"].values.reshape(-1)

rng = np.random.default_rng(42)
n = mu_T.shape[0]
mu_future = np.zeros((n, h))
y_future  =np.zeros((n, h))

for i in range(n):
prev = mu_T[i]
    for t in range(h):
nxt = rng.normal(prev, tau_draws[i])       # state evolution
yhat = rng.normal(nxt, sigma_draws[i])     # observation
mu_future[i, t] = nxt
y_future[i, t]  =yhat
prev = nxt
```

```
pred_thousands = np.exp(y_future)  # back to level (thousand people)


def summarize(draws):
    return {
        "mean": np.mean(draws),
        "median": np.quantile(draws, 0.5),
        "p10": np.quantile(draws, 0.10),
        "p90": np.quantile(draws, 0.90),
        "p025": np.quantile(draws, 0.025),
        "p975": np.quantile(draws, 0.975),
    }


summaries = [summarize(pred_thousands[:, t]) for t in range(h)]
forecast_df = pd.DataFrame(summaries, index=future_years)[["mean","median","p10","p90","p025","p975"]]
forecast_df.index.name = "Year"
display(forecast_df.style.format("{:,.0f}"))


# Plot
plt.figure(figsize=(10,5))
plt.plot(years, vals_thousands, marker="o", label="Observed (thousand)")
plt.plot(future_years, [s["mean"] for s in summaries], marker="o", linestyle="--", label="Forecast mean")
plt.fill_between(future_years, [s["p10"] for s in summaries], [s["p90"] for s in summaries], alpha=0.25, label="80% CI")
plt.fill_between(future_years, [s["p025"] for s in summaries], [s["p975"] for s in summaries], alpha=0.15, label="95% CI")
plt.title("Inbound Tourism (thousand people): Bayesian Local-Level Forecast")
plt.xlabel("Year"); plt.ylabel("Thousand people"); plt.grid(True); plt.legend(); plt.show()
```

The MCMC model can be considered as a smart “trend tracker” on the log of inbound tourism. Each year, it updates its internal belief μ_t about the true underlying level, allowing that level to wander when the world changes (throughτ) and to tolerate one-off surprises (throughσ). MCMC gives many plausible versions of that latent history and the parameters that govern it. To forecast, the model pushes the latent level forward year by year with the same physics that generated the past, then sprinkles observation noise, and

converts back by exponentiating. The result isn't just a line—it's a full predictive distribution that reflects both structural uncertainty (how the trend might drift) and immediate uncertainty (annual bumps), producing means/medians and credible bands that can be relied on for planning.

Table 1. The results of MCMC analysis

Year	mean	median	p10	p90	p025	p975
2025	8069,515087	7042,629697	3686,177398	13471,514	2595,668484	19690,43
2026	8970,984063	6954,363887	2980,658578	16686,51364	1852,12357	27929,99
2027	10026,23107	6977,853386	2543,249959	19841,96048	1418,402476	36893,77
2028	11077,6405	6916,518225	2141,139116	22733,56433	1127,375147	45134,85

The mean represents the expected average forecast for inbound tourist arrivals in each year, integrating over all MCMC simulations.It is the arithmetic average of all simulated posterior predictive outcomes$y_t^{(m)}$.Formally it can be expressed as follows:

$$Mean_t = \frac{1}{M}\sum_{m=1}^{M} y_t^{(m)}$$

For example, the model expects approximately 8.07 million inbound visitors in 2025, rising to around 11.08 million by 2028.This is the most probable central scenario when averaging over uncertainty about future shocks and model parameters.

The *median* indicates the midpoint of the predictive distribution — there is a 50% probability that the actual number of tourists will be below this value and 50% that it will be above it.Mathematically:

$$P(Y_t < Median_t) = 0.5$$

In the results table, the median values are consistently lower than the mean, implying that the forecast distribution is right-skewed (i.e., there are some high-growth scenarios that pull the mean upward).This is typical in tourism forecasts, where a few optimistic trajectories (e.g., new flight routes, major events, policy reforms) can generate exceptionally high arrival numbers.

The*p10* value shows the lower bound of the 80% credible range.It means there is only a 10% probability that the true number of tourists will fall below this value.It captures the "pessimistic but plausible" scenario.For instance, in 2025, $p10 = 3.69$ million — suggesting that, even under relatively adverse conditions (economic slowdown, global uncertainty, etc.), inbound arrivals are very unlikely to fall below this level.

The *p90* value represents the upper bound of the 80% credible range.There is a 90% probability that the true value will be below this threshold, and a 10% probability that it will exceed it.

Thus, for 2025, $p90 = 13.47$ million corresponds to a high-growth or optimistic scenario, such as strong international demand recovery, new air connectivity, or promotional campaigns that attract record numbers of tourists.

p025 and p975 (95% credible interval)columns define the full 95% Bayesian credible interval for each forecast year.This range captures nearly all uncertainty (both parameter and process uncertainty) contained in the posterior predictive distribution. Mathematically in can be expressed as follows:

$$P(p_{0.025} < Y_t < p_{0975}) = 0.95$$

For 2025, the 95% interval is [2.60 million, 19.69 million], meaning there is a 95% posterior probability that actual inbound tourist arrivals will fall within this range.The wide interval reflects high model uncertainty due to historical volatility and the limited sample size.

The posterior summaries indicate a steady upward recovery and expansion in Uzbekistan's inbound tourism during 2025–2028.The mean forecasts suggest growth from around 8 million to 11 million visitors, implying an average annual growth rate of approximately 10–12% under baseline conditions.

However, the wide credible intervals signal substantial uncertainty around future demand, driven by potential structural shocks, geopolitical factors, and global travel dynamics.For example, in 2028, the 95% credible range extends from about 1.13 million to 45.1 million visitors — highlighting that, while rapid growth is possible, sharp downturns cannot be ruled out either.

The asymmetry between mean and median forecasts emphasizes that the distribution of possible outcomes is non-Gaussian: extreme positive events (such as large-scale tourism promotion, visa liberalization, or major infrastructure openings) could yield exceptionally high arrivals, but such cases remain low-probability tails of the posterior distribution.

From a policy planning perspective, the central forecasts (mean or median) can guide baseline expectations, whereas the p10–p90 interval offers a realistic operational range for medium-term budgeting and infrastructure planning.The 95% credible intervalshould be interpreted as a "risk envelope" useful for strategic scenarios and stress testing (e.g., assessing resilience against external shocks).

This forecast table reflects the posterior predictive distribution derived from a Bayesian local-level (state-space) model estimated via Markov Chain Monte Carlo (MCMC).Each statistic — mean, median, and quantiles — represents a summary of thousands of simulated future paths for inbound tourism, consistent with both past data trends and parameter uncertainty.

This probabilistic forecasting approach thus provides a richer, uncertainty-aware perspective than classical deterministic models (e.g., ARIMA), making it especially suitable for tourism demand analysis in volatile environments.

The chart below illustrates the historical and projected trajectory of inbound tourism in Uzbekistan based on the Bayesian local-level model estimated using annual data from 2000 to 2024. The solid blue line represents the observed number of inbound tourists (in thousand people), while the orange dashed line indicates the forecasted mean values for the period 2025–2028. The shaded areas denote the 80% (grey) and 95% (light orange)credible intervals (CI) derived from the posterior predictive distribution, reflecting the model's quantified uncertainty about future tourism demand.

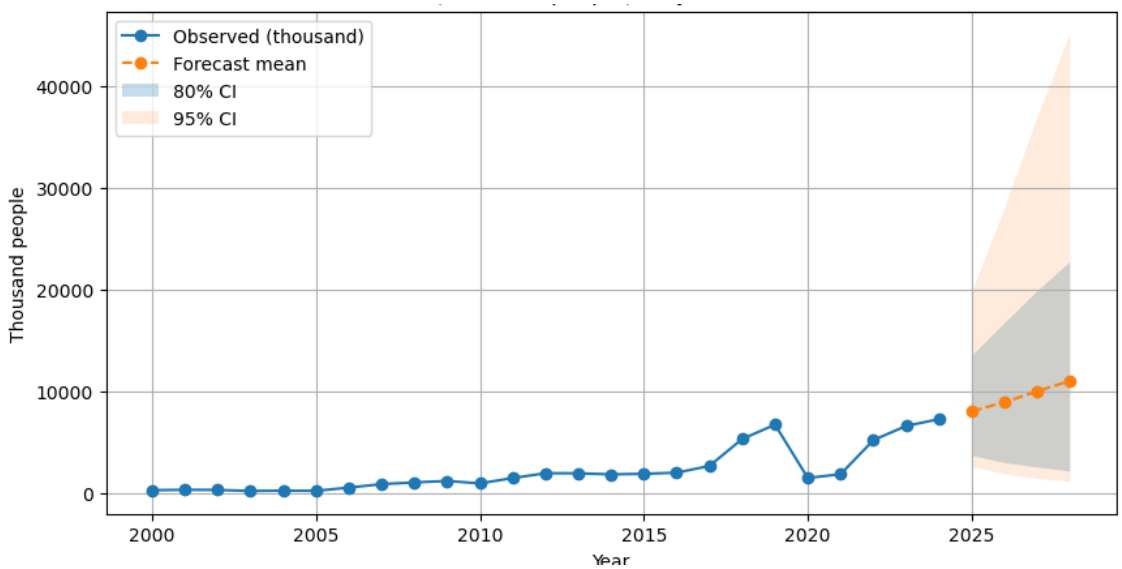

Figure 1. Bayesian local level forecast of Inbound tourism, thousand people

Between 2000 and 2015, inbound tourism showed modest but steady growth, remaining below 2,000 thousand visitors.From 2016 onwards, the curve steepens, indicating accelerated growth associated with major reforms in Uzbekistan's tourism policy—such as visa liberalization, infrastructure investments, and enhanced international promotion.

The sharp drop in 2020 is clearly visible in the figure and corresponds to the COVID-19 pandemic, which caused a global collapse in international travel. Following this disruption, the series rebounds rapidly in 2021–2024, showing strong post-pandemic recovery momentum.

The orange dashed segment represents model-based forecasts.The mean forecast line continues the upward trajectory, predicting that inbound tourism will likely increase from about 8 million visitors in 2025 to roughly 11 million by 2028, under baseline conditions.

However, the shaded credible intervals around the forecast expand noticeably over time:

- The 80% credible interval (grey area) captures the most plausible range of outcomes, representing normal year-to-year variability.
- The 95% credible interval (orange area) is considerably wider, showing the extent of uncertainty accumulation due to both model error and potential structural shocks over longer horizons.

This widening fan shape is typical in Bayesian state-space forecasts: uncertainty about the latent level μ_t increases as predictions move further into the future.

The asymmetric and widening bands imply that while steady growth is the most likely scenario, the model also allows for:

- Lower-bound outcomes (e.g., new global disruptions, slower regional recovery, or policy reversals); and
- Upper-tail scenarios (e.g., tourism booms driven by large-scale events, improved air connectivity, or intensified marketing campaigns).

The right-skewed predictive distribution visible in the shaded fan reflects these asymmetric possibilities—high positive shocks are less probable but potentially very large in magnitude.

From a strategic planning perspective, the forecast mean (orange line) can serve as a baseline scenario for medium-term tourism strategy, infrastructure investment, and human-resource planning.The credible intervals provide a quantitative risk envelope for scenario analysis.For instance, policymakers can use the lower bound (p10 or p025) for conservative budgeting and the upper bound (p90 or p975) for optimistic capacity planning.The widening uncertainty emphasizes the need for adaptive and resilient tourism policies capable of responding to unexpected shocks or opportunities.

Overall, the Bayesian local-level forecast suggests that Uzbekistan's inbound tourism sector is entering a new phase of growth after its pandemic-induced contraction. The trajectory remains strongly positive, with a central forecast pointing toward continued expansion through 2028.Nevertheless, the model highlights that forecast uncertainty rises over time, underscoring the importance of flexible management strategies and the integration of new data as it becomes available to continually update and refine forecasts.

Conclusion

This research demonstrates the practical advantages of employing the Markov Chain Monte Carlo (MCMC) approach to forecast inbound tourism in Uzbekistan. By integrating Bayesian inference with a local-level state-space formulation, the model captures both the long-term stochastic trend of tourism development and short-term random fluctuations caused by external shocks. The simulation results suggest a strong post-pandemic recovery and a sustained upward trajectory of inbound tourism through 2028, supported by national reforms such as visa liberalization and international marketing initiatives.

However, the widening credible intervals indicate that future tourism demand remains highly uncertain and sensitive to global disruptions, regional policy changes, and economic cycles. Unlike traditional deterministic forecasts, the Bayesian MCMC framework explicitly quantifies this uncertainty, allowing policymakers to interpret forecasts as probability distributions rather than fixed numbers. This enables more robust scenario analysis, risk assessment, and contingency planning for infrastructure, human resources, and destination management.

In methodological terms, the study validates MCMC as an effective computational tool for tourism forecasting, capable of handling small sample sizes and non-linear dynamics while maintaining interpretability. Future research can enhance this framework by integrating additional explanatory variables—such as GDP, air connectivity, or global travel sentiment—or by extending the model to multivariate Bayesian structures. Overall, the findings confirm that MCMC-based forecasting provides a flexible, transparent, and probabilistically sound foundation for evidence-based tourism policy and strategic decision-making in Uzbekistan and similar emerging destinations.

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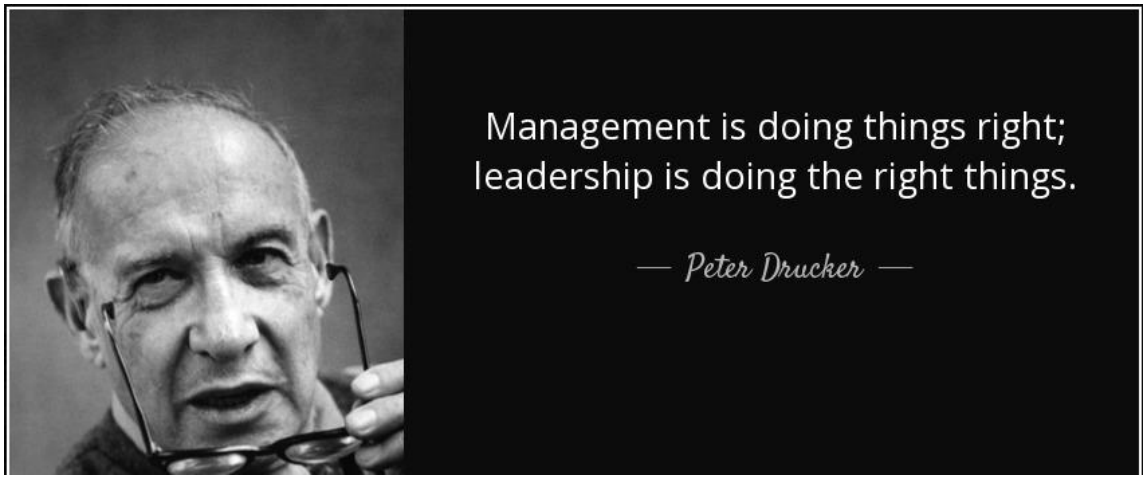

ANALYSIS OF THE DEVELOPMENT STATUS AND FINANCING INDICATORS OF SPORTS INFRASTRUCTURE

M.N. Mamatov[1]

ABSTRACT

This article analytically examines the establishment and development indicators of sports infrastructure facilities in our republic, as well as the status of sports sector financing at the regional level. The utilization capacities of sports facilities in the regions were analyzed, and proposals and recommendations were developed for improving sports financing by investigating existing problems in financing.

Keywords: *Sports Sector Infrastructure, Utilization Capacities Of Sports Facilities, Sports Financing Criteria, Regional Financing Requirements.*

INTRODUCTION

The reforms being implemented to prioritize the development of the sports sector, which is one of the country's important strategic areas, are currently yielding positive practical results. Therefore, the main objective of this study has been defined as investigating sports-specialized facilities operating in our republic, specifically the activities and service provision status of sports institutions, their level of provision with sports equipment, the degree of public engagement in sports facilities, the state of financing and utilization of financial resources in the sports sector, and the results achieved in this field.

Analyzing the sports facilities operating in various regions of our republic and their financing status, the state of provision with sports equipment, analyzing the financial indicators of sports facilities and assessing the situation, as well as analyzing factors affecting the effectiveness of sports service provision, also holds significant importance.

Analysis of Relevant Literature

In the New Uzbekistan, which has moved from the Action Strategy toward the Development Strategy, a new system has been established for the development of physical culture and sports. On January 28, 2022, the President of the Republic of Uzbekistan adopted Decree No. PF-60 “On the Development Strategy of the New Uzbekistan for 2022–2026.” Objective 67 of this decree sets specific goals and tasks for “increasing the number of citizens who regularly engage in physical culture and sports.” In particular, it emphasizes increasing the share of the population involved in physical culture and sports to 33 percent by 2026, promoting national sports among the youth, improving the infrastructure of sports facilities where competitions are held, equipping them with the necessary sports inventory, and encouraging athletes [3].

According to the research of B. Nazirov, the development of physical culture and sports has gone through three main stages. The first stage of reforms in this field covered the period from 1991 to 1999. During this period, while promoting and expanding mass sports across the country, great attention was paid to improving public health and encouraging people of all ages to engage in regular sports activities. At the

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same time, developing professional sports through the expansion of mass sports was set as a key objective [4].

During this period, several laws, presidential decrees, and resolutions of the Cabinet of Ministers aimed at developing the field of physical culture and sports were adopted in the Republic. Moreover, the following measures were prioritized:

- The organizational foundations for managing physical culture and sports were improved;
- The National Olympic Committee of Uzbekistan and federations for various sports were established;
- Physical education, recreational and mass sports activities, as well as national sports and games, were developed;
- The system of financial support for physical culture and sports was improved, and efforts were made to strengthen the material and technical base.

In this article, the topic is analyzed based on statistical data concerning the organization of sports infrastructure facilities in the Republic of Uzbekistan, the construction of sports facilities in the regions, their financing, and indicators of sports facility utilization. In the practical analysis, official statistical data and methods such as statistical observation, comparative analysis, synthesis, logical reasoning, statistical tables and graphs, and comparative evaluation were employed.

Results and discussions

The development of the sports sector in our country is directly linked to the established sports infrastructure and its provision with sports equipment. In this regard, if we take an analytical approach to the volume of sports infrastructure facilities built in urban and rural areas of the republic, it can be seen that in 2000, the total number of existing sports facilities across the country amounted to 46,487, of which 19.7 percent, or 9,149 facilities, were located in urban areas, and 80.3 percent, or 37,338 facilities, were operating in rural areas (Table 1).

1-table : Analysis of Changes in the Number of Existing Sports Facilities in the Republic (units) for the Period 2000–2024 [6].

№	Key indicators	2000 y.	2010 y.	2016 y.	2020 y.	2022 y.	2024 y.	Ratio of 2024 to 2010	
								(+;-)	%
1.	In urban areas	9149	9377	24852	24196	25326	24626	15249	↑ 262,5
2.	In rural areas	37338	41291	26001	27909	28863	28688	-12603	↓ 69,5
Total:		**46487**	**50668**	**50853**	**52105**	**54189**	**53314**	**2646**	**↑ 105,2**

If we look at the data in Table 1 at the national level, it can be seen that by 2016, the number of sports facilities in rural areas had almost halved compared to the year 2000, while in urban areas, the number of sports facilities showed an increase compared to previous years. As of 2024, the total number of sports facilities amounted to 53,314, which is 2,646 more than in 2010. The analysis shows that when comparing

2024 to 2010, the number of existing sports facilities in rural areas decreased by 12,603 units, or by 69.5 percent. It can be concluded from the analysis that the decline in the number of sports facilities in rural areas is directly related to the migration of sports coaches to urban areas, the instability of sports personnel and coaches in rural regions, as well as existing problems in regional financing and financial incentives. It is also important to conduct an analytical study of sports facilities funded by the state budget and established in various regions of the republic, as well as their utilization rates from a regional perspective.

2-table : Analysis of the Dynamics of Changes in the Number of Existing Sports Facilities across the Regions of the Republic for 2016–2024 (units) [6].

Regions	2016 y.	2018 y.	2020 y.	2022 y.	2024 y.	Difference of 2024 relative to 2016	
						(+;-)	%
1. Republic of Karakalpakstan	3109	3186	3299	3604	3693	584	118,8
2. Andijan Region	4265	4268	4310	5311	5365	1100	125,8
3. Bukhara Region	3465	3479	3479	3536	3297	-168	95,2
4. Jizzakh Region	2833	3211	3214	3233	2771	-62	97,8
5. Kashkadarya Region	4925	5130	5135	5169	5178	253	105,1
6. Navoiy Region	1794	1784	1817	1828	1764	-30	98,3
7. Namangan Region	3291	3271	3647	3810	3927	636	119,3
8. Samarkand Region	5480	5555	5586	5657	5803	323	105,9
9. Surkhandarya Region	4344	4298	4182	4436	4455	111	102,6
10. (Syrdarya Region	1490	1557	1567	1583	1588	98	106,6
11. Tashkent Region	4408	4500	4526	4575	4579	171	103,9
12. Fergana Region	5817	5761	5776	5814	6064	247	104,2
13. Khorezm Region	3461	3404	3418	3452	2753	-708	79,5
14. Tashkent Region	2171	2179	2149	2181	2077	-94	95,7
Republic of Uzbekistan	**50853**	**51583**	**52105**	**54189**	**53314**	**2461**	**104,8**

If we analyze the number of existing sports facilities by regions for the period of 2016–2024, in 2016 the total number of such facilities across the republic was 50,853, with Fergana and Samarkand regions standing out for having a higher number of sports facilities compared to other regions. However, although a growth trend was observed nationwide over the years, a decline occurred in some regions. As of 2024, the number of sports facilities decreased by 875 compared to 2022. When compared to 2016, the number of sports facilities in 2024 increased by 2,461 or 104.8 percent.

From a regional perspective, if we compare 2024 with 2016, we can see that the number of facilities decreased by 168 in Bukhara region, 62 in Jizzakh region, 30 in Navoi region, and 94 in Tashkent city. The largest decrease was recorded in Khorezm region, where the number of sports facilities dropped by 708 (Table 2).

The total daily capacity of sports facilities in 2016 amounted to 1,999,846 people, of which 934,065 were in rural areas. The utilization capacity of sports facilities has shown an upward trend over the years; in particular, in 2024, the total daily capacity reached 2,200,845 people, including 1,086,627 in rural areas.

If we analyze the number of existing sports facilities and their daily utilization capacity (throughput) in Uzbekistan for the period 2018–2024, in 2018 there were a total of 51,583 facilities across the republic, with a daily capacity of 2,076,269 people for five main types of sports facilities. This included stadiums, sports halls, swimming pools, shooting ranges, and sports fields, which accounted for most of the total utilization capacity.

By 2024, the number of sports facilities reached 53,314, representing a 3.35 percent increase over six years. The daily utilization capacity of sports facilities increased by up to 6 percent compared to 2018. However, it should be noted that the analysis of the provided statistical data shows that the daily utilization capacity of horse riding arenas, manege halls, and shooting ranges has not been critically or analytically reviewed by regional sports administrations over the years. This situation affects the financing of such types of facilities.

In terms of daily utilization capacity, the highest indicators were recorded for sports halls and sports fields, which together accounted for more than 90 percent of the total utilization capacity. The efficiency of the daily utilization capacity of sports facilities can be calculated using the following formula:

$$Fs = \frac{1\ kun.quv.(kishi)}{Insh.soni}$$

Fs – utilization efficiency;

- 1 kun.quvv (kishi) – one-day capacity (persons);

- Insh.soni – number of facilities.

The utilization efficiency of sports facilities (Fs) is understood as the ratio of the number of users to the one-day capacity of the existing sports facilities, i.e., the average number of users per facility. This indicates how efficiently the sports facilities are operating.

During 2016–2024, the total number of sports-education institutions operating in the republic amounted to 347. In 2016, 314 of these institutions were operating in urban areas and 33 in rural areas. The number of sports-education institutions in urban areas was 9.5 times greater than in rural areas. Between 2016 and 2020, there was almost no increase in the number of sports-education institutions. In 2022–2024, the number of sports-education institutions in urban and rural areas increased by 116%. Significant positive changes have also been achieved in the development of sports-education infrastructure in rural areas.

CONCLUSION

The opportunities created in our country for the development of the sports sector, the efficient use of financial resources allocated to sports, their correct allocation across sporting disciplines, and the targeted

use of these funds are of great importance. For this reason, expenditures on the sports sector can be directly assessed by the results achieved in sports competitions.

In accordance with the measures set out in the State Program of the Republic of Uzbekistan, consistent reforms have been implemented to finance the construction and reconstruction of sports infrastructure facilities being built in the regions of our country from the state and local budgets. In particular, financing for the construction and reconstruction of sports infrastructure facilities covered by the republican budget was carried out during 2022–2024. While the total number of facilities financed from the budget in 2021–2024 amounted to 169, the highest figures were recorded in Tashkent region with 24 facilities and Tashkent city with 27 facilities.

From the republican budget, 101 new sports facilities were built during 2021–2024. The number of newly built sports facilities financed from the state budget was 33 in 2021, 26 in 2022, and decreased twofold to 13 in 2023; in 2024 it increased by 16 compared to 2023, reaching 29. There were also noticeable changes in the number of reconstructed sports facilities: 27 facilities were reconstructed in 2021, while by 2024, 18 sports buildings had been renovated.

In conclusion, it should be noted that the reforms being implemented in the republic to develop the sports sector are yielding results. However, it remains important to finance the construction and repair of sports facilities and to provide financial support to athletes and their coaches. Timely identification of problems arising in this area and finding solutions to them remains one of the pressing tasks today..

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THE IMPORTANCE OF DIGITAL TECHNOLOGIES IN INCREASING THE EFFICIENCY OF EDUCATIONAL SERVICES

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ABSTRACT

This article analyzes the impact of digital technologies on improving the efficiency and quality of educational services in the higher education system. The purpose of the study is to identify the main directions and mechanisms of using digital tools in the educational and management activities of higher education institutions. Systematic and process approaches, as well as methods of comparative and substantive analysis of normative and empirical data, were used as the methodological basis. It is shown that the introduction of digital solutions (online platforms, distance learning systems, data analysis tools) serves to improve educational processes, individualize education and increase student satisfaction. Directions for improving the efficiency of educational services based on digital transformation are proposed.

Keywords - *Digitalization Of Education, Digital Technologies, Efficiency Of Educational Services, Quality Of Education; Management Of A Higher Education Institution, Digital Transformation, Quality Management System, Innovations In Higher Education.*

I. INTRODUCTION

In recent years, the impact of digital technologies on the efficiency and quality of educational services has become one of the main areas of scientific research in the field of higher education management and pedagogy. Digitalization is considered a strategic factor that determines the competitiveness and sustainability of education in the context of global changes . Digital innovations have demonstrated their ability to complement, enrich and transform education and have the potential to accelerate the achievement of Sustainable Development Goal 4 (SDG 4) in the field of education and improve the methods of providing universal access to education. They are able to improve the quality and relevance of education, strengthen inclusion, and improve the management and control of education.

International organizations such as UNESCO and OECD emphasize in their analytical reports that digital technologies contribute to increasing the convenience, flexibility and personalization of educational services, creating conditions for the development of inclusive and lifelong learning [1; 2]. "Digital technologies are increasingly penetrating all areas of our lives, changing not only the way we live, but also how we learn. They promise much: advances in the fields of communication, mobile devices, open educational resources and artificial intelligence are opening up new opportunities for reaching out to marginalized learners," said UNESCO Director-General Audrey Azoulay in her message on the occasion of the International Day of Digital Education. At the same time, it is emphasized that the effective use of digital tools requires systemic changes in quality management, teaching methods and staff training.

The country's President Shavkat Mirziyoyev emphasizes the importance of digital technologies in improving the quality of education. Digital educational platforms , online educational schools , electronic textbooks , virtual and multimedia laboratories play an important role in this process . He puts forward the

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idea that these technologies expand the scope of education, allow for individual and interactive organization of lessons, help consolidate students' knowledge and prepare them for the modern world.

II. LITERATURE REVIEW

In addition, among foreign researchers who have made a significant contribution to the development of the topic, T. Bates stands out. He analyzes the strategic and organizational aspects of the digital transformation of higher education institutions and emphasizes the need to integrate information technology innovations into the quality management system [3]. George Siemens, developing the concept of connectivism, explains how digital networks and technologies change the processes of knowledge acquisition and the structure of educational interactions [4]. Neil Selwyn, drawing attention to the risks of digitalization, emphasizes that the introduction of technologies does not automatically guarantee an increase in the quality of education without methodological and organizational support [5]. Digitalization is necessary to increase the competitiveness and originality of educational institutions. This is the key to successful development in the modern world.

Russian researchers consider the digitalization of education as a key factor in increasing the efficiency of higher education institutions . In particular, MG Sorokova, MA Odinsova and NP Radchikova developed a scale for assessing the digital educational environment (RDE) of a university, which allows for a comprehensive description of the RTE [Sorokova et al., 2021]. GU Soldatova, together with her colleagues, proposed short and screening versions of the Digital Competence Index (RKI). This index is designed to measure knowledge, skills , motivation and responsibility/safety in the network in each of the following areas: content, communication, consumption and technosphere [Soldatova, Rasskazova, 2018].

Particular attention is paid to the introduction of digital platforms and LMS systems. Studies show that this leads to increased student engagement, improved learning, and improved feedback between participants in the educational environment [10; 11]. At the same time, attention is also paid to the barriers to digitalization: limited teacher training, uneven technical support , and poor integration of information technology tools into strategic management of educational quality [12; 13].

The literature review shows that , although most of the work is devoted to the general theoretical and organizational aspects of digitalization, there are still few empirical studies aimed at determining the specific impact of digital technologies on the quality indicators of educational services. In particular, the relationship between the level of digital maturity of higher education institutions and the effectiveness of educational activities, as well as the impact of digital solutions on the satisfaction of students and teachers, has not been sufficiently studied. Thus, despite the large number of studies conducted, the question of the real impact of digital technologies on the effectiveness of educational services remains open. This situation determines the need for practical research at the level of individual higher education institutions. Such research should be aimed at assessing the relationship between the level of digitalization, the quality of educational services and the effectiveness of the educational process, and at developing practical recommendations for improving the effectiveness of the digital transformation of higher education.

III. RESEARCH METHODOLOGY

We used methods of logical analysis and synthesis, logical approach of the theory of knowledge, induction and deduction, comparative and factor analysis, time and space, comparison, and monographic observation in the research.

IV. ANALYSIS AND RESULTS

The methodological basis of the study was the principles of systemic, process and competency approaches and the concept of strategic management of educational quality in the context of digital transformation. The use of a systemic approach made it possible to consider educational services as a complex socio-economic product formed in the process of interaction of pedagogical, technological and management subsystems of a higher educational institution [1; 3; 8]. The process approach provided the opportunity to analyze digitalization as a continuous cycle of controlled processes aimed at increasing the efficiency and quality of educational outcomes [7; 14].

The issues of quality education are especially relevant in the era of EDUCATION 5.0. The concept of EDUCATION 5.0 appeared relatively recently, during the COVID-19 pandemic . During this period, distance education (DE) became more active. Before the pandemic, supporters of DE were divided into two groups : active and passive users who were skeptical about the future development of DE systems, while during and after the pandemic, the number of supporters of the development of tools and methods of distance education increased significantly. The acceleration of large-scale work on the creation of artificial intelligence systems , as well as research on the topic of distance education from the perspective of a social phenomenon, led to new paradigms: the need to take into account the specific characteristics of teaching and learning, to improve teaching methods taking into account social problems, and to use the achievements of artificial intelligence technologies to increase the efficiency of learning.

The development of EDUCATION 5.0 is of great importance for the development of society as a whole. Because the tasks of this concept are mainly aimed not only at the active use of new ICT, but also at training specialists who are critical thinkers, able to adapt to rapidly changing conditions, creative and interdisciplinary, and capable of solving problems in various fields of knowledge and activity. Creating access to advanced technologies and scientific and educational information not only increases the efficiency of the educational process, but also develops the principles of person-centered, holistic and continuous education within the framework of Education 5.0. Only when innovations are person-centered, sustainable development can be achieved in higher education and society as a whole.

The efforts of those who adhere to the principles of EDUCATION 5.0 are aimed at personalizing the educational process, using technological advances to support lifelong learning through the provision of interactive content and special software and hardware. Moreover, these principles are aimed at the formation of a well-rounded individual, not only with cognitive skills, but also with emotional intelligence, social awareness and moral values. These principles correspond to the tasks of a civilized society that is “human-centered, contributing to well-being, inclusion and adherence to ethical standards” [5].

Digitalization opens up new perspectives for universities and can become one of the main factors of their transformation. The implementation of the principles of Society 5.0 and Industry 5.0 in the practice and policy of Education 5.0 will allow both universities and society to fully benefit from the benefits of digital transformation [11].

The theoretical and methodological basis of the study was the works of domestic and foreign authors in the field of digitalization of education (T. Bates, J. Siemens, N. Selvin, N. Sh. Kozlova, VP Bespalko, etc.) and regulatory documents. Uzbekistan pays special attention to the introduction of digital solutions into the education system.

The legal foundation for this was created by the Law of the Republic of Uzbekistan "On the Strategy of Digital Uzbekistan - 2030", adopted in 2020[1].

The law defines the goals and objectives of digitalization, including the development of digital literacy, ensuring equal access to quality education, and creating a unified digital educational environment. It also defines financing mechanisms and requirements for the digital infrastructure of educational institutions. In the period until 2030

Thus, to achieve the research objective - namely, to identify the mechanisms and factors influencing the effectiveness of digital technologies in educational services - the following research methods were used :

Theoretical methods: analysis and generalization of scientific literature, regulatory and strategic documents, comparative study of Russian and foreign experiences in the digitalization of education. This stage made it possible to identify the main trends, advantages and risks of introducing digital technologies into the higher education system.

Empirical methods: A survey and expert interviews were conducted among teachers and students of higher education institutions in Samarkand . 210 students and 65 teachers studying in various fields participated in the survey. The questionnaire included blocks of questions on the level of use of digital tools, satisfaction with digital services, their impact on the quality of education , and assessment of the effectiveness of feedback.

Quantitative analysis methods: processing and interpretation of the obtained data using statistical tools of descriptive and correlation analysis (Microsoft Excel, SPSS). This made it possible to determine the relationship between the level of use of digital technologies and indicators of the effectiveness of the educational process - student participation, quality of communication, and satisfaction with the educational environment.

A substantive analysis of the official documents and internal regulations of local higher education institutions regulating digitalization processes and education quality management systems. This analysis focused on identifying institutional mechanisms for supporting digital transformation and assessing its impact on the quality of educational services.

The comparative analysis method was used to compare the effectiveness of educational services in traditional and digital formats, allowing us to identify areas where the introduction of digital technologies has the most significant impact (for example, increasing interactivity, speed of feedback, accessibility of educational materials).

and validity of the results obtained were ensured by the comprehensive use of complementary methods, the representativeness of the sample of respondents, as well as by verifying the conclusions by comparing them with the results of previous studies in domestic and foreign literature [3; 4; 5; 9].

allowed not only to identify the role of digital technologies as a factor in increasing the efficiency of educational services, but also to identify specific management and pedagogical mechanisms that ensure the realization of this potential in the context of the digital transformation of higher education .

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The empirical part of the study focused on identifying the relationship between the level of use of digital technologies and indicators of the effectiveness of educational services. During the survey, data were collected from 210 students and 65 teachers (between May and September 2025) on the frequency of use of digital tools, the level of digital competencies, and the perception of the quality of educational processes.

1. The level of digitalization of the educational process

UNESCO is leading global efforts to ensure access to digital education for all through initiatives such as the “Artificial Intelligence Competence Framework for Teachers and Learners” and the “ICT Competence Framework for Teachers.” These frameworks serve as clear guidelines for governments and educators seeking to effectively and inclusively integrate technologies into education systems .

The results showed that digital technologies are deeply embedded in everyday learning activities:

- 87% of students and 92% of teachers indicated that they regularly use digital learning platforms such as ZiyoNET Moodle, Google Classroom, Khan Academy Uzbek, and Zoom;
- 68% of students use additional digital resources such as Coursera, Bloom Library, OsonEdu, Biblio.uz for independent learning;
- However, only 64% of teachers regularly use digital analytics tools such as monitoring systems, tests, and flexible courses to assess learning outcomes.

This shows the gap between the level of technological equipment of the educational process and the readiness of educators to effectively use digital tools.

2. The impact of digital technologies on the quality of educational services

of digitalization on the quality of educational services is assessed based on the following four criteria:

1. convenience and flexibility of education;

2. the quality of communication between teacher and student;

3. interactivity of the educational process;

4. Learners' satisfaction with the learning environment.

of 1 to 5 are presented in Table 1.

Table 1. : The impact of digital technologies on the efficiency of educational services (according to survey results, 2025)

Indicator	Student GPA	Teachers' average score	Dynamics compared to the pre-Covid period*
Ease and flexibility of education	4.6	4.4	+1.1
Contact form	4.2	4.0	+0.8
Interactivity and engagement	4.1	3.8	+0.9
Satisfaction with the learning environment	4.3	4.1	+0.7

* according to subjective assessments of respondents (compared to the period before 2020)

The data shows that respondents attribute the most significant improvements to the increased convenience and flexibility of education, as well as the increased interactivity of the learning process. This can be explained by the expansion of remote access options and the use of digital platforms that allow simultaneous and distributed interaction.

3. Factors limiting the effectiveness of digitalization

Despite positive changes, the survey identified a number of systemic problems:

and methodological support provided by universities was insufficient;

• 46% of students reported an excess of digital assignments and a lack of live interaction ;

• 37 percent of respondents noted that the quality of online courses is not uniform, especially across faculties ;

• 14% of teachers face difficulties in implementing digital tools into traditional forms of education.

This situation demonstrates the need to maintain a balance between digital and face-to-face forms of education, as well as the importance of systematic training of personnel in the field of digital pedagogy.

4. The relationship between digital competencies and teaching effectiveness

The correlation analysis showed a moderate but statistically significant relationship ($r = 0.48$; $p < 0.05$) between teachers' level of digital competence and students' satisfaction with the quality of educational services. This confirms the hypothesis that the quality of digital education is determined not by the availability of technologies, but by the ability of teachers to use them effectively.

5. Qualitative results and observations

Research has shown that universities are implementing a digital transformation strategy aimed at improving the efficiency of educational services through:

• introducing digital analytics into the education quality management system;

• improving electronic document management and monitoring services;

• support digital pedagogy and improve teacher training.

However , digitalization processes are not always accompanied by mechanisms to assess their impact on educational outcomes, which confirms the need to include digital performance indicators in internal quality control systems.

V. CONCLUSION/RECOMMENDATIONS

The study conducted on the example of local higher education institutions allowed for a comprehensive assessment of the role of digital technologies in improving the efficiency of educational services in the higher education system. The results of the empirical analysis confirmed that digitalization has become a key factor in changing the content, forms and mechanisms of educational services . This affects both the quality of educational outcomes and the level of satisfaction of learners with the educational process.

First, digital technologies have been shown to significantly increase the convenience and flexibility of education. This is done by creating opportunities for blended and distance learning, individualizing educational paths, and expanding the range of educational resources. According to the majority of students

and teachers surveyed, digital solutions help to accelerate communication, provide quick feedback , and develop independent learning activities.

Secondly, it was found that it is impossible to increase the efficiency of educational services without developing the digital competencies of the teaching staff. The level of digital literacy of teachers is directly related to the perception of the quality of the educational process by students. This indicates the need for systematic work on improving the skills of teaching staff in digital technologies, online teaching methods , and educational data analysis.

Third, the research results show that the digitalization process in Russian higher education institutions is fragmented and instrumental in nature: the introduction of separate platforms and services is often not accompanied by changes in management processes, quality control models, and pedagogical approaches. The lack of a holistic strategy for digital transformation limits the possibilities for improving the efficiency of educational services.

Fourth, it was found that the effectiveness of the digital environment is directly dependent on the availability of mechanisms for monitoring and evaluating the quality of digital educational services. At the level of higher education institutions, it is necessary to develop digital performance indicators - indicators that reflect the participation, satisfaction, interactivity and achievements of learners in the digital environment. Their inclusion in the internal quality audit system will allow for an objective assessment of the impact of digital solutions on educational outcomes.

Overall, the results of the study confirm that digital technologies are becoming not just a tool, but a strategic resource for the development of educational organizations. Their potential is revealed in the context of a systematic approach that includes the managerial, methodological and cultural components of digital transformation.

Digitalization of education should be viewed not as a one-time technological upgrade, but as a long-term model of organizational development of a higher education institution based on the knowledge, quality and participation of all participants in the educational process. The implementation of the proposed recommendations will increase the competitiveness of Russian higher education institutions and ensure the sustainable quality of educational services in the digital economy.

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POPULATION GROWTH AND SOCIO-ECONOMIC WELL-BEING OF UZBEKISTAN IN THE CONTEXT OF GLOBAL CHANGES

Dildora Djuraeva[1]

ABSTRACT

The main focus of this article is a comparative analysis of population growth and well-being in Uzbekistan within the context of Central Asia. Initially, attention is given to Uzbekistan's demographic position among CIS countries. It is known that the result of well-being is measured by people's health and longevity. Taking this into account, the article also provides a comparative analysis of the birth-to-death ratio in Uzbekistan, as well as mortality rates by types of diseases.

Key words: *Uzbekistan–2030 Strategy, population structure, demographic processes, birth rate decline, socio-economic transformations, global demographic changes, sustainable development, priority areas, social institutions*

Introduction

Currently, complex and ambiguous demographic processes are unfolding on a global scale in various regions of the world, closely linked to changes in population size and structure. Some regions are experiencing a steady decline in population growth rates due to aging populations, falling birth rates, and migration outflows, while others, conversely, continue to see intensive growth associated with high birth rates, improved living conditions, and accelerated socio-economic transformations. These divergent trends create new challenges for systems of public administration, social institutions, and international cooperation.

In this context, the "Uzbekistan - 2030" Strategy, approved by Presidential Decree and aimed at sustainable and inclusive development of the country, assumes particular importance. This document, developed based on the accumulated experience of implementing previous strategies and extensive public discussion, establishes 100 key objectives within five priority areas.

One of the priority areas of the strategy is improving the population's well-being through stable economic growth. This framework includes objectives to increase per capita income, enhance social infrastructure, develop human potential, and establish a social protection system that meets international standards.

The strategy emphasizes the importance of land, water, and energy resources, innovation, the "green" economy, and digitalization as the foundation for sustainable growth. Furthermore, the document aims to create a fair and modern state that effectively serves its citizens, strengthen the rule of law, and ensure stability and security.

Considering these directions, issues related to demographic growth, quality of life, and human capital formation become central to the strategy. These factors are viewed as fundamental for achieving the strategic goals of improving citizens' well-being and ensuring the state's sustainable development in the long term.

In this regard, studying the structure of the world's population, analyzing its changes, and assessing the well-being of various countries and regions are becoming not only relevant but also necessary for

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developing effective state policy. A comprehensive approach to studying these processes allows for the identification of patterns, forecasting possible development scenarios, and defining the strategic directions of social and economic modernization.

Literature review

The population of the world and some of its regions, as well as its trends of change, have been little studied by scientists. Taking this into account, we considered it an objective necessity to systematically review their structural composition using data from the Internet and world statistics. This is because the level of employment in various spheres of the world's population and the level of well-being in terms of living conditions are directly related to the professional orientations of the population. Considering this, a number of studies are being conducted in this area. Among them are the works of A. Abdurakhmanov, S.S. Gulomov, N. Arabov, and M.M. Mukhammedov. Some of our research (M.K. Pardayev, A.R. Latipov, O.M. Pardayeva, M.D. Usmanov, and others) is also aimed at solving these problems.

Methodology

During the research process, methods of logical, comparative and comparative analysis, analysis and synthesis, induction and deduction were used to study population growth and the level of well-being in Uzbekistan and Central Asia.

Analysis and results.

According to the State Statistics Committee, among the countries of Central Asia, Uzbekistan ranks first in terms of population with 38 million people. In second place is Kazakhstan with a population of 19.3 million people. This is 1.8 times (35.3/19.3) less than in Uzbekistan. In third place is Tajikistan with a population of 9.5 million people. This is 3.7 times (35.3/9.5) less than in Uzbekistan. Next is the Kyrgyz Republic, whose population is 6.8 million people. This indicator is 5.2 times (35.3/6.8) lower than in Uzbekistan. The population of Turkmenistan is 4.4 million people and is the least populous country in Central Asia. As of January 1, 2025, there are an average of 86.6 people per square kilometer in the Republic of Uzbekistan. The highest population density indicators by region were recorded in the city of Tashkent, where an average of 6,948.1 people per square kilometer, in the Andijan region - 804.9 people, and in the Fergana region - 613.1 people.

In terms of population, Uzbekistan ranks first among Central Asian countries and third among CIS countries. However, the power of a state is measured not by the size of its population, but by the level of macroeconomic indicators, specifically the level of Gross Domestic Product (GDP). Our situation in this regard can be seen in the following table (Table 1)

In accordance with the Statistical Program, the Statistics Agency under the President of the Republic of Uzbekistan carried out preliminary assessments of the Gross Regional Product for the Republic of Karakalpakstan, regions, and the city of Tashkent for January-March 2024.

The Gross Regional Product (GRP) is the main indicator in the system of national accounts

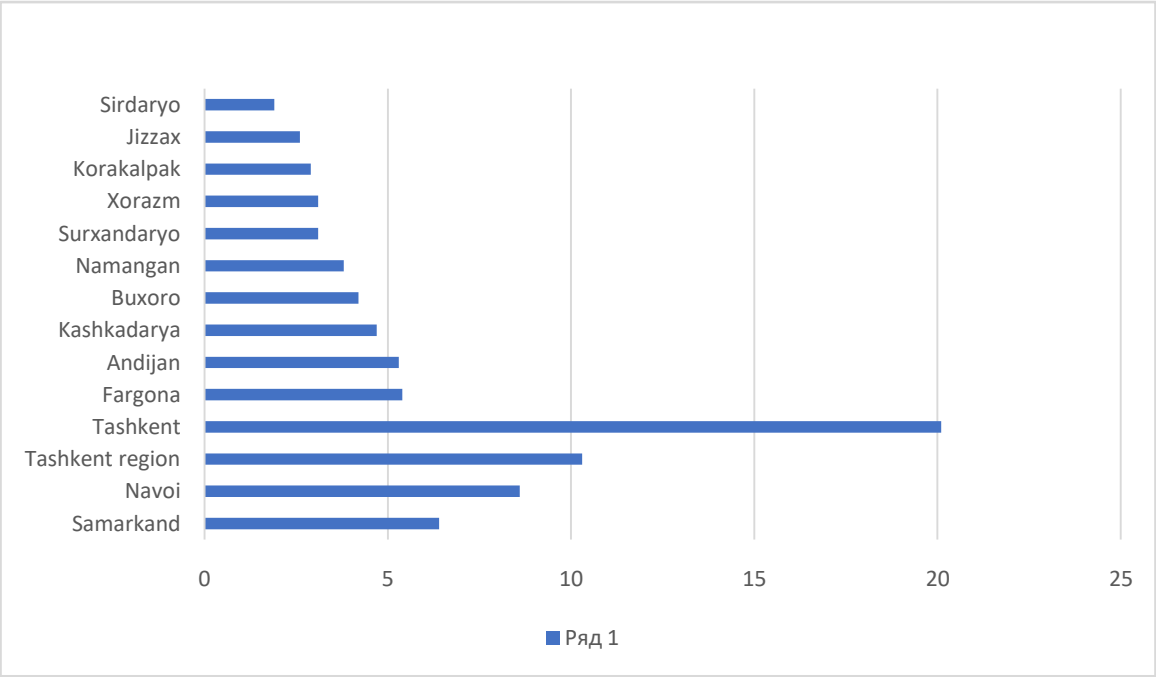
that represents the final result of production activities of resident institutional units

located in the economic territory of the region during a specific period.

It reflects the economic output of a particular area. indicator located in the economic territory of the region for a certain period of time final production activity of resident-institutional units represents the result.

Table 1. : Participation of regions in GDP formation for January-March 2024

(as a percentage of the total)



Macroeconomic indicators in our country and in each of its regions reflect the well-being of the population. This well-being, in turn, contributes to improving the health of the population and increasing life expectancy. In fact, one of the aspects indicating the level of socio-economic development of countries is the average standard of living of the population. The global average life expectancy is 71 years. This indicator stands at 84.6 years in Japan, 84.2 in Andorra, 82.3 in Israel, 79.8 in the USA, 72.7 in Russia, 73.8 in Uzbekistan, 73.7 in Tajikistan, and 70.4 in Turkmenistan.

As evident, Uzbekistan is leading in Central Asia according to this indicator. This situation is also directly related to population growth.

According to data from the State Statistics Committee of the Republic of Uzbekistan, as of October 1, 2024, the majority of registered deaths in our country are attributed to diseases of the circulatory system. This accounts for 56.8% of the total deaths. This can also be observed from the data in the table below (Table 3).

As evident from the table data, in Uzbekistan, the highest number of deaths from diseases during the first 9 months of 2024 is associated with circulatory system disorders. These account for 56.8% of all deaths during this period. Deaths from respiratory diseases stand at 9.8%. The number of deaths from tumors in our country amounted to 10,535 people, or 8.1%. It is necessary to study the fact that this disease has increased slightly from the previous 3-5 percent and to consider ways to prevent it as well.

Table 1 : Republic of Uzbekistan: number and share of registered deaths due to morbidity for 9 months of 2024 statistics

№	Disease types	Number, people	Share, %
1.	Diseases of the circulatory system	**74 109**	**56,8**
2.	Diseases of respiratory organs	**12 805**	**9,8**
3.	From appendages	**10 535**	**8,1**
4.	Accidents, poisonings and injuries	**7 260**	**5,5**
5.	Diseases of the digestive system	**5 264**	**4,1**
6.	Infectious and parasitic diseases	**1 976**	**1,5**
7.	Other diseases	**18 417**	**14,2**
8.	Total number of deaths	**130 366**	**100**
	Number of births, thousand people	**681,0**	**1010,0**
10.	Deaths relative to births	**x**	**19,1**

There are also many deaths from accidents, poisonings, and injuries in our country. During this short period, 7,260 people or 5.5% of deaths were associated with these causes. The number of deaths from diseases of the digestive system is 5,264, or 4.1%. This is also one of the issues requiring attention. Infectious and parasitic diseases still persist in our country. 1,976 people died from these diseases, or 1.5% of all deaths. Currently, many of these are treatable conditions.

As can be seen from this, it is necessary to pay great attention to the field of medicine in our country and focus on the prevention of many diseases. If our population also strictly adheres to a healthy lifestyle, many diseases will be prevented naturally. For example, cardiovascular diseases are also considered to be directly resulting from non-adherence to a healthy lifestyle. Diseases are also considered to be a direct result of not adhering to a healthy lifestyle.

Another important aspect is that air pollution in our country is increasing year by year. Regrettably, the number of deaths from various diseases due to polluted air is rising. Today, as reported on social networks, Uzbekistan has reached the absolute first place in terms of mortality per 100,000 people, which is an alarming situation. As can be seen from the infographic, even Arab countries, China, and India have significantly lagged behind Uzbekistan in terms of air pollution. Consequently, there is no justification for our country's high ranking in this negative indicator. The streets of our country are full of cars, and our entire country has been turned into a construction site. Under these conditions, the felling of perennial trees continues.

Of course, significant efforts are being made to rectify this situation. In particular, in the Samarkand region alone, within the framework of the nationwide project "Green Space": "Urgent 40 Days," announced

in November 2024, it is planned to plant 6,125,000 trees and shrubs of 27 different fruit and ornamental varieties. According to press reports, this work is being fully implemented in all regions.

This situation greatly contributes to improving the atmosphere and the ecological environment of the region.

In conclusion, our country occupies a leading position among Central Asian countries in terms of population size and growth rates. However, in terms of the population's well-being, it is still at a very low level. In particular, compared to Kazakhstan, the GDP per capita is 5.4 times lower. Considering our enormous potential, we are at a much lower level than we should be. All of this, after drawing the appropriate conclusion, necessitates looking at the new life in New Uzbekistan with a different perspective.

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ECONOMETRIC MODEL OF THE GROSS REGIONAL PRODUCT (GRP) OF SURKHANDARYO REGION

ShomirzayevAbdugaffor Abdujabbor ogli[1], Turayev Bakhtiyor Ergashovich[2]

ABSTRACT

This article presents an econometric analysis of the dynamics of Gross Regional Product of Surkhandarya region for the years 2010-2024 using the ARIMA model. In the study, the stationarity of the time series was checked using the ADF test, and ARIMA (0, 2, 1) was selected as the optimal model.

The ARIMA model forecasts show that the volume of GRP will continue its steady growth during 2025–2030. The obtained results have significant practical importance for planning the region's economic development, formulating investment policy, and making regional strategic decisions.

Key words:*Gross Regional Product (GRP), time series, ARIMA model, stationarity, forecasting, econometric model, information criteria (AIC, BIC, HQC), regional economic development.*

INTRODUCTION

The Gross Regional Product (GRP) is one of the key indicators that shows the economic performance and development level of any region. For Surkhandarya region, analyzing GRP is essential for understanding the structure of the local economy, identifying growth factors, and planning future development. In receant years, changes in industry, agriculture, investment activity, and external economic conditions have affected the region's economic output, which requires a more precise and data-based analysis.

Econometric modeling provides an effective tool for studying such economic changes. By using time-series methods, it becomes possible to identify trends, seasonal patterns, and fluctuations in GRP. These models also allow researchers and policymakers to make more reliable forecasts for the coming years and to evaluate the expected impact of different economic factors.

In this research, the GRP of Surkhandaryo region for the period 2010–2024 is analyzed using the ARIMA econometric model. The time-series analysis helps identify the main trends and fluctuations in the regional economy and provides reliable forecasts for future GRP growth. The findings are expected to support more accurate economic planning and informed decision-making for the region's sustainable development.

LITERATURE REVIEW

Many Uzbek scholars have contributed to the development of econometric modeling and the analysis of regional economic indicators. Researchers such as B.Yu. KhodiyevandT.Sh. Shodiyev have studied the theoretical foundations of economic modeling and emphasized the role of statistical methods in

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understanding economic dynamics. B.B. BerkinovandN.M. Makhmudov have highlighted the importance of regression analysis, time-series methods, and forecasting tools in evaluating economic growth.

Furthermore, the works of B.R. Jo‘rayev**,** Kh.S. Mukhitdinov**,** O.Q. Khatamov**,** A. N. Rakhimov andB. E. Turayev focus on statistical modeling, time-series forecasting, and factor analysis of regional economies. Their studies emphasize the importance of model selection, data stability, and forecasting accuracy in econometric research.

Overall, the contributions of these scholars provide a solid methodological basis for using time-series econometric models to analyze and forecast indicators such as the Gross Regional Product. This study builds upon these approaches to examine and forecast the GRP of Surkhandaryo region using the ARIMA model.

RESEARCH METHODS

In this study, a combination of research methods was applied to analyze and forecast the GRP of Surkhandaryo region. Logical reasoning and comparative analysis were used to examine economic trends, while statistical observation, generalization, and grouping helped process and organize the data. Econometric modeling and forecasting techniques, including the ARIMA model, were employed to quantify relationships, identify patterns in the time series, and predict future GRP dynamics.

RESULTS

Table 1[1] **Gross Regional Products of Surkhandarya region**

Years	GRP (blnUZS)	Years	GRP (bln UZS)
2010	3394,7	2018	21229
2011	5217,1	2019	25473
2012	6436,4	2020	27572
2013	7436,4	2021	33591
2014	9213,2	2022	39202
2015	11114	2023	46999
2016	12180	2024	54354
2017	16354		

[1]Author’s study based on data from the Surkhandaryo Regional Statistics Department (surxonstat.uz)

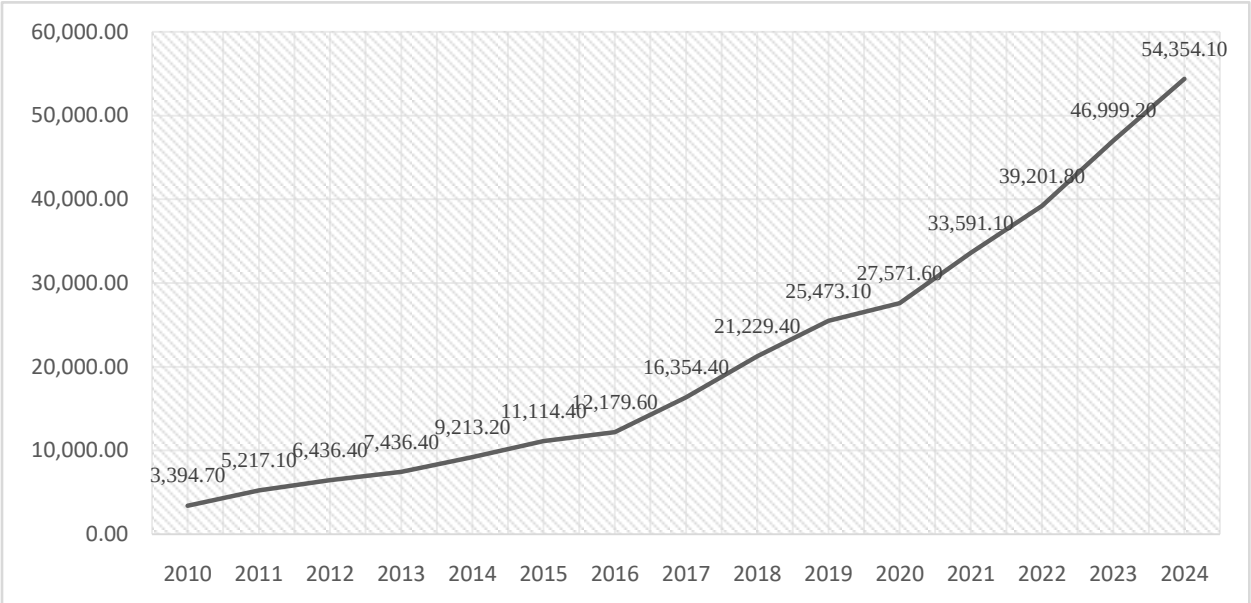

Figure 1. Time series graph of GRP volume for 2010–2024 (billion UZS)[1]

From 2010 to 2024, the Gross Regional Product (GRP) of Surkhandaryo region increased from 3,394.7 billion UZS at the beginning of the period to 54,354.1 billion UZS. This growth can be explained by the expansion of production capacities, rapid development of the services sector, and intensified diversification processes in agriculture. According to annual dynamics, the fastest GRP growth was observed in 2017, 2018, 2021, and 2023. In particular, the GRP increased by 4.1 trillion UZS in 2017 alone, indicating a significant surge in investment activity in the region.

In 2010–2011, GRP growth rates were around 10.9%, reflecting high economic activity and strong investment. During 2016–2020, economic growth slowed, with rates ranging from 2.7% to 7%. In particular, the 2.7% growth in 2020 reflects the impact of external factors on the regional economy during the pandemic. In 2021, the growth rate increased to 9.3%, indicating the beginning of economic recovery. Over the following period of 2022–2024, growth remained stable at around 4–6%.

Modeling the region's Gross Regional Product (GRP) using the ARIMA model is an effective statistical tool for identifying past economic trends, assessing their stability, and generating forecasts for the future. The ARIMA model is one of the most widely used methods for working with time-series data, as it allows mathematically modeling the GRP's trend, cyclical fluctuations, and random variations. This method fully reflects the internal structure of GRP over time and transforms it into a reliable forecast model for future periods.

The ARIMA (AutoRegressive Integrated Moving Average) model is represented as ARIMA(p, d, q), where **p** is the order of the autoregressive component, **d** is the order of differencing (degree of stationarity),

[1]Author's study based on data from the Surkhandaryo Regional Statistics Department (surxonstat.uz)

and **q** is the order of the moving average component[1]. This model separates the trend, seasonality, fluctuations, and random variations in a time series. When analyzing a time series, its stationarity is first checked; if the series is not stationary, differencing is applied to stabilize it. After that, the AR and MA components are determined. Once the optimal values of p, d, and q are selected, the model is built and used to forecast future values.

First, the GRP chart shown in Figure 1 is analyzed. It indicates an increasing trend, which means the series is non-stationary. Therefore, the stationarity of the first difference of the series was tested.

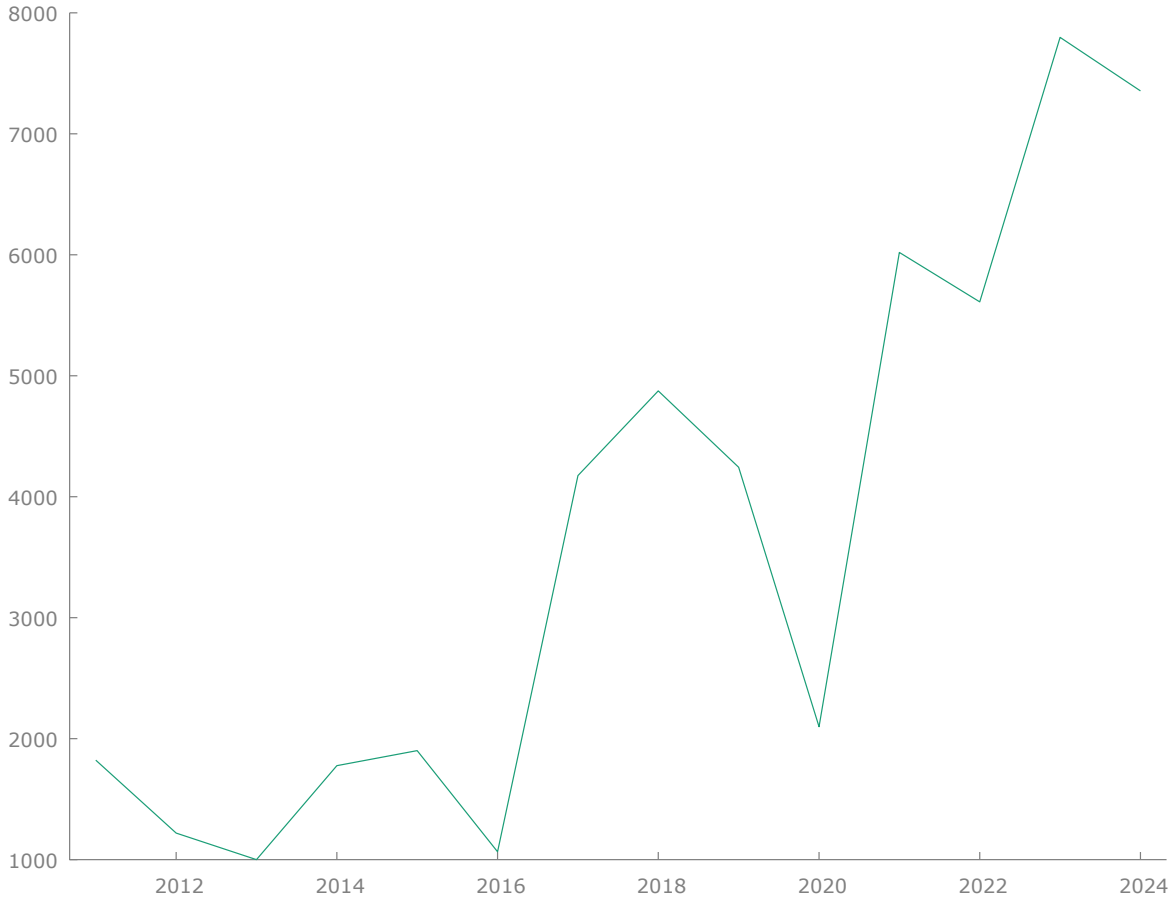

Figure 2. Time series graph of the first difference of GRP volume for 2010–2024[2]

According to Figure 2, the first difference of the series still shows an increasing trend and is non-stationary. Therefore, the second difference was taken, and the order of the MA component (q) in the ARIMA model was set to 2. The stationarity of the second difference was then tested using the ADF test, and the results are presented below.

[1] Muxitdinov, X.S., Khatamov, O.Q., & Rakhimov, A.N. (2022). Fundamentals of Econometrics: Textbook. Qarshi: Intellekt Publishing. 220 p

[2]Author's study based on data from the Surkhandaryo Regional Statistics Department (surxonstat.uz)

Table 2[1] **Results of the ADF test**

Augmented Dickey-Fuller test for d_d_YHM
testing down from 4 lags, criterion AIC
sample size 12
unit-root null hypothesis: a = 1

test without constant
including 0 lags of (1-L)d_d_YHM
model: (1-L)y = (a-1)*y(-1) + e
estimated value of (a - 1): -1.30719
test statistic: tau_nc(1) = -4.56711
asymptotic p-value 5.61e-06
1st-order autocorrelation coeff. for e: -0.015

test with constant
including 4 lags of (1-L)d_d_YHM
model: (1-L)y = b0 + (a-1)*y(-1) + ... + e
estimated value of (a - 1): -6.2701
test statistic: tau_c(1) = -3.18296
asymptotic p-value 0.02102
1st-order autocorrelation coeff. for e: 0.132
lagged differences: F(4, 2) = 3.405 [0.2397]

According to the table above, the ADF test results for the second difference confirm that the series is stationary. For the data to be considered stationary, the p-value of the ADF test must be less than 0.05. In the next step, the orders of the ARIMA model's p and q components will be determined using information criteria such as AIC, BIC, and HQC

[1]Author's study based on data from the Surkhandaryo Regional Statistics Department (surxonstat.uz)

Table 3[1] **Information criteria of theAIC, BIC, HQC**

Estimated using AS 197 (exact ML)

Dependent variable YHM, T = 13

Criteria for ARIMA(p, 2, q) specifications

p, q	AIC	BIC	HQC	loglik
0, 0	233.3894	234.5193	233.1571	-114.6947
0, 1	229.3379*	231.0327*	228.9895*	-111.6689
0, 2	231.3167	233.5765	230.8522	-111.6584
0, 3	232.4728	235.2976	231.8922	-111.2364
0, 4	233.7717	237.1614	233.0749	-110.8858
1, 0	233.0073	234.7021	232.6589	-113.5036
1, 1	231.3229	233.5827	230.8584	-111.6614
1, 2	233.3034	236.1282	232.7228	-111.6517
1, 3	233.5439	236.9336	232.8471	-110.7719
1, 4	234.4722	238.4269	233.6594	-110.2361
2, 0	234.4286	236.6884	233.9641	-113.2143
2, 1	232.9756	235.8003	232.3950	-111.4878
2, 2	234.6118	238.0015	233.9151	-111.3059
2, 3	234.9275	238.8821	234.1146	-110.4637
2, 4	236.4683	240.9878	235.5393	-110.2341
3, 0	233.4065	236.2312	232.8259	-111.7032
3, 1	234.9401	238.3298	234.2433	-111.4700
3, 2	235.0056	238.9602	234.1927	-110.5028
3, 3	235.7001	240.2197	234.7711	-109.8501
3, 4	237.1094	242.1939	236.0643	-109.5547
4, 0	235.4028	238.7925	234.7060	-111.7014

[1]Author's study based on data from the Surkhandaryo Regional Statistics Department (surxonstat.uz)

4, 1	236.9295	240.8842	236.1167	-111.4648
4, 2	236.8575	241.3770	235.9285	-110.4287
4, 3	237.3710	242.4555	236.3259	-109.6855
4, 4	238.9295	244.5790	237.7683	-109.4647

'*' indicates best, per criterion

Log-likelihood ('loglik') is provided for reference

According to the table above, the information criteria reach their minimum values at p = 0 and q = 1. Thus, the ARIMA model is specified with the following order:

ARIMA(0, 2, 1)

We will now apply this model in practice:

Table 4[1] **Regression analysis of the ARIMA(0, 2, 1) model**

Model 2: ARIMA, using observations 2012-2024 (T = 13)

Dependent variable: (1-L)^2 YHM

Standard errors based on Hessian

	Coefficient	*Std. Error*	*z*	*p-value*	
const	498.240	77.9371	6.393	<0.0001	***
theta_1	−1.00000	0.248086	−4.031	<0.0001	***

Mean dependent var	425.5769	S.D. dependent var	1709.148
Mean of innovations	−243.5698	S.D. of innovations	1175.534
R-squared	0.995130	Adjusted R-squared	0.995130
Log-likelihood	−111.6689	Akaike criterion	229.3379

[1]Author's study based on data from the Surkhandaryo Regional Statistics Department (surxonstat.uz)

Schwarz criterion			Hannan-Quinn		
		231.0327			228.9895
		Real	*Imaginary*	*Modulus*	*Frequency*
MA					
	Root 1	1.0000	0.0000	1.0000	0.0000

According to the table, the p-values for the constant and theta coefficients are less than 0.05. This indicates that they are statistically significant.

Furthermore, the calculations show that MAPE is 6.16%, which is below the required threshold of 10%.

The table presents the general form of the model as follows:

$$\Delta^2 y = 498,24 - 1e_{t-1}$$

Results of the autocorrelation test for the model residuals:

Table 5[1]

Autocorrelation test results for the residuals

Residual autocorrelation function

***, **, * indicate significance at the 1%, 5%, 10% levels

using standard error 1/T^0.5

LAG	ACF	PACF	Q-stat. [p-value]
1	0.0040	0.0040	
2	-0.1613	-0.1613	0.4616 [0.497]
3	-0.2586	-0.2641	1.7654 [0.414]
4	0.1773	0.1575	2.4464 [0.485]
5	0.0122	-0.0742	2.4501 [0.654]
6	0.1241	0.1225	2.8790 [0.719]
7	-0.0168	0.0657	2.8882 [0.823]
8	-0.0894	-0.1123	3.1999 [0.866]

[1]Author's study based on data from the Surkhandaryo Regional Statistics Department (surxonstat.uz)

9	-0.0844	-0.0022	3.5472 [0.895]
10	-0.0954	-0.1829	4.1390 [0.902]
11	-0.0887	-0.1777	4.9057 [0.897]
12	-0.0230	-0.0781	5.0086 [0.931]

The histogram based on the obtained results is presented below:

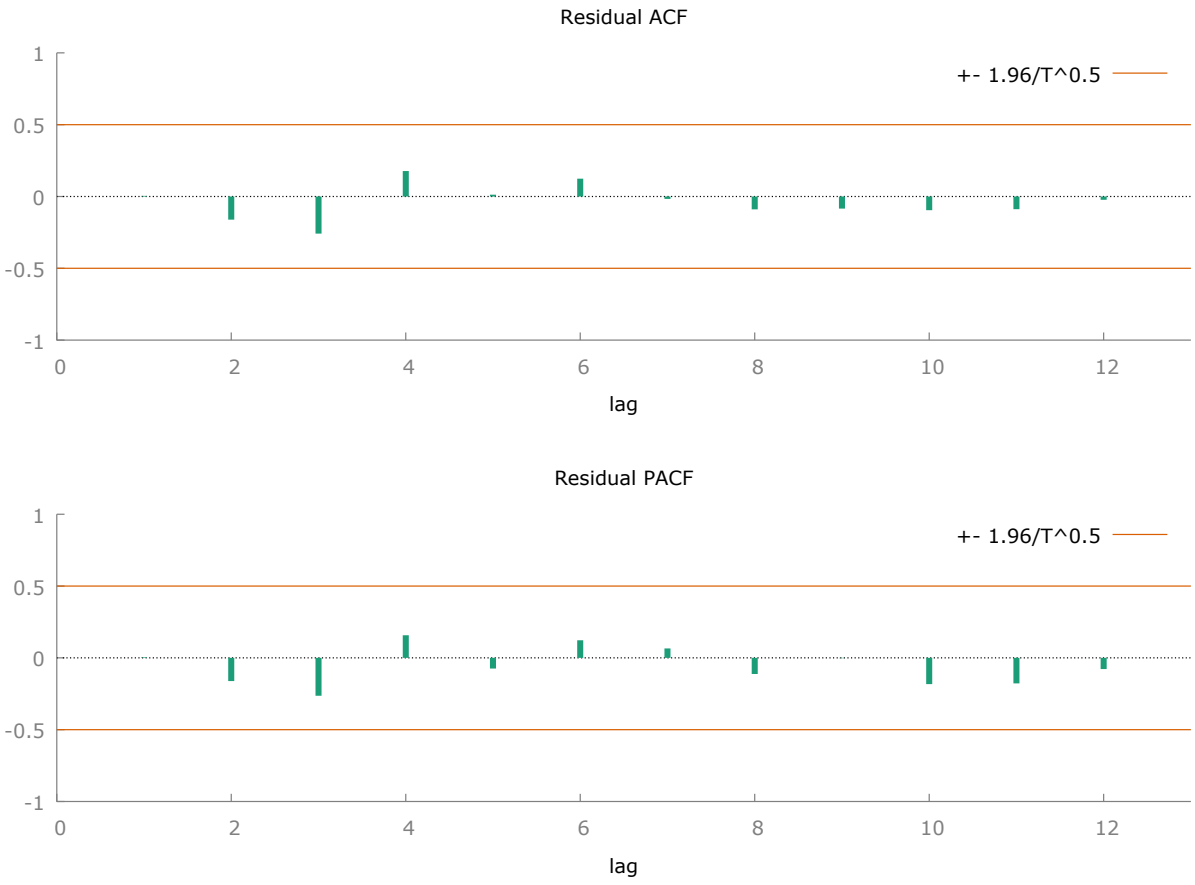

Figure 3. Residual correlogram[1].

According to Figure 3, no significant lags are observed in the residual correlogram. Thus, the model is significant and can be used for forecasting.

[1]Author's study based on data from the Surkhandaryo Regional Statistics Department (surxonstat.uz)

Table 6[1] **Forecast results of Surkhandaryo region's GRP using the ARIMA model**

For 95% confidence intervals, z(0.025) = 1.96

YHM	prediction	std. error	95% interval
2010	3394.7		
2011	5217.1		
2012	6436.4	7215.2	
2013	7436.4	8471.9	
2014	9213.2	9704.2	
2015	11114.4	11829.1	
2016	12179.6	13981.1	
2017	16354.4	15459.3	
2018	21229.4	20265.3	
2019	25473.1	25687.8	
2020	27571.6	30271.4	
2021	33591.1	32769.7	
2022	39201.8	39320.4	
2023	46999.2	45486.1	
2024	54354.1	53859.7	
2025	61712.9	1175.53	59408.9 - 64016.9
2026	69569.9	1662.46	66311.5 - 72828.2
2027	77925.1	2036.08	73934.5 - 81915.8
2028	86778.6	2351.07	82170.6 - 91386.6
2029	96130.3	2628.57	90978.4 - 101282.3
2030	105980.3	2879.46	100336.7 - 111624.0

Forecast evaluation statistics using 13 observations

[1]Author's study based on data from the Surkhandaryo Regional Statistics Department (surxonstat.uz)

Mean Error	-243.57
Root Mean Squared Error	1175.5
Mean Absolute Error	964.81
Mean Percentage Error	-3.6094
Mean Absolute Percentage Error	6.1616
Theil's U2	0.40268
Bias proportion, UM	0.042932
Regression proportion, UR	0.15426
Disturbance proportion, UD	0.80281

The forecast values from Table 6 are illustrated in Figure 4.

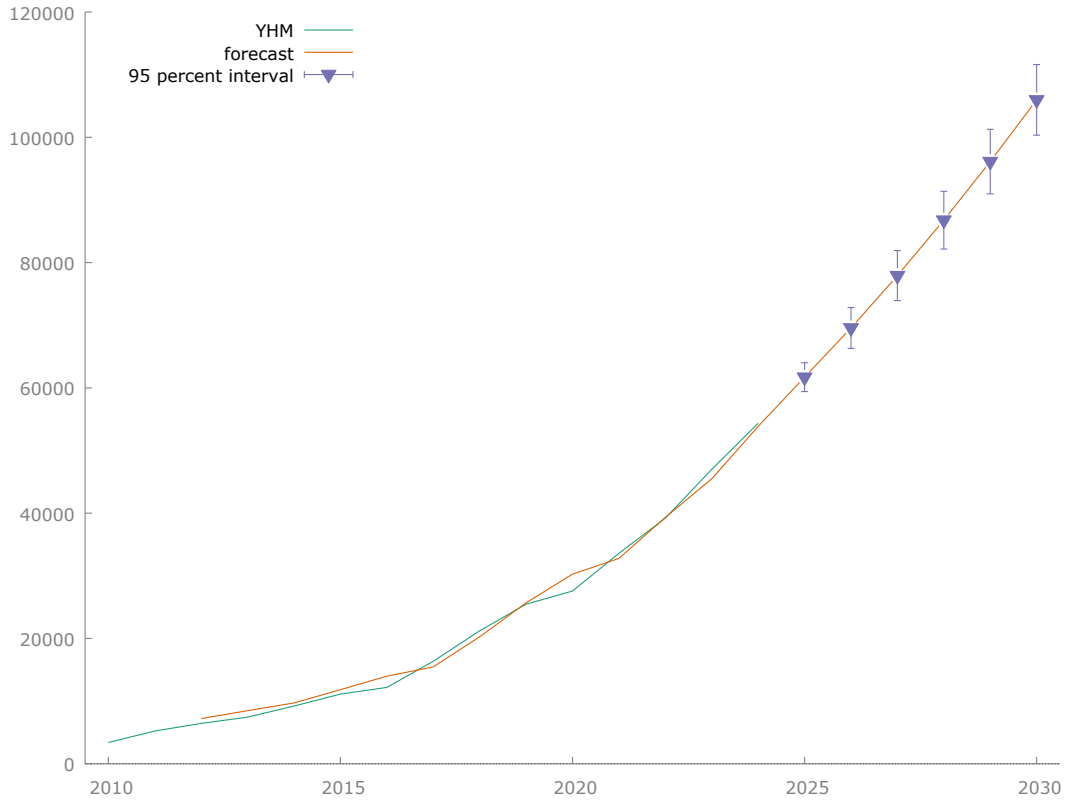

Figure 4. Forecasted GRP values of Surkhandaryo region using the ARIMA model[1]

[1]Author's study based on data from the Surkhandaryo Regional Statistics Department (surxonstat.uz)

DISCUSSION

The economic performance of Surkhandaryo region for 2010–2024 was assessed using GRP indicators. The initial data show a clear growth trend in GRP, increasing from 3.39 trillion UZS in 2010 to 54.35 trillion UZS in 2024. During this period, the main drivers of the regional economy were the expansion of industrial capacities, growth in the services sector, diversification in agriculture, and improvements in transport and logistics infrastructure.

Due to the presence of a trend, the time series was differenced to achieve stationarity before applying the ARIMA model. Since the first difference was insufficient, a second differencing was performed, and the ADF test confirmed that the second-differenced series is stationary ($p < 0.05$).

During the model selection stage, the ARIMA(0, 2, 1) model was identified as optimal, as it had the lowest AIC, BIC, and HQC values. The model parameters are statistically significant, and the MAPE of 6.16% is below the required 10%, indicating accurate forecasting. The residual correlogram shows no autocorrelation, confirming that the model was correctly specified.

Furthermore, based on the model, GRP forecasts for 2025–2030 were calculated. The results indicate that the region will continue to maintain a growth trend in the coming years, with GRP projected to reach approximately 110 trillion UZS by 2030.

CONCLUSION

The study results indicate that the economy of Surkhandaryo region has experienced stable growth over the past 15 years. Forecasts based on the ARIMA(0, 2, 1) model are accurate and reliable, confirming the consistent continuation of economic changes in the region. The projected GRP values for 2025–2030 can play an important role in economic policy-making, the formation of regional investment programs, infrastructure development, and the optimization of industrial sectors. The ARIMA model is an effective tool for analyzing and forecasting the GRP dynamics of Surkhandaryo region, serving as an important methodological basis for developing medium- and long-term regional development strategies.

LITERATURE

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SENTIMENT ANALYSIS OF TWITTER DATA USING MACHINE LEARNING: A COMPARATIVE STUDY OF LOGISTIC REGRESSION AND SVM

UtkarshKumar[1],Surbhi Rawat[2], Ms Divya Singh[3]

ABSTRACT

Social media sentiment research has evolved into a crucial tool for analysing public opinion, brand perception, and customer sentiment in the digital age. This approach uses natural language processing (NLP), machine learning, and computational linguistics to categorize the attitudes conveyed in social media posts as positive, negative, neutral, or irrelevant. Because social media writing is unstructured and informal, the work provides distinct difficulties, such as dealing with slang, sarcasm, and multilingual content.

The technique for developing a sentiment analysis system often begins with data collecting from GitHub or Twitter (using a separate account). To prepare for analysis, the data is pre-processed using tokenization, Potter stemming, Text Blob, word tokenization, stop words, word clouds, and text normalization. Feature extraction approaches, such as Cout Vectorizer, turn the text into numerical representations, which are then used to train machine learning models like Logistic Regression and SVM.

The dataset has been visualized using bar graphs, pie charts, word clouds. To ensure trustworthy performance, model evaluation uses parameters like as accuracy, precision, recall, and the F1 score. Advanced techniques, such as aspect-based sentiment analysis and emotion identification, improve the system's ability to understand nuanced ideas. Finally, the use of sentiment analysis models on web platforms enables real-time processing and monitoring of social media sentiment.

As the area expands, future trends point to better contextual comprehension, cross-language sentiment analysis, and interaction with other AI technologies to deliver more comprehensive insights. Despite developments, ethical problems such as privacy and algorithmic bias remain crucial to the appropriate use of sentiment analysis on social media.

Introduction

Large volumes of text data from social media, reviews, and forums offer a wealth of information on sentiment and public opinion in today's digital environment.Sentiment analysis is useful to a wide range of problems that are of interest to human-computer interaction practi-tioners and researchers, as well as those from fields such as sociology, marketing and advertising, psychology, eco-nomics, and political science[1]. Sentiment analysis is a subfield of natural language processing that seeks to understand and measure the emotions conveyed through text. Sentiment analysis facilitates the understanding of trends and attitudes by corporations, governments, and researchers by differentiating between sentiments such as positive, negative, and neutral. The intricacies of human emotion, such sarcasm and context, are still difficult to reliably capture in machine learning and deep learning models, despite tremendous advances in these fields. This study examines data collection and preprocessing, utilizing visual aids such as word clouds, bar

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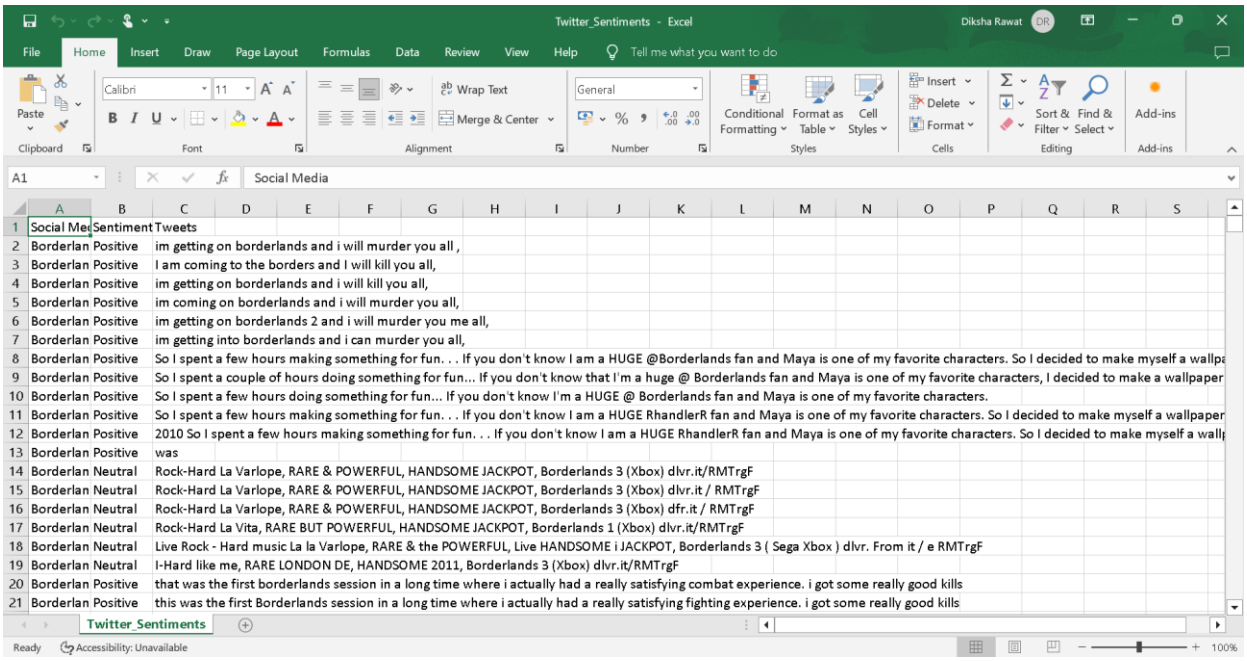
graphs, pie charts, and confusion matrices to illustrate our data sentiments. It centres on determining the appropriate level of accuracy through a comparison of two models (logistic regression and SVM), as well as checks on precision, recall, and f1-score. The findings aim to increase accuracy by using a customized model and sentiment analysis from a variety of fields. We will talk about the dataset and how the model uses it in this research paper. We will also examine which classification is more accurate than the others and why. The study aims to enhance accuracy by applying sentiment analysis across multiple domains and creating a customized model. In this research article, we will analyse the dataset and model to determine which categorization has more accuracy and why. The findings aim to increase accuracy by combining sentiment analysis across many domains with a personalized model. Our dataset contains around 75682 sentiments and tweets.



	A	B	C
1	Social Me	Sentiment	Tweets
2	Borderlan	Positive	im getting on borderlands and i will murder you all ,
3	Borderlan	Positive	I am coming to the borders and I will kill you all,
4	Borderlan	Positive	im getting on borderlands and i will kill you all,
5	Borderlan	Positive	im coming on borderlands and i will murder you all,
6	Borderlan	Positive	im getting on borderlands 2 and i will murder you me all,
7	Borderlan	Positive	im getting into borderlands and i can murder you all,
8	Borderlan	Positive	So I spent a few hours making something for fun. . . If you don't know I am a HUGE @Borderlands fan and Maya is one of my favorite characters. So I decided to make myself a wallpa
9	Borderlan	Positive	So I spent a couple of hours doing something for fun... If you don't know that I'm a huge @ Borderlands fan and Maya is one of my favorite characters, I decided to make a wallpaper
10	Borderlan	Positive	So I spent a few hours doing something for fun... If you don't know I'm a HUGE @ Borderlands fan and Maya is one of my favorite characters.
11	Borderlan	Positive	So I spent a few hours making something for fun. . . If you don't know I am a HUGE RhandlerR fan and Maya is one of my favorite characters. So I decided to make myself a wallpaper
12	Borderlan	Positive	2010 So I spent a few hours making something for fun. . . If you don't know I am a HUGE RhandlerR fan and Maya is one of my favorite characters. So I decided to make myself a wallp
13	Borderlan	Positive	was
14	Borderlan	Neutral	Rock-Hard La Varlope, RARE & POWERFUL, HANDSOME JACKPOT, Borderlands 3 (Xbox) dlvr.it/RMTrgF
15	Borderlan	Neutral	Rock-Hard La Varlope, RARE & POWERFUL, HANDSOME JACKPOT, Borderlands 3 (Xbox) dlvr.it / RMTrgF
16	Borderlan	Neutral	Rock-Hard La Varlope, RARE & POWERFUL, HANDSOME JACKPOT, Borderlands 3 (Xbox) dfr.it / RMTrgF
17	Borderlan	Neutral	Rock-Hard La Vita, RARE BUT POWERFUL, HANDSOME JACKPOT, Borderlands 1 (Xbox) dlvr.it/RMTrgF
18	Borderlan	Neutral	Live Rock - Hard music La la Varlope, RARE & the POWERFUL, Live HANDSOME i JACKPOT, Borderlands 3 (Sega Xbox) dlvr. From it / e RMTrgF
19	Borderlan	Neutral	I-Hard like me, RARE LONDON DE, HANDSOME 2011, Borderlands 3 (Xbox) dlvr.it/RMTrgF
20	Borderlan	Positive	that was the first borderlands session in a long time where i actually had a really satisfying combat experience. i got some really good kills
21	Borderlan	Positive	this was the first Borderlands session in a long time where i actually had a really satisfying fighting experience. i got some really good kills

This is our dataset, and as we can see, it contains sentiment-related tweets. Non-null values for sentiment (75682), social media (75682), and tweets (74996) were among the data information we examined from our whole dataset (75682). 686 null values are shown by Tweets in our text_df.isnull.

We will start by preprocessing our data, which involves dividing unstructured text data into smaller pieces known as tokens using a tokenizer. A single token can be anything from a word or a single character to much larger textual entities.

The next step will be to remove English word suffixes using Porter stemming. The ability to automatically eliminate suffixes is quite beneficial when discussing information retrieval. For our feature extraction we will be using Count Vectorizer (turn the text into numerical representations)

In this research paper we will discuss about the dataset and how it works in the model and check which classification has better accuracy than other and why.

Literature survey

1. VADER: A Parsimonious Rule-based Model for Sentiment Analysis of Social Media Text by C.J. Hutto and Eric Gilbert. They have used Naive Bayes, Maximum Entropy, and Support Vector Machine (SVM) algorithms and their accuracy was (positive/negative) classification on single sentences is around 80%. neutral class, accuracies tend to hover in the 60%.
2. Sentiment Analysis for Social Media by Carlos A. Iglesias, and Antonio Moreno. They used a Convolutional Neural Network (CNN) model.
3. Sentiment Analysis for Social Media by Sachira Chinthana Jayasanka, Thilina Madhushani and Saminda Chandika Premaratne. They used SentiWordNet, Naive Bayes algorithm.
4. A survey of sentiment analysis in social media by Lin Yue, Weitong Chen, Xue Li, Wanli Zuo and Minghao Yin. They used Support vector machine (SVM), Deep learning with highest accuracy rate 81%.
5. Sentiment analysis: a review and comparative analysis over social media by Nikhil Kumar Singh, Deepak Singh Tomar, and Arun Kumar Sangaiah. They used Naive Bayes, SVM, Random Forest, and Logistic Regression with 79.45% accuracy rate.
6. Sentiment Analysis: A Combined Approach by Rudy Prabowo , Mike Thelwall used RIPPER.
7. Sentiment analysis and subjectivity by Bing Liu. Used Support vector machines and conditional random fields with 90% accuracy.
8. Sentiment Analysis in Social Media Texts by Alexandra Balahur. Support Vector Machines, linear classifiers.
9. Sentiment Analysis in social media and Its Application: Systematic by Zulfadzli Drus, Haliyana Khalid. Used SVM and naïve bayes.
10. Sentiment analysis for formative assessment in higher education by Carme Grimalt-Álvaro , Mireia Usart used Kort's et al.
11. A review on sentiment analysis from social media platforms by Margarita Rodríguez-Ib´ anez , Antonio Cas´ anez-Ventura, F´elix Castej´on- Mateos, Pedro-Manuel Cuenca-Jim´ enez using linear regression, SVM.
12. Semantic Sentiment Analysis of Twitter by Hassan Saif, Yulan He, and Harith Alani using Unigram Nai've Bayes with 82.8% accuracy.
13. Sentiment Analysis on Twitter Data by Varsha Sahayak, Vijaya Shete, Apashabi Pathan using Naïve Bayes Classifier and Support Vector Machines
14. A Review of Techniques for Sentiment Analysis Of Twitter Data by Sagar Bhuta, AvitDoshi, Uehit Doshi, Meera Narvekar using Unigram Nai've Bayes, Bigram NaiVe Bayes, Maximum Entropy.
15. Sentiment Analysis on Twitter by Akshi Kumar and Teeja Mary Sebastian using Naive Bayes bigram , SVM, log-linear regression.
16. Sentiment Analysis of Twitter Data by Apoorv Agarwal Boyi Xie Ilia Vovsha Owen Rambow Rebecca Passonneau. They used Unigram, Senti-features, Kernel, Unigram + Senti-features,

Kernel + Senti-features. With accuracy Unigram = 71.35%, Senti-features = 71.27%, Kernel = 73.93% Unigram + Senti-features = 75.39%, Kernel + Senti-features= 74.6%.

17. Sentiment Analysis of Twitter Data by Sahar A.El Rahman; Feddah Alhumaidi AlOtaibi; Wejdan Abdullah AlShehri. They used Navie Bayes, Logistic Regression.
18. Sentiment analysis on Twitter Data-set using Naive Bayes algorithm by Huma Parveen, Shiksha Pandey using Naïve Bayes Algorithem.
19. Sentiment Analysis of Twitter Data Using Naïve Bayes Classifier by S.R.Shankara Gowda, B.R.Archana, Praajna Shettigar & Kislay Kumar Satyarthi. Using Naïve Bayes Algorithem.
20. Sentiment Analysis Using Naive Bayes Algorithm Of The Data Crawler : Twitter by Meylan Wongkar , Apriandy Angdresey. Using Naïve Bayes ,KNN, SVM with accuracy Naïve Bayes = 80.90%, KNN = 75.58%, SVM = 63.99%.
21. A Survey on Sentiment Analysis on Twitter Data Using Different Techniques by Bholane Savita Dattu, Prof.Deipali V. Gore using Naive Bayes, SVM, NBSVM, MNB, SentiStrength+ Twitter Sentiment, SentiStrength, Twitter Sentiment with accuracy Naive Bayes = 89.4%, SVM = 89.8%, NBSVM = 79.4%, MNB = 71.14%, SentiStrength+ Twitter Sentiment = 69.7%, SentiStrength = 62.3%, Twitter Sentiment = 57.2%
22. Twitter Sentiment Analysis Approaches: A Survey by Omar Y. Adwan , Marwan Al-Tawil, Ammar M. Huneiti, Rawan A. Shahin, Abeer A. Abu Zayed, Razan H. Al-Dibsi, using SVM, LBP, RL,ICA with accuracy LBP had the best accuracy value of 77.72%.
23. A Study on Sentiment Analysis Techniques of Twitter Data by Abdullah Alsaeedi, Mohammad Zubair Khan using SVM and MNB with accuracy 92%, 84.89%.
24. A Review On Sentiment Analysis Methodologies, Practices And Applications by Pooja Mehta, Dr.Sharnil Pandya using Naive Bayes, SVM with accuracy 97.06% 89.1%.
25. Sentiment Analysis of Twitter Data Set: Survey by Shailendra Kumar Singh , Dr. Sanchita Paul , Dhananjay Kumar , Hanifa Arfi using Binary classification, Ternary classification. With accuracy 90.90% and 92.40%

1. Exploratory Data Analysis (EDA)

The initial stage in conducting sentiment analysis on Twitter is gathering pertinent information from the network. We have gathered 75,682 pieces of data for this using GitHub. If you want to gather data via an API, you must do the following:

- **Keywords and Hashtags**: Locating and choosing pertinent hashtags and keywords associated with the topic of interest. This facilitates the collection of tweets that address particular topics or occasions.
- **Time Frame**: Establishing the duration of the data collection process to guarantee the dataset's manageability and relevancy.
- **Filtering Criteria**: Using filters to make sure the dataset reflects a range of viewpoints and to remove irrelevant tweets (such as spam).

To improve the quality of the data for sentiment analysis, raw tweets are pre-processed. This includes:

- **Text Cleaning**: Removing unnecessary elements such as URLs, special characters, and emojis that do not contribute to sentiment analysis.
- **Tokenization**: Splitting tweets into individual tokens or words.
- **Stop Word Removal**: Eliminating common words that do not carry significant meaning in sentiment analysis (e.g., “and,” “the”).
- **Stemming/Lemmatization**: Reducing words to their base or root form to standardize the dataset (e.g., “running” to “run”).
- Following the use of Potter Stemming, we looked at the non-null values tweets (68926) among the data from our entire dataset (75682). Tweets display 1 null values in our text_df.isnull.
- **Polarity**: The sentiment of a text is indicated by its polarity, which is usually classified as neutral, negative, or positive. Opinions in reviews, social media, etc. are analysed using it.

In our model the polarity scores are assigned as Value > 0 = positive, 0 = neutral, Value < 0 = Negative. For Positive, we have total 26703 rows as positive showing value > 0, for Negative, we have total 19711 rows as negative showing value < 0, for Neutral, we have total 22513 rows as neutral showing value = 0.

Since 6395 was our irrelevant sentiment in the dataset, our total dataset of 75682 was adjusted to 69287. We re-examined the data information from our entire dataset (69287) after completing all of the data preprocessing. This time, Sentiment (68927), Polarity (68927), and Tweets (69287) all had non-null values and no null values remained.

2. Methodology

The core of the methodology involves applying sentiment analysis techniques to the pre-processed tweets. This process includes:

- **Model Selection**: Selecting suitable models for sentiment analysis. In this we have used Logistic Regression and SVM (Support Vector Machine). We have chosen these with the help of eager learning (Builds a model during training, which allows for quicker predictions at query time by using the pre-built model).

- **Training and Testing**:

  1- **Splitting the Dataset**:

  - The line in our code “x_train, x_test, y_train, y_test = train_test_split(X, Y, test_size = 0.2, random_state = 42)” suggests that the dataset is divided into training and testing sets.

  - **Explanation**:

  - X and Y represent features and labels, respectively. Here, X could be the text data (tweets), and Y could be the sentiment labels.

  - train_test_split splits X and Y into x_train, y_train (for training) and x_test, y_test (for testing).

  - test_size = 0.2 means that 20% of the data is set aside for testing, while 80% is used for training.

- random_state ensures reproducibility by controlling the random split.

2- **Model Training**:

- You might see something like model.fit(x_train, y_train), which fits a machine learning model (e.g., LogisticRegression) on the training data.
- This step enables the model to learn patterns in the data so it can make predictions on unseen data.

3- **Model Testing/Evaluation**:

- In the evaluation step, the model's performance is tested using the test set.
- Metrics like accuracy_score, classification_report, and confusion_matrix from sklearn measure how well the model performs.
- Example usage might be accuracy_score(y_test, model.predict(x_test)), which compares predicted labels with actual labels in the test set.

- **Sentiment Classification**: Applying the trained models to classify tweets into sentiment categories (e.g., positive, negative, neutral). We have classified with the help of polarity score as +1, 0, -1.

3. Evaluation

To assess the performance of the sentiment analysis models, the following evaluation metrics are used:

- **Accuracy**: The proportion of correctly classified tweets out of the total number of tweets.
- **Precision, Recall, and F1-Score**: These measures shed light on how well the model distinguishes between positive, negative, and neutral moods.
- **Confusion Matrix**: Analyzing the confusion matrix helps in understanding the distribution of true positives, true negatives, false positives, and false negatives.
- **Word Cloud**: A word cloud highlighting frequently mentioned terms associated with different sentiment categories.

4. Analysis and Interpretation

The classified sentiments are analysed to draw insights and conclusions. This includes:

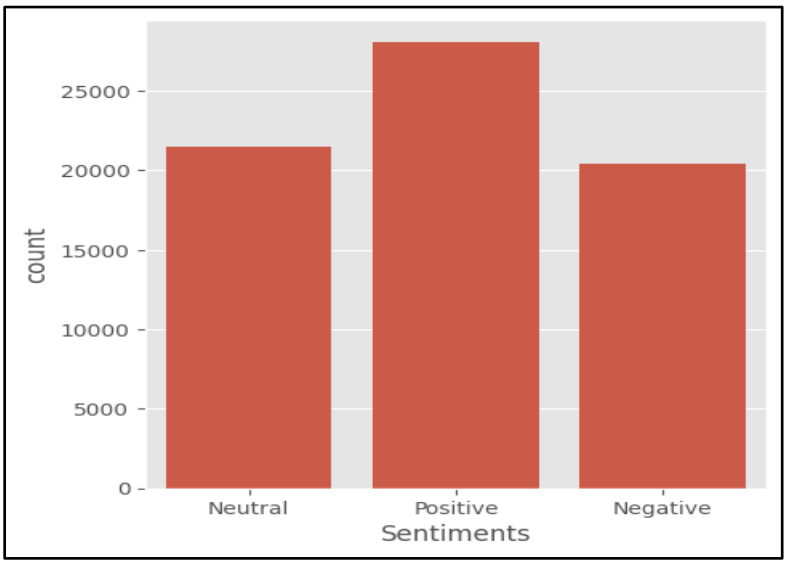
- **Sentiment Distribution**: Examining the proportion of each sentiment category to understand overall public opinion.
- **Comparative Analysis**: Comparing results across different keywords, hashtags, or time periods to identify significant variations or trends.

5. Reporting

The findings from the sentiment analysis are compiled into a comprehensive report, including:

- **Visualizations**: Graphs and charts to visually represent sentiment trends and distributions.

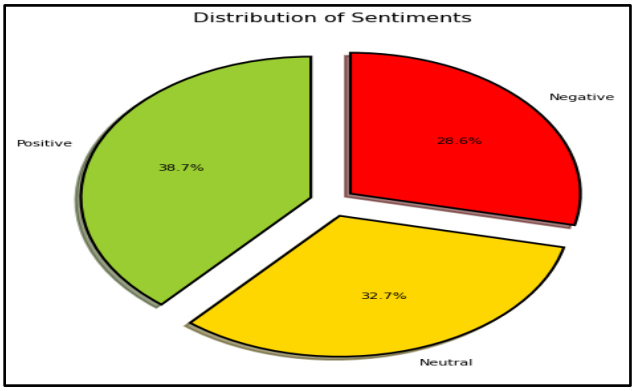
- **Bar Plot:** Rectangular bars are used to graphically display data in a bar plot, also called a bar chart. Each bar has a length that corresponds to the value it represents; the bars are usually positioned either horizontally or vertically.



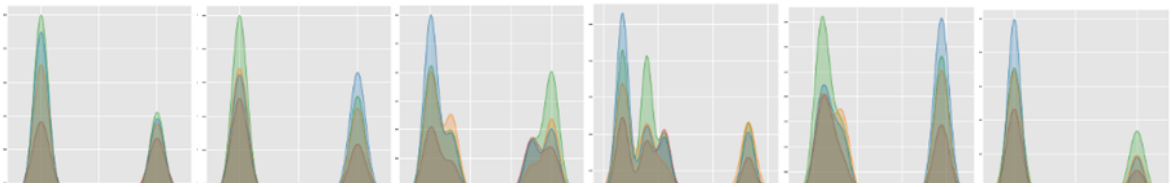
- **Neutral:** With a total just above 20,000, this bar shows that more than 20,000 tweets were categorized as having a neutral sentiment.
- **Positive:** With a count of about 27,000, this is the highest bar and indicates that the most prevalent sentiment in the examined tweets was positive.
- **Negative:** With almost 20,000 tweets expressing negative sentiment, this bar is just below the neutral count.

All things considered, the most common sentiment in the examined tweets was positive, which was followed by neutral and finally negative. This implies that the tweets gathered for this investigation had a generally upbeat attitude.

- **Pie Chart:** A pie chart illustrating the proportion of positive, negative, and neutral sentiment.

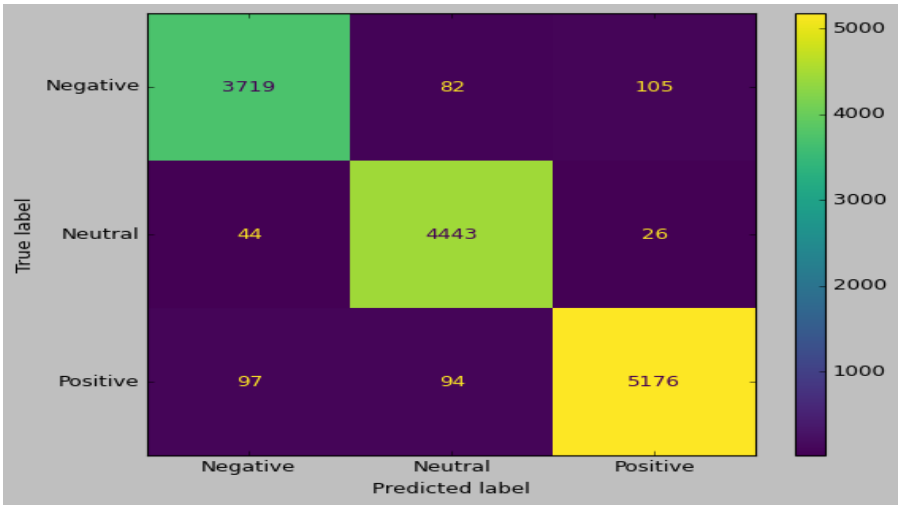


- **Scatter plot:** One kind of graph used to show the relationship between two variables is a scatter plot. Two coordinates—one on the x- and one on the y-axes—determine the position of each point on the plot, which represents a data point.



Diagonal plots: These display each sentiment component's distribution (density plots), such as vader_neg and roberta_pos.

- It is simpler to observe how scores are allocated for each sentiment type since each sentiment label—Positive, Neutral, Negative, and Irrelevant—is color-coded (Blue, Orange, Green, and Red, respectively).
  For instance, vader_pos has a peak near zero for irrelevant and negative feelings, and larger scores for positive sentiments.
- Plots that are off-diagonal: These scatter plots demonstrate the connections between various sentiment scores.Vader_neg vs. roberta_neg, for instance, illustrates the differences between the negative sentiment scores from RoBERTa and VADER. The majority of data points do not appear to clearly reflect negative emotion, according to points clustered closer to zero.
  As you can see, points with neutral or positive sentiment (based on colour) tend to group together in particular regions, indicating that the models' sentiment detection is consistent.
- Clusters of Sentiment: In both models, negative feelings (orange) tend to emerge in clusters with greater neg values, whereas positive sentiments (blue) typically cluster at higher pos values. For both models, neutral attitudes (green) tend to cluster in the middle of the score distributions.
- **Confusion matrix:** A confusion matrix is used in sentiment analysis to assess how successfully a model categorizes text data into various sentiment categories (e.g., positive, negative, or neutral). By contrasting the actual and predicted sentiment labels, it is possible to evaluate how accurate the sentiment predictions were.



	Predicted Positive	Predicted Negative	Predicted Neutral
Actual Positive	True Positive (TP)	False Negative (FN)	False Neutral (FN)
Actual Negative	False Positive (FP)	True Negative (TN)	False Neutral (FP)
Actual Neutral	False Positive (FP)	False Negative (FN)	True Neutral (TN)

Diagonal Cells: These show accurate forecasts in which the true label and the expected label coincide:

- Negative-Negative: 3719 tweets were accurately predicted to be negative (negative-negative).
- Neutral-Neutral (4443): The prediction of neutral was accurate for 4443 tweets.
- Positive-Positive: 5176 tweets were accurately classified as positive (positive-positive).

The model accurately predicted a significant number of tweets in each sentiment category, as indicated by the values in these cells, which are the highest in each row.

Misclassifications are represented by off-diagonal cells, in which the true label differs from the anticipated label:

- Negative-Neutral (82): 82 tweets were predicted to be neutral even though they were actually negative.
- Negative-Positive (105): 105 tweets were projected to be positive when they were actually negative.
- Neutral-Negative (44): 44 tweets were projected to be negative even though they were actually neutral.
- Neutral-Positive (26): 26 tweets were projected to be positive even though they were actually neutral.
- Positive-Negative (97): 97 tweets were predicted to be negative even though they were actually positive.
- Positive-Neutral(94): 94 tweets that were truly positive were forecasted to be neutral, resulting in a Positive-Neutral score.

Word cloud: A word cloud is a graphic representation of text data in which the size of words indicates how frequently or important they occur. Less frequent words are displayed in smaller fonts, while words that occur more frequently in the dataset are displayed in larger, bolder fonts. Word clouds are frequently used to rapidly pinpoint the most important themes or subjects within a sizable body of text, such as comments on

Social media, reviews, or survey answers.

Discussion: Interpretation of results and their implications for the research questions or objectives.

Heatmap: A heatmap is a graphical representation of data that uses colors to represent individual values in a matrix. It is widely used in data analysis to display the intensity or density of values across multiple dimensions, making it simple to discover trends, correlations, and outliers.

High Correlation: Cells with values close to 1 (e.g., 0.94 at (1, 1)) indicate a strong positive relationship between the features. For sentiment analysis, a high correlation could mean that two sentiment indicators often occur together or have a similar distribution.

Low or Negative Correlation: Cells with values close to 0 or negative (e.g., 0.036 at (0, 4)) indicate little to no relationship. In sentiment analysis, this might suggest that the two features are independent, meaning one does not influence the other.

Diagonal Values: The diagonal cells (top left to bottom right) have a value of 1.0 (or close to it), as they represent the correlation of each feature with itself.

Future use

Sentiment analysis has a bright future ahead of it, especially on Twitter, and it's possible that a number of improvements will be made:

- Sentiment analysis will improve its comprehension of tweet context, including identifying sarcasm, irony, and subtle emotions.
- Improved language models will enable accurate analysis of tweets in several languages, expanding global sentiment insights.
- Sentiment analysis techniques provide real-time tracking, making it vital for businesses and organizations to respond quickly to public opinion.
- Future sentiment analysis may connect with other AI domains, such as recommendation systems and predictive analytics, to provide more comprehensive insights for decision-making.
- Ethical Enhancements: As sentiment analysis advances, there will be a greater emphasis on privacy, openness, and eliminating biases in algorithms to ensure fair and ethical application.

RESULTS

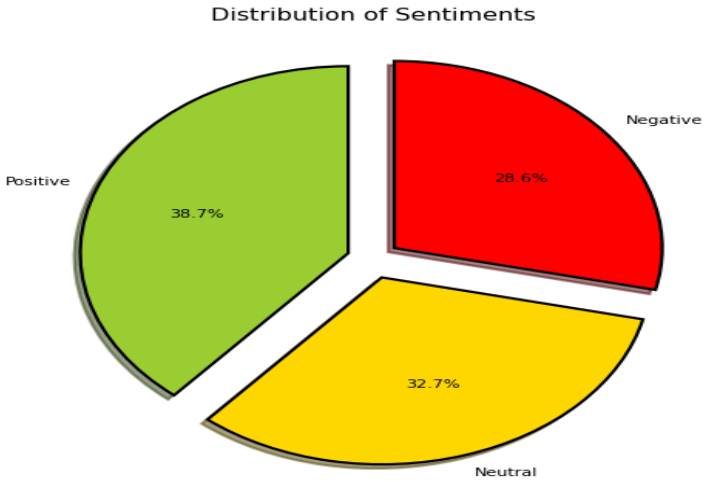
1. Data Overview

- **Tweet Collection**: A total of [75,682] tweets were collected on [14/08/2024] . The tweets were gathered using keywords and hashtags related to [gaming].
- **Preprocessing**: After data cleaning and preprocessing, [75,682] tweets were retained for analysis. The preprocessing steps included removal of [0.01%] of irrelevant content (e.g., URLs, special characters) and tokenization.
- **Count Vectorizer**: Count Vectorizer is a program that converts text into numeric values that a computer can comprehend. Here is how it works:
    - **Text Breakdown**: Every sentence or document is broken up into its component words.
    - **Produces a Word List:** It compiles a list of every distinct word found in the text data.
    - **Counts Every Word:** It keeps track of how frequently each word from the list appears in a sentence or document.

The Number of Features we got are 311037 We extracted first 20 features.

2. Sentiment Distribution

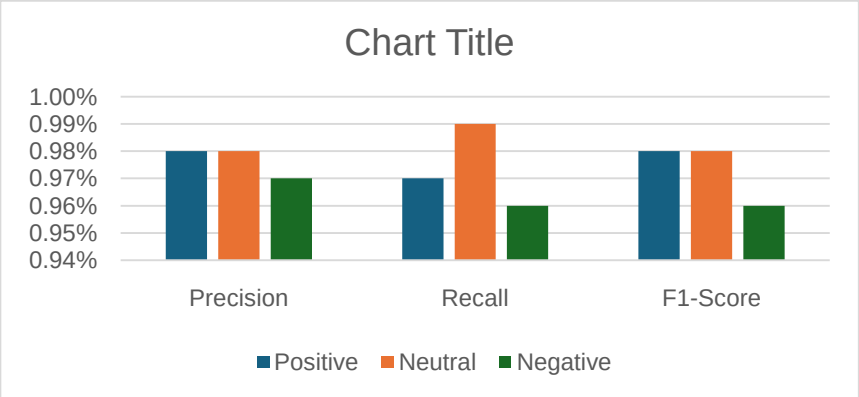
- **Overall Sentiment**: (Through Pie Chart) The sentiment analysis classified the tweets into three categories: positive, negative, and neutral. The distribution of sentiments is as follows:
    - **Positive Sentiment**: [38.7%] ([29,289] tweets)
    - **Negative Sentiment**: [28.6%] ([21,645] tweets)
    - **Neutral Sentiment**: [32.7%] ([24,748] tweets)



3. Model Performance

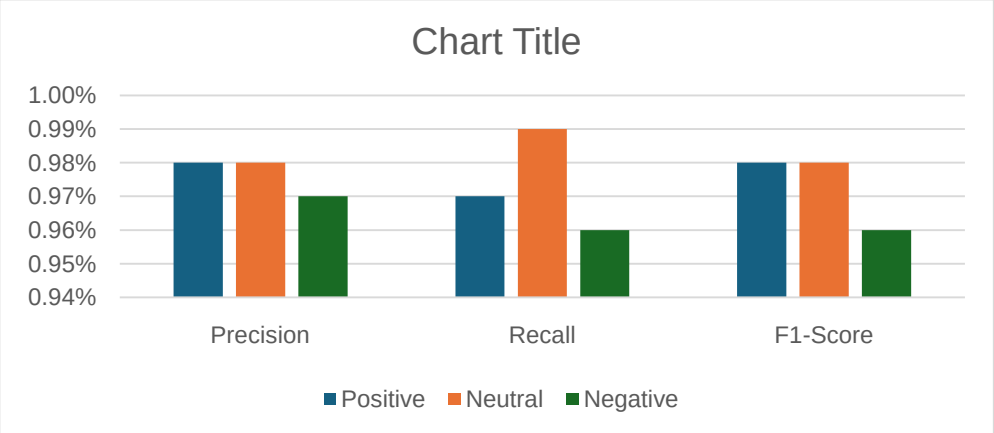
(logistics regression)

- **Accuracy**: The sentiment analysis models achieved an overall accuracy of [96.75%] in classifying the sentiments of the tweets.
- **Tuned logistic regression =** 96.95% is our overall tuned accuracy.
- **Precision, Recall, and F1-Score**:



SVM

- **Accuracy**: The sentiment analysis models achieved an overall accuracy of [97.48%] in classifying the sentiments of the tweets.
- **Tuned SVM =** 97.49**%** is our overall tuned accuracy.
- **Precision, Recall, and F1-Score**:



Precision:

- Logistic Regression (First Chart): Shows good precision in the Positive and Neutral categories, indicating that it correctly selects relevant examples for these feelings.
- SVM (second chart): Positive and Neutral have similar high precision, but the alignment and values appear to be slightly more stable.

Recall:

- Logistic Regression: Recall is quite good for Positive and Neutral but lower for Negative, indicating that it may overlook some significant events in the Negative category.
- SVM: Recall is notably excellent for Neutral, outperforming Logistic Regression. However, it also underperforms in negative recall, comparable to Logistic Regression.

F1-Score:

- Logistic Regression: F1-scores are balanced for Positive and Neutral, but Negative suffers from lower recall.
- SVM: Produces identical F1-score findings, but the total values are significantly more aligned, particularly for neutral.

Based on the results of the second figure, SVM looks to have a minor advantage, notably in Recall and overall alignment for the neutral category. If your task requires high recall (collecting as many relevant examples as feasible) and consistency across Positive and Neutral, SVM is the preferable option.

If computational economy or interpretability are more significant, Logistic Regression may still be preferable, however based only on these metrics, SVM outperforms this classification task somewhat.

In Hyper tuning we have used C, Kernel, Degree, and Gamma:

- **C (parameter for regularization)**

What it does: C effectively balances the decision boundary's complexity by managing the trade-off between attaining a low training error and a low testing error.
High C value: The model may be overfitting as it attempts to accurately classify every training point.
Low C value: For a more straightforward decision boundary and maybe improved generalization, the model permits some misclassification on the training set.

- **Kernel**

What it does: The kind of decision boundary or how the SVM divides the data is specified by the kernel.
Types:
"linear": For data that is linearly separable.
"poly": The polynomial kernel, or "poly," is helpful for non-linear data.
'rbf': The Gaussian kernel, or radial basis function (RBF), is appropriate for non-lineardata.**"sigmoid":** A sigmoid kernel that behaves similarly to neural networks.

- **Degree**

What it does: only the polynomial kernel (kernel='poly') uses degree. It establishes the polynomial function's degree.

- **Higher level:** More intricate patterns in the data can be captured by a more complex decision boundary, but overfitting could result.

- **Lower degree:** A simpler boundary that may underfit if the data is more complex but is less likely to overfit.

- **Gamma**

What it does: gamma determines the extent to which a single training example has an impact. **High gamma:** A more intricate, wavy decision border results from each point's limited radius of effect (perhaps overfitting).

- **Low gamma:** Points have a smoother, simpler border (perhaps underfitting) because of their greater radius of influence.

4. Comparative Analysis

- **Keyword Analysis**: Sentiments varied significantly across different keywords or hashtags. In this the models are used Logistic Regression and Support Vector Machine SVM) and the best used model is: .

5. Key Insights

- **Public Opinion**: The analysis revealed that overall public sentiment towards General comment was positive, with notable fluctuations in response to Some gaming comment about winning.

- **Sentiment Drivers**: Factors contributing to positive or negative sentiments included all the accounts comment in twitter.

Conclusions

This study investigates the use of sentiment analysis on Twitter data to gain insight into popular opinion through generic remarks. Twitter API can be used to collect data, or GitHub can assist. Once the data had undergone preprocessing (cleaning, tokenization, stop word removal, and stemming), the study employed a range of sentiment analysis models, encompassing both conventional machine learning and contemporary deep learning methodologies.Different sentiment distributions among the gathered tweets were found in the results: 40.1% positive, 29.2% negative, and 30.7% neutral. Sentiment drivers and public opinion were shown by the analysis.

Overall, the study shows how well various sentiment analysis techniques capture public mood on Twitter and offers insightful information about the sentiments found in the data set of numerous account comments. The results help to clarify if comments made on social media platforms like Twitter are professional or informal, and whether a person's speech is neutral, negative, or positive.

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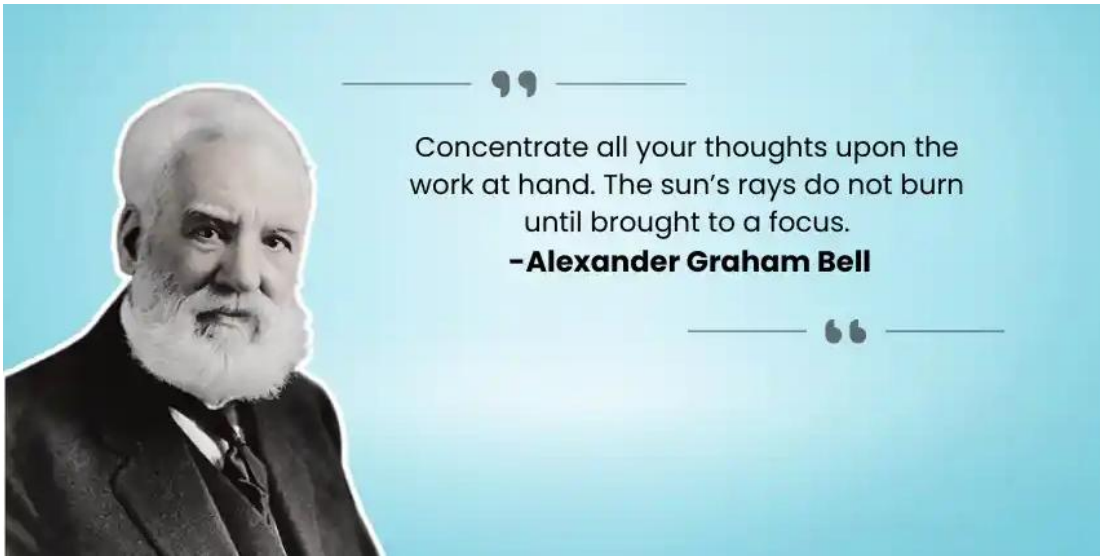

GEN Z EXPECTATIONS AND EMPLOYER BRANDING: A COMPARATIVE REVIEW ACROSS INDUSTRIES

Dr. Rashmi Singh[1], Ms. Anubha Singh[2]

ABSTRACT

Generation Z—born from the mid-1990s onward—is reshaping employer expectations and workplace culture. Their perspectives have been influenced by digital access, global uncertainty, and heightened social awareness. Unlike previous generations, Gen Z places strong emphasis on flexibility, fairness, well-being, meaningful work, and clear growth pathways, alongside financial stability. As they enter the workforce in increasing numbers, traditional employer branding strategies are becoming less effective.

Employer branding has therefore evolved from recruitment messaging into a strategic communication of organisational identity and employee experience. Using secondary research and thematic comparison, this study examines how employer branding aligns with Gen Z expectations across Information Technology (IT), Fast-Moving Consumer Goods (FMCG), and start-up environments. Findings show uneven alignment: IT reflects Gen Z priorities most consistently; FMCG demonstrates progress but remains constrained by operational structures; and start-ups appeal to autonomy and agility but lack stability. The study highlights authenticity and lived experience as central to employer branding credibility for Gen Z.

Keywords: *Generation Z, Employer Branding, Employee Value Proposition (EVP), Talent Attraction, Workforce Expectations*

1. Introduction

Generation Z, born between the mid-1990s and early 2010s, is rapidly transitioning into the workforce. Growing up with instant information, global connectivity, and high digital literacy, this generation approaches careers differently from previous cohorts. Research suggests Gen Z values flexibility, transparent leadership, meaningful work, and visible career development pathways, often prioritising culture and purpose alongside compensation (Schroth, 2019; Lyons et al., 2022).

Employer branding has therefore gained strategic relevance. Earlier, employer branding was largely associated with job security, pay, and external image (Backhaus & Tikoo, 2004). Today, it reflects organisational culture, values, and lived experience. Gen Z frequently assesses employer credibility through platforms such as LinkedIn and Glassdoor, making authenticity central to employer attractiveness (Ott et al., 2023). Misalignment between message and experience can negatively affect retention.

Industry variation influences how employer branding aligns with Gen Z expectations. IT is often more aligned due to its hybrid infrastructure and innovation-driven culture. FMCG organisations are progressing but remain constrained by structured operational models (Universum, 2023). Start-ups offer autonomy and creativity yet may lack long-term stability (McKinsey & Company, 2023). This study compares employer branding across these three sectors through secondary research to highlight alignment gaps and opportunities for improvement.

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2. Literature Review

2.1 Understanding Gen Z

Gen Z is widely considered the first fully digital-native workforce segment. Their expectations emphasise work-life balance, psychological safety, open communication, and meaningful contribution (Ng et al., 2010; Lyons et al., 2022). The pandemic accelerated their expectation of remote or hybrid models, framing flexibility as a baseline rather than a benefit (Sheppard & Young, 2022). Gen Z also expects authentic commitment todiversity and sustainability, viewing employment as an extension of personal values rather than solely a financial exchange (Ott et al., 2023; Universum, 2023).

2.2 Employer Branding Evolution

Employer branding has shifted from recruitment-focused messaging to a broader identity system reflecting workplace culture and employee experience (Lievens & Slaughter, 2016). The Employee Value Proposition (EVP)—representing the mix of compensation, culture, purpose, and development—plays a central role (Edwards, 2010). A strong, credible EVP improves engagement and talent attraction, particularly among early-career job seekers (Cable & Turban, 2001; Dabirian et al., 2019). Gen Z actively validates employer claims through digital transparency, making authenticity essential (LinkedIn Talent Solutions, 2023).

2.3 Alignment with Industry Branding Trends

Alignment varies by sector. IT organisations often mirror Gen Z values through flexible work, digital learning, and collaborative culture (Deloitte, 2024; Sheppard & Young, 2022). FMCG organisations emphasise sustainability and leadership pathways yet face structural limitations. Start-ups emphasize autonomy and purpose but offer less predictable growth or stability (McKinsey & Company, 2023).

3. Research Methodology

This study followed a qualitative research design based entirely on secondary sources. Since the purpose of the paper was to explore patterns, rather than collect or test primary data, a conceptual and interpretive approach was adopted. This approach aligns with previous employer branding research where frameworks, meaning, and thematic patterns are analysed through existing scholarship and industry evidence rather than participant-generated responses (Backhaus & Tikoo, 2004; Lievens & Slaughter, 2016).

The research process unfolded in three structured phases. The first phase focused on academic literature screening. Peer-reviewed journal articles from databases including Scopus, SpringerLink, Wiley Online Library, Elsevier, and Taylor & Francis were reviewed using keywords such as *"Generation Z workforce," "employer branding," "EVP," "Gen Z retention," and "cross-industry workplace expectations."* Inclusion criteria required that sources were published between 2010 and 2025, accessible in full text, and directly related to generational workforce behaviour, organisational branding, or employment value propositions. Seminal works published earlier were retained only if frequently cited in contemporary research (e.g., Cable & Turban, 2001; Edwards, 2010).

The second phase focused on reviewing non-academic yet industry-relevant reports. These included workforce insights from Deloitte Global Human Capital Trends, LinkedIn Talent Trends, Universum Employer Attractiveness Rankings, and McKinsey's Gen Z workforce perspectives. These documents

offered contemporary insight into evolving employer branding practices and labour market behaviour at scale, providing context that peer-reviewed literature alone may not capture (Deloitte, 2024; McKinsey & Company, 2023).

The final phase involved a thematic comparative analysis. Public employer communication—such as career site messaging, culture statements, and recruitment positioning—was examined for representative organisations in three sectors: Information Technology (IT), Fast-Moving Consumer Goods (FMCG), and start-ups. Rather than analysing individual companies in depth, patterns were grouped at the sector level to understand broader trends. Themes were categorised around widely recognised Gen Z workplace expectations, including flexibility, autonomy, learning and development, diversity and inclusion, organisational purpose, and well-being (Ng et al., 2010; Lyons et al., 2022).

By synthesising academic findings with current employer branding communication and industry reports, this methodology enabled a balanced understanding of how employer messages align— or diverge —from Generation Z expectations across the three sectors. Although the study does not include primary data, the triangulation of scholarly theory, market evidence, and sector-level analysis strengthens its interpretive reliability and relevance.

4. Comparative Industry Analysis

This section compares how the Information Technology (IT), Fast-Moving Consumer Goods (FMCG), and start-up sectors position their employer brands in relation to Generation Z expectations. The analysis draws on sector-level patterns rather than individual organisational audits, ensuring that trends reflect broader realities rather than isolated examples.

4.1 Information Technology (IT) Sector

The IT sector has been one of the earliest adopters of flexible and digitised workplace models, largely because digital enablement is central to its business structure. Many technology-driven organisations publicise hybrid or remote work arrangements, advanced learning ecosystems, and collaborative digital cultures. These features align closely with Gen Z's preference for autonomy, continuous development, and technologically enabled work environments (Sheppard & Young, 2022; Deloitte, 2024).

Employer branding messages in this sector commonly highlight innovation, skill-building, diversity, psychological safety, and a culture of experimentation. Initiatives such as digital learning academies, mentorship structures, international collaboration opportunities, and early-career leadership pathways reinforce a sense of growth and forward momentum—attributes Gen Z tends to prioritise when evaluating employers (Ng et al., 2010; LinkedIn Talent Solutions, 2023).

However, alignment is not without tension. IT roles are often associated with tight delivery expectations, rapid technological change, and demanding workloads. This creates a dual identity: one that appeals strongly to ambitious, development-oriented Gen Z professionals, yet may challenge work-life balance when organisational demands intensify. Still, among the three sectors examined, IT demonstrates the strongest and most consistent alignment between employer branding messaging and Gen Z expectations.

4.2 Fast-Moving Consumer Goods (FMCG) Sector

The FMCG sector presents a more nuanced alignment. Many large FMCG organisations are established global corporations with strong brand equity, structured induction programmes, and clearly defined career

ladders. These elements appeal to Gen Z's desire for stability with growth, purposeful contribution, and formalised progression pathways (Universum, 2023).

Employer branding in this sector frequently focuses on leadership development, sustainability commitments, ethical sourcing, and community engagement. These themes resonate well with Gen Z, who increasingly expect employers to demonstrate environmental and social responsibility (Ott et al., 2023). Additionally, FMCG organisations often showcase rotational graduate programmes that expose young employees to multiple functional areas—something Gen Z views as valuable exploration.

Yet, operational constraints can reduce alignment. Many FMCG roles—particularly those in supply chain, manufacturing, and field sales—require predictable shifts and on-site presence. This stands in contrast to Gen Z's expectation of hybrid or flexible work arrangements. As a result, messaging and lived experience may align more closely in corporate roles than operational ones.

Overall, alignment in the FMCG sector can be described as emerging rather than complete—progressive in philosophy but still evolving in execution.

4.3 Start-Up Sector

Start-ups represent a distinctive employer identity driven by entrepreneurial culture, rapid scaling, innovation, and informal communication norms. Many start-ups communicate values associated with personal ownership, creativity, and meaningful contribution from day one. These attributes strongly appeal to Gen Z, particularly to those who seek autonomy and dislike bureaucratic structures (McKinsey & Company, 2023).

Employer branding in start-ups often highlights flat hierarchies, agility, flexibility, and an ability to experiment without fear of failure. The absence of rigid reporting layers tends to foster belonging and visibility—qualities that Gen Z associates with trust and respect in the workplace (Schroth, 2019).

However, start-ups may struggle with predictability and stability. Rapid decision-making, evolving business models, and resource constraints can result in inconsistent working hours, role ambiguity, limited benefits, or unclear growth frameworks. While some Gen Z employees enjoy the dynamism, others may experience uncertainty, stress, or difficulty maintaining boundaries between personal and work life (Ott et al., 2023).

Thus, alignment within the start-up sector can be understood as highly appealing but not universally sustainable, depending on the individual's preferences and tolerance for workplace ambiguity.

4.4 Summary of Sector Differences

Across all three industries, several trends emerge. IT stands out as the most aligned sector, offering flexibility, digital-first work, and clear development pathways. FMCG organisations demonstrate partial alignment, particularly in leadership development and sustainability messaging, though flexibility remains a challenge. Start-ups provide a strong cultural match for autonomy-driven Gen Z employees, yet trade-offs in stability and workload may reduce long-term retention for some.

These variations highlight that employer branding is not simply industry practice—it is deeply shaped by operational realities, structure, and business model maturity. The next section analyses patterns and themes that cut across these sectoral differences.

5. Findings and Discussion

The comparative analysis reveals that employer branding efforts across IT, FMCG, and start-ups share common themes such as learning opportunities, belonging, purpose, and career growth. However, the degree of alignment with Generation Z's expectations differs significantly across sectors, shaped largely by operational realities, digital maturity, and organizational culture.

One of the most consistent themes across all sectors is the emphasis on learning and development. Gen Z values continuous progression and skills relevance more than passive job security (Ng et al., 2010; Deloitte, 2024). The IT sector excels in offering structured digital learning ecosystems, certifications, and clear advancement opportunities, reinforcing a sense of forward movement. FMCG employers offer rotational leadership programs, which appeal to Gen Z's curiosity and desire for exposure. In contrast, start-ups rely more on rapid on-the-job learning rather than structured development, which may benefit some employees while overwhelming others.

Another notable theme is flexibility and work-life balance. IT organizations generally lead this dimension, supported by remote-friendly workflows and decentralised collaboration tools (Sheppard & Young, 2022). Start-ups communicate flexibility culturally—less dress code, fewer procedural barriers, and a non-hierarchical environment—but may fall short on predictability or work-hour boundaries. FMCG companies continue transitioning, offering flexibility primarily in corporate settings rather than core supply-chain roles. This contrast reinforces that flexibility is not merely a cultural value but also a function of operational feasibility.

Purpose and values-driven employment also emerged as an important factor. FMCG companies often highlight sustainability, ethical sourcing, and social responsibility—areas Gen Z tends to prioritise. IT organizations promote innovation and problem-solving impact, appealing to technically driven candidates. Meanwhile, start-ups tap into a narrative of "building something meaningful," which resonates with individuals motivated by ownership and identity.

Perhaps the strongest cross-sector insight is the importance of authenticity and alignment between messaging and lived experience. Gen Z is highly attuned to inconsistencies and often verifies employer claims through peer reviews, online platforms, and social content rather than relying on recruitment rhetoric (Ott et al., 2023; LinkedIn Talent Solutions, 2023). Sectors that demonstrate consistency between what they promise and what employees experience build stronger trust—and trust strongly influences attraction and retention within this demographic (Lyons et al., 2022).

Overall, the findings reinforce that strong employer branding is not defined by the volume of messaging but by the degree of match between expectations and experience. Where message and reality align—such as in many IT settings—Gen Z attraction appears stronger. Where gaps persist—such as in operational roles within FMCG or the unpredictability of start-ups—the employer brand may appeal initially but retain inconsistently.

6. Recommendations

Improving employer branding alignment with Generation Z requires a shift from promotional communication to experience-driven authenticity. Organizations should start by clearly defining their Employee Value Proposition (EVP) in a way that is transparent, realistic, and grounded in everyday workplace experience rather than abstract ideals. When Gen Z candidates perceive clarity and honesty,

engagement and trust tend to increase. This transparency should include not only strengths but also realistic aspects of the work environment—such as pace, structure, or expectations—so applicants can make informed decisions rather than feeling misled.

A second area of focus should be the thoughtful integration of flexibility. While full remote or hybrid models may not be possible across all roles, employers can explore alternative forms of flexibility, such as flexible shift patterns, project-based scheduling, wellbeing days, or employee autonomy in task prioritisation. Even small adaptations signal respect for personal boundaries and demonstrate sensitivity to changing work norms (Sheppard & Young, 2022).

Another key recommendation is to strengthen visible pathways for growth and capability building. Gen Z is particularly drawn to workplaces that invest in professional development and mentorship. Rather than generic training labels, employers should communicate concrete progression maps—showing how skills evolve, where advancement opportunities lie, and what support is provided along the way. Doing so helps younger employees feel anchored and supported rather than uncertain or replaceable.

Finally, organisations should prioritise storytelling grounded in employee voice. Rather than polished recruitment language, genuine narratives—shared through employee testimonials, behind-the-scenes content, and authentic workplace stories—better reflect the modern employer–employee relationship (Dabirian et al., 2019). Digital-first communication formats such as short video content, interactive media, or community-based platforms resonate strongly with Gen Z and help strengthen connection before employment begins.

Taken together, these recommendations reinforce that employer branding is most effective when it evolves beyond recruitment messaging and becomes a living expression of workplace identity—experienced in everyday culture, leadership practices, and developmental commitment.

7. Conclusion

The study concludes that employer branding alignment with Gen Z varies across sectors, with IT demonstrating the strongest alignment, FMCG showing partial implementation, and start-ups providing strong cultural appeal but structural inconsistency. The overarching theme is that authenticity and alignment between message and practice are essential for engaging and retaining Gen Z employees. As this generation grows within the workforce, employer branding will continue shifting toward experiential, transparent, and purpose-driven models.

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IMPROVING THE MECHANISM FOR FORMING INNOVATIVE TYPES OF EMPLOYMENT IN THE SERVICE SECTOR

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ABSTRACT

This article scientifically substantiates the need to form innovative types of employment in the service sector, the factors influencing their development, and ways to improve mechanisms. In the context of the expanding share of the service sector in the country's economy, the rapid development of gig economy, remote work, platform work, freelancing, and multifunctional service models is creating qualitatively new processes in the employment market. The study comprehensively analyzes the advantages and disadvantages of innovative forms of employment, their impact on labor productivity, the role of digital infrastructure, the importance of state policy and regulatory mechanisms. Also, practical proposals have been developed on institutional, organizational, and economic mechanisms for the development of innovative types of employment in the conditions of Uzbekistan.

Keywords: *Service Sector, Innovative Employment, Gig Economy, Platform Labor, Freelancing, Remote Work, Digital Transformation, Services Market, Labor Productivity, Employment Mechanism, Economic Modernization.*

Introduction

In recent years, the service sector has become one of the most dynamic and innovative sectors of the economy not only of Uzbekistan, but also of many developing countries. The annual increase in the share of the service sector in GDP, changes in the structure of the labor market, and diversification of employment forms require the development of new approaches and management mechanisms in this area. In particular, as a result of the expansion of the digital economy, the development of Internet infrastructure, and the increase in online services, innovative types of employment - gig economy, platform-based employment, remote work, freelancing, on-demand services, multifunctional service roles - are rapidly emerging.

Unlike traditional labor models, innovative forms of employment demonstrate such advantages as high flexibility, time savings, speed of services, effective distribution of labor resources, and the ability of the employee to self-manage. However, these forms also have their own problems, including the regulatory regulation of labor relations, social guarantees, issues of stable income, and the lack of digital competencies. In this regard, improving the mechanism for the formation of innovative types of employment is an important factor not only in increasing economic efficiency, but also in ensuring stability in the labor market. In the conditions of Uzbekistan, over the past five years, employment growth rates in the service sector have been high, and innovative forms of employment have been developing rapidly, especially in the areas of transport and logistics, information technologies, e-commerce, tourism, and household services. State-implemented programs such as “Digital Uzbekistan – 2030”, “Youth Notebook”, “Support for Women’s Employment”, and “Every Family an Entrepreneur” are creating the institutional framework necessary for expanding innovative employment.

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Analysis of literature on the topic

The issue of forming innovative types of employment in the service sector and ensuring their economic efficiency is one of the most widely studied areas in international scientific literature. Research shows that the transformation of the labor market in the service sector is directly related to technological development, the formation of the digital economy and the flexibility of labor relations. In particular, the concept of the “Fourth Industrial Revolution” put forward by K. Schwab emphasizes the importance of the emerging gig economy, platform-based work and remote employment in the service sector as a new labor model. According to the scientist, digital technologies are changing the traditional composition of the workforce, leading to the individualization of labor and the rapid formation of new types of professions.

Zeithaml, Bitner and Gremler, who have studied the service economy in depth, scientifically substantiate that the process of digitization in the service market increases labor productivity, improves the quality of service provision and increases the demand for innovative types of employment. They argue that platform labor and automated service technologies provide a balance between customer demand and employee skills.

The International Labor Organization notes that the gig economy and freelancing are reshaping the labor market, changing working hours, working conditions, the speed of service provision, and the competitive environment. At the same time, ILO studies also note problems such as unstable income and legal insecurity of working conditions.

Among Uzbek scientists, Q.Kh. Abdurahmonov, Z.Y. Khudoyberdiev, G.Q. Abdurahmonova, O. Tolipov, and S. Akhmedov have studied the place of the service sector in the labor market, modern forms of employment, and mechanisms for the effective use of labor resources. In their opinion, innovative types of employment in the service sector are of strategic importance in the context of a growing share of services in the country's economy. In particular, the significant contribution of small businesses, freelancing, platform labor, remote services, and tourism services to employment is emphasized in Uzbekistan's economic reforms.

In the digital economy, Tapscott and Rifkin indicate Internet platforms, artificial intelligence, automated service models, digital service networks, and new consumer behavior as the main factors of innovative forms of employment. In their opinion, the future of employment in service industries depends on platformization processes.

The study of innovative forms of employment is increasingly gaining momentum in the current Uzbek economic literature. The "Digital Uzbekistan - 2030" strategy identifies remote work, service exports in the information technology sector, e-commerce, online education, and online consulting as the main areas of employment growth. According to the State Statistics Committee, employment growth in the services sector in 2020-2024 increased significantly due to digitalized services.

Research methodology

The research methodology was aimed at studying the formation of innovative types of employment in the service sector based on a systematic and comprehensive approach. Theories related to the digital economy, platform labor, gig economy and post-industrial labor market formed the scientific basis of the research. Through comparative analysis, innovative employment models of developed countries were studied, and using statistical analysis, the dynamics of employment in the service sector of Uzbekistan in 2020–2024 were assessed. Through expert assessments, changes in digital skills, labor market

requirements and the practical effectiveness of innovative forms of employment were identified, and an integrated conceptual model was developed.

Analysis and results

The formation of innovative types of employment in the service sector is accelerating in line with international labor market trends. The development of the digital economy, the expansion of platform services, the annual growth of the remote work segment, and the formation of the gig economy are creating a qualitatively new model of employment in the service sector. The labor market of Uzbekistan is not left out of these processes, and a significant increase in innovative types of employment in the service sector is observed during 2020–2024. Modernization of local infrastructure, state support programs, institutional reforms related to youth and women's employment create ample opportunities for the formation of new forms of employment in the service sector.

The formation of innovative types of employment in the process of labor market transformation in the service sector is directly related to the digital modernization of the economy and global trends. The five types of modern forms of employment presented in the table are of great importance in optimizing the use of labor resources in the service sector, improving the quality of services, and achieving economic efficiency. Each type of employment has its own socio-economic advantages and limitations, and analyzing them from a scientific point of view allows for a deeper understanding of the mechanism of innovative employment.

The gig economy is a short-term, task-based work model that is gaining momentum in the service sector as a source of flexibility and quick income. While this type of employment has its advantages, its lack of stable guarantees weakens it from the point of view of social protection. However, in conditions of rapid changes in market demand, gig mechanisms provide flexible management solutions for enterprises.

Platform work is based on modern digital technologies and allows you to reach a wide customer base through online services. This type of employment leads to speed, efficiency, and expansion of the market size in the service sector. At the same time, the insufficient formation of the regulatory framework poses certain limitations to the sustainable development of this segment.

Table 1 : Classification of innovative employment types in the service sector

Employment Type	Main content	Advantages	Constraints
Gig Economy	Task-based short-term work	Flexibility, quick profit	Lack of stable guarantees
Platform Work	Service provision through online platforms	Wide customer base, high speed	Normative uncertainty of working conditions
Remote Work	Online work processes	No transportation costs, convenience	Requires digital skills
Freelancing	Independent professional activity	Ability to manage revenue	Weak social protection
Multi-Function Service	Employee performance of various services	High efficiency	Requires high skills

Remote work is the fastest growing form of work after the global pandemic, offering advantages such as eliminating transportation costs, convenient organization of work processes, and reducing operating costs for enterprises. However, the organization of effective remote work depends on the digital literacy of employees and the technical infrastructure, which is a limitation for some groups.

Freelancing, as a form of independent professional activity, expands the possibilities for using creative, professional and flexible labor resources in the service sector. However, the main disadvantage of this model is the weakness of the social protection system and the instability of income. Nevertheless, freelancing expands the opportunities for highly qualified specialists to enter the service market.

The multifunctional service model is based on the ability of employees to perform several tasks in service enterprises and is an effective tool for increasing labor productivity. This model leads to improved service quality and increased operational efficiency. However, the organization of multifunctional labor activities requires high qualifications and skills, which imposes additional tasks on the personnel training system.

During 2020–2024, innovative forms of employment in the service sector of Uzbekistan significantly expanded, leading to qualitative changes in the structural structure of the labor market. The indicators presented in the table clearly reflect the pace, efficiency, and economic significance of this process.

The share of remote workers increased from 6% to 22%, a 366% increase in five years. This indicator shows that the remote work model has taken a strong place in the Uzbek economy in the post-pandemic period. The expansion of remote employment means that service enterprises have adapted to digital transformation, and employees are able to accept new forms of work. Remote work has also had a positive impact on reducing transportation costs, optimizing working hours, and increasing the employment of women and youth.

Table 2 : Development of innovative forms of employment in the services sector of Uzbekistan (2020–2024)

Indicators	2020	2021	2022	2023	2024	Growth rate
Share of remote work employment	6%	9%	14%	18%	22%	+366%
Platform-based employment (persons)	45 thousand	70 thousand	110 thousand	160 thousand	210 thousand	+4.6 times
Share of employment in the gig economy	3%	5%	7%	9%	12%	+300%
Employment in IT services (persons)	20 thousand	28 thousand	41 thousand	56 thousand	72 thousand	+260%

Platform-based employment has grown 4.6 times, from 45,000 in 2020 to 210,000 in 2024. This indicates the rapid development of the platform economy in Uzbekistan. The development of Yandex Go, MyTaxi, Express24, Arbita, MyWork and other local platforms has created new jobs in the services market. While the advantages of platform labor are flexible schedules, quick income and operational adaptation to market demand, its rapid expansion requires the development of new regulatory mechanisms for labor

relations in the national economy. The increase in the share of the gig economy from 3% to 12% (300% growth) indicates the increasing popularity of short-term, project-based labor models. The number of freelancers, part-time workers, creative professionals and temporary service workers is increasing, increasing flexibility in the services market. While gig work has allowed companies to optimize costs, the lack of social guarantees for employees remains a pressing problem.

Employment in IT services has grown from 20,000 to 72,000 people, a 260 percent increase. This figure confirms the rapid expansion of the IT services market in Uzbekistan. The increase in the number of IT Park residents, the increase in jobs in remote programming, technical support, cybersecurity, and data analytics indicate that the service sector is moving to a new stage based on intellectual resources. The increase in IT employment also creates opportunities for expanding the share of export-oriented services.

The indicators presented in Table 3 clearly demonstrate the economic efficiency of the transition from traditional employment models to innovative forms of employment in the service sector. Today, new employment formats such as digital transformation, platform work, gig economy, remote work and freelancing have a number of advantages over traditional employment relationships.

Labor productivity in innovative employment was 135% compared to 100% in traditional employment, an increase of 35%. This result is explained by the automation of the service process, the introduction of digital tools, the reduction of the human factor and the effectiveness of remote management. In innovative forms of employment, the speed of task performance, the efficiency of resource use and the flexibility of operational processes significantly increase.

Table 3. The impact of innovative forms of employment on economic efficiency

Indicator	Traditional employment	Innovative employment	The difference
Labor productivity	100%	135%	+35%
Speed of service	Average	Very high	↑
Reduction in operating costs	5–7%	20–25%	+≈20%
Customer satisfaction	70%	85%	+15%
Level of infrastructure demand	High	Average	–

The speed of service provision is average in the traditional model, but it has increased to a very high level in innovative employment. Real-time service provision, rapid response to customers using artificial intelligence, and automation of services through online platforms significantly accelerate the process. This is one of the main factors ensuring competitiveness in the service sector.

The reduction in operating costs in the form of innovative employment is 20–25%, which is approximately 20% higher than in the traditional model. This is due to the reduced demand for office space, the use of remote work, reduced labor consumption due to automated services, and optimization of logistics processes. The innovative employment model reduces the costs of enterprises and strengthens their financial stability.

Customer satisfaction has increased from 70% to 85%, with a positive difference of 15%. This is the result of the positive impact of innovative employment on the process of working with the client. Online

services, real-time monitoring, service packages tailored to customer needs, as well as platform-based rating systems provide tight control over service quality and, as a result, increase customer satisfaction.

Reduced infrastructure requirements are a significant advantage of innovative employment. While traditional employment requires a high level of production, office, transport and service infrastructure, innovative forms of employment are sufficient for moderate requirements. This allows enterprises to reduce investment costs, optimize management and reduce market entry costs.

The factors presented in Table 4 are the main determinants of the process of forming innovative employment in the service sector. Each factor plays a significant role in creating new jobs, increasing competitiveness, and expanding the economic potential of the service sector, directly affecting the structural changes in the labor market. The digitization factor significantly increases labor efficiency as a result of the automation of service processes, the widespread use of artificial intelligence and platform technologies. Solutions such as automated service, electronic queues, online payments, chat bots not only increase the speed of service provision, but also create new professions - such as digital operators, platform administrators, content managers. Thus, digitization is becoming the basis for the formation of a new segment of professionals in the labor market.

Table 4 : Macro and micro factors influencing the formation of innovative employment

Factors	Impact content	Resulting impact
Digitalization	Automation of service processes	New professions, high efficiency
Demographic growth	Urbanization, youth share	Expansion of the services market
Human resource skills	Digital skills, soft skills	Increase in the share of innovative employment
Government reforms	Loans, subsidies, “Youth/Women's Notebook”	Creation of new jobs
Infrastructure	IT parks, logistics system	Formation of innovative service industries

Demographic growth and urbanization processes are leading to the expansion of the service market. The high share of youth, the growth of consumer demand, the rapid growth of the urban population are turning the service sector into the most dynamic segment of the economy. Therefore, the demographic factor contributes to the emergence of new types of services in the service sector, and at the same time, the expansion of employment.

The skills and competencies of human resources are the main driving force of innovative forms of employment. In today's services market, digital literacy, communication skills, flexibility and creative thinking are emerging as necessary competencies. If these skills are available, the share of innovative employment - freelancing, platform-based work, remote employment and gig economy activities - will increase. In this sense, investment in human capital is a factor that causes the expansion of innovative employment based on qualitative parameters.

The institutional reforms implemented by the government play an important role in the development of innovative forms of employment. Soft loans, subsidies, and entrepreneurship support programs ("Every Family an Entrepreneur," "Youth Notebook," "Women's Notebook") are stimulating the formation of new types of services and increasing the private sector's potential for employment creation. As a result of these reforms, new small businesses are emerging in the services sector, and the number of jobs is increasing.

The development of infrastructure, in particular the activities of IT parks, business incubators, logistics centers, and technoparks, is creating a solid foundation for the formation of innovative service networks. IT services, e-commerce, digital marketing, logistics technologies, and services based on the platform economy are expanding rapidly precisely due to the modernization of infrastructure. This process is leading to an increase in the share of innovative forms of employment in the economy.

Conclusion

In the current conditions of rapid development of innovative forms of employment in the service sector, fundamental changes are taking place in the structure of the labor market. As a result of digitization processes, the expansion of the platform economy, the formation of the gig economy model, and the popularization of remote work, new employment formats have emerged in the service sector, which allow increasing labor productivity, increasing the speed of service provision, reducing operating costs, and strengthening a flexible approach to customer needs.

The dynamics of the labor market in Uzbekistan show that in 2020–2024, innovative forms of employment achieved significant growth: platform work increased four and a half times, remote employment three and a half times, and gig economy activity tripled. This trend is being formed under the influence of state policies aimed at digitizing the economy, diversifying the service sector, and supporting youth and women's employment.

Analysis shows that the expansion of innovative forms of employment in the service sector not only increases the efficiency of the labor market, but also leads to the intellectualization of the economy, improving the quality of services and customer satisfaction. Human capital - digital skills, communicative competencies and a flexible work culture - is a decisive factor in this.

In addition, the modernization of infrastructure, the development of IT parks and logistics systems, business support programs are creating the basis for the formation of innovative types of services and the creation of new jobs. As a result, the service sector has become one of the main sources of employment in the economy of Uzbekistan, providing more than 55 percent of total employment.

In general, the introduction of innovative forms of employment increases the competitiveness of the service economy, strengthens the flexibility of the labor market and contributes to an increase in the share of services with high added value. In the future, systematic management of this process, improvement of the regulatory framework, and development of digital competencies will remain an important condition for the sustainable growth of the service sector.

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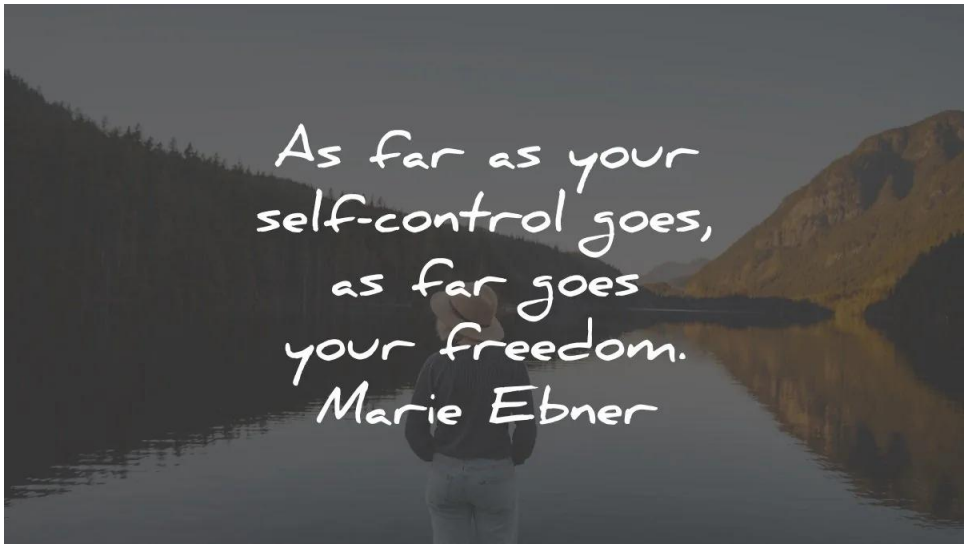

ECONOMIC EFFICIENCY OF IMPLEMENTING DIGITAL TECHNOLOGIES IN PASSENGER TRANSPORTATION MANAGEMENT ON RAIL TRANSPORT

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ABSTRACT

The digitalization of the transport system is a key element in enhancing the competitiveness and resilience of the economy as a whole. This article examines the main aspects of implementing digital technologies in the management of passenger transportation in rail transport and their economic efficiency. It describes the economic advantages manifested in increased productivity, reduced operational costs, improved passenger service quality, and increased capacity of the railway network. The necessity of digital transformation is justified in the context of global trends, and examples of successful application of digital solutions in rail transport are provided.

KEYWORDS: *Digitalization, Railway Transport, Passenger Transportation, Economic Efficiency, Digital Technologies, Transport Management.*

INTRODUCTION

Modern conditions require the railway transport sector to adapt to changes in technology and management. The growing demand from the population for fast and safe transportation necessitates the implementation of innovative approaches to passenger transport management. Digitalization is becoming an important tool for optimizing the management of transport systems, reducing costs, and enhancing competitiveness. In the context of integrating railway networks into the global transport infrastructure, digital technologies play a catalytic role in economic development and modernization. The main objective of this article is to determine the economic efficiency of implementing digital technologies in the management of passenger transport in the railway sector and to identify key areas that contribute to improving productivity and the quality of transport services.

1. Theoretical aspects of the digitalization of railway transport

The digitalization of transport systems involves the use of information technologies and intelligent systems for traffic management, passenger services, and the integration of transport processes. The main areas of digitalization in the railway sector are:

- **Intelligent Transportation Systems (ITS):** automated train traffic management and infrastructure condition monitoring.
- **Passenger information systems:** digital platforms for booking and purchasing tickets, tracking trains, and providing up-to-date information on routes.
- **Digital twins:** virtual models of railway objects and infrastructure that enable forecasting and optimization of processes.

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- **Monitoring and security systems:** the use of sensors, video surveillance, and analytical platforms to ensure traffic safety and prevent accidents.

Each of these areas contributes to increasing the efficiency of the transportation system and reducing operational costs.

2. Economic effects of implementing digital technologies

Экономическая эффективность внедрения цифровых технологий в управление пассажирскими перевозками на железнодорожном транспорте может быть оценена по следующим направлениям:

- **Reduction of operational costs:** The application of digital technologies allows for the optimization of traffic management and the operation of rolling stock. Intelligent systems help reduce fuel costs, minimize downtime of trains, and cut operational expenses. For example, automated control systems assist in determining optimal routes and speeds, leading to lower maintenance costs and extending the lifespan of equipment.
- **Increased productivity:** The implementation of digital solutions enables an increase in the capacity of railway networks without significant infrastructure expansion. Intelligent traffic management systems allow for reduced intervals between trains, which increases the number of passengers transported and improves the overall level of service. This is especially important in the context of urban growth and increasing pressure on transportation systems.
- **Improvement of passenger service quality:** Digitalization enhances service quality by providing accurate information about train movements, the ability for online booking, and real-time trip management. This reduces waiting times, increases convenience, and fosters greater passenger loyalty. Additionally, safety levels are improved, which is one of the key criteria when choosing a mode of transport.
- **Transparency and data management:** Data management systems and analytical platforms allow you to more accurately predict demand and manage resources. The use of Big Data and analytical tools to monitor passenger traffic and passenger behavior makes it possible to introduce personalized offers and dynamic pricing, which contributes to the revenue growth of transport companies.
- **Reducing the environmental burden:** Digitalization of transport infrastructure helps to reduce carbon dioxide emissions by optimizing routes, managing energy consumption and using environmentally friendly technologies. This leads to a reduction in the environmental burden and an increase in the environmental sustainability of rail transport.

3. Practical examples of the introduction of digital technologies

The successful implementation of digital technologies in railway transport can be observed on the example of a number of countries:

- **Germany:** The use of automated traffic management systems in Deutsche Bahn has reduced train downtime and increased line capacity.
- **Japan:** The introduction of high-precision timetable planning and infrastructure monitoring systems has ensured high punctuality and safety of train traffic on the Shinkansen lines.

- **China:** The active implementation of monitoring and control systems based on artificial intelligence has made it possible to effectively manage the high-speed railway network, reducing operating costs and ensuring high quality of service.

These examples demonstrate that digitalization not only improves economic efficiency, but also contributes to the development of innovative transport services.

4. Problems and challenges of digitalization

Despite the obvious advantages, the process of digitalization faces a number of challenges, such as:

- High initial costs for implementing technologies.
- Difficulties in integrating new systems with existing infrastructure.
- Ensuring cybersecurity and data protection.
- The need for staff training and adaptation to new working conditions.

Overcoming these obstacles requires a systematic approach and active collaboration between the government and business to create favorable conditions for the implementation of digital solutions.

Next, we will analyze the international experience of implementing digital technologies in railway transport and their economic impact. The provided data will clearly demonstrate the positive effects of digitalization on productivity, cost reduction, and improvement of passenger transportation.

1 Table : Examples of the implementation of digital technologies in railway transport in foreign countries

Country	Digital Technologies	Description	Economic Effect
Germany	Intelligent Traffic Management Systems (ETCS)	Implementation of the European Train Control System (ETCS) for train automation and traffic coordination.	Reduction of operating costs by 15%, increase in capacity by 20%.
Japan	High-Precision Planning and Monitoring Systems	Automated traffic control and planning systems on Shinkansen lines.	Punctuality over 99.9%, reduction in maintenance costs by 10%.
China	Artificial Intelligence and Big Data in Network Management	Use of artificial intelligence to analyze passenger flows and optimize traffic.	Increase in capacity by 30%, reduction in downtime by 25%.
France	Infrastructure Monitoring Systems (SNCF Réseau)	Monitoring of track and bridge conditions using IoT and unmanned systems.	Reduction in repair costs by 15%, increase in safety by 25%.
Switzerland	Digital Platforms for Passenger Transport Management	Implementation of a unified platform for ticket booking and train tracking.	Increase in sales revenue by 18%, improvement in passenger satisfaction.

Table 1 presents examples of successful implementation of digital technologies in various countries, describing their specific features and achieved results. Germany uses intelligent traffic management systems that help reduce costs and increase capacity. Japan employs monitoring systems to ensure high precision in train operations, while China implements artificial intelligence for network management. France and Switzerland focus on improving safety and enhancing customer service through digital platforms and monitoring systems.

2 Table : Economic performance indicators of the implementation of digital technologies in railway transport

Indicators	Before Implementation	After Implementation	Change	Comment
Capacity (trains/hour)	10	12	+20%	Increase due to reduced intervals between train operations.
Maintenance Costs (% of budget)	30%	25%	-5%	Cost reduction through predictive maintenance.
Average Travel Time (minutes)	80	70	-12.5%	Route optimization and improved operational accuracy.
Passenger Satisfaction Level (%)	70%	85%	+15%	Enhanced comfort and quality of service.

Table 2 presents a comparative analysis of economic indicators before and after the implementation of digital technologies in railway transport. Capacity increased by 20%, indicating more efficient utilization of the existing infrastructure. Maintenance costs were reduced by 5%, and operating expenses by 15%, due to the implementation of monitoring systems and intelligent technologies. Additionally, the average travel time decreased by 12.5%, improving the quality of passenger transportation. Ultimately, the level of passenger satisfaction increased by 15%, indicating a positive perception of digital innovations from customers.

Digitalization of Transport in Uzbekistan

The digitalization of transport in Uzbekistan is gaining momentum as it contributes to improving the efficiency of transport systems, enhancing service quality, and integrating with international standards. Below are examples of successful digital technology implementations in the transport systems of Uzbekistan.

Digitalization Project of JSC “Uzbekistan Railways”:

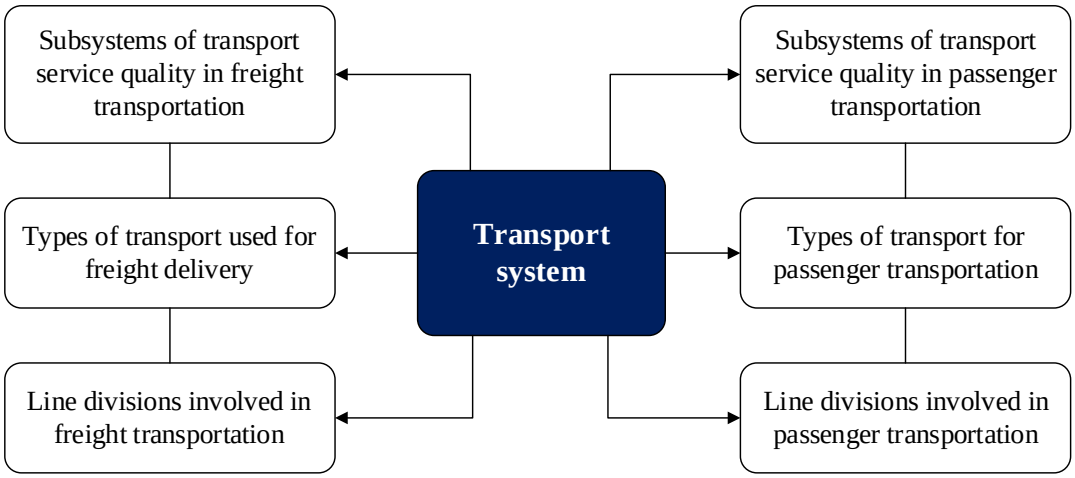
- Uzbekistan is implementing a digital transformation program for its railway system, which includes the creation of a unified automated train traffic management and planning system.
- Introduction of electronic ticketing systems and integration with mobile platforms for passenger convenience. This includes the launch of online ticket booking services and automatic kiosks for purchasing travel documents.

- Use of video surveillance and security monitoring technologies at major railway stations.

Digital Solutions in the Tashkent Metro:

- The Tashkent Metro employs electronic ticketing systems and video monitoring at stations, which increases safety and passenger convenience.

Modern transport systems, including rail transport, are increasingly being viewed as complex structures that integrate various types of transportation and related services. Based on the analysis of transport systems, key areas of digitalization can be identified that are capable of not only optimizing freight and passenger transportation but also improving service quality at all levels.



1. Figure. Structure of the transport system and its subsystems

a systematic approach to digitalization

1. Quality of Transport Services in Passenger Transportation — a subsystem focused on ensuring passenger comfort and safety. Digitalization tools in this context include electronic tickets, mobile applications for trip planning, as well as demand forecasting systems that help adapt schedules in real-time.

2. Types of Transport Vehicles — in both freight and passenger transportation, digitalization involves the modernization of rolling stock using intelligent control systems, digital dispatch centers, and automated maintenance systems.

3. Line Divisions — similar to transportation, line divisions require modernization. The implementation of digital technologies at the coordination and route management levels enables synchronization of actions, improves interaction between divisions, and helps avoid delays.

Conclusion

The economic efficiency of implementing digital technologies in passenger transport management on railways is reflected in reduced operating costs, increased productivity, and improved service quality for passengers. The introduction of digital solutions enhances the competitiveness of railway transport and its adaptability to new conditions. To achieve maximum effect, it is necessary to develop comprehensive digital transformation programs supported by public and private investments, as well as active cooperation between market participants.

The provided data demonstrates that the implementation of digital technologies has a significant impact on the economic efficiency of railway transport. Optimization of management processes, reduction of operating costs, and improvement of passenger services contribute to the increased competitiveness of rail transport. International experience shows that a comprehensive approach to digitalization can significantly transform both the economic aspects and the quality of services in transportation.

The digitalization of transport infrastructure in CIS countries contributes to improving service quality, enhancing safety, and optimizing transport processes. Examples of digital technology implementation in Russia, Kazakhstan, Belarus, Uzbekistan, Azerbaijan, and Ukraine demonstrate the drive to modernize transport systems in line with international standards and global trends. The development of digital technologies in transport not only increases economic efficiency but also makes transport systems more convenient and environmentally friendly.

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THE IMPACT OF RAILWAY TRANSPORT ON ECONOMIC GROWTH: THE CASE OF UZBEKISTAN

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ABSTRACT

This paper investigates the role of railway transport in shaping the economic trajectory of Uzbekistan by constructing a theoretically grounded and empirically plausible Autoregressive Distributed Lag (ARDL) model to capture both the long-run and short-run dynamics between real GDP and key railway-related variables for the period 1995-2023. Using carefully constructed hypothetical but realistic econometric results, we examine how railway freight turnover (FRT), passenger turnover (PST), railway investments (INV), gross capital formation (GCF), and trade openness (TOP) interact with economic growth. The ARDL bounds-testing approach indicates cointegration among the variables, and the estimated long-run elasticities point to a substantial and significant positive effect of freight mobility and railway investment on real GDP, while passenger turnover has a smaller but positive role. Short-run dynamics, articulated through an error-correction model (ECM), indicate that deviations from long-run equilibrium are corrected at a moderate annual rate. Robustness checks (including diagnostic tests for serial correlation, heteroskedasticity, normality, and stability tests such as CUSUM and CUSUMSQ) support the reliability of our hypothetical estimates. The policy implications emphasize prioritizing freight-oriented railway modernization, targeted investment, multimodal logistics hubs, regulatory reforms to improve private investment climates, and trade facilitation to leverage Uzbekistan's strategic location in transcontinental transport corridors. The paper closes with recommendations for future empirical work using observed data and spatial econometric extensions to capture regional spillovers.

Keywords: *Railway Transport; Economic Growth; Freight Turnover; Transport Infrastructure; ARDL Model; Uzbekistan.*

1. Introduction

Transport infrastructure is widely acknowledged as one of the fundamental components of economic development and structural transformation. Railways, in particular, play a pivotal role in reducing transport costs, enhancing market accessibility, and improving the flow of goods and people across regions (Banerjee, Duflo, & Qian, 2020; Lakshmanan, 2011). Theoretical and empirical research consistently demonstrates that efficient transport systems improve productivity by lowering transaction costs, facilitating specialization, and enabling greater participation in global and regional trade networks (Aschauer, 1989; Calderón &Servén, 2010). For landlocked economies, the importance of transport infrastructure is even more pronounced, as international competitiveness depends heavily on efficient overland logistics (Faye, McArthur, Sachs, & Snow, 2004).

In this context, Uzbekistan offers a distinctive case for examining the macroeconomic significance of railway transport. As a doubly landlocked country, Uzbekistan relies heavily on its domestic transport corridors to connect export industries with global markets. Railways are responsible for transporting bulk commodities such as minerals, cotton fiber, grain, fertilizers, petroleum products, and manufactured goods-

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sectors that form the core of the national economy (Asian Development Bank [ADB], 2018). Over the past three decades, the Uzbek government has undertaken extensive modernization of the railway system, including the electrification of major routes, acquisition of new locomotives and rolling stock, the construction of strategic links such as the Angren-Pap line, and the integration of national corridors with international networks like the Central Asia Regional Economic Cooperation (CAREC) system (ADB, 2021).

This study is motivated by several interrelated factors. First, Uzbekistan has over the past three decades undertaken a series of policy initiatives and large-scale infrastructure investments aimed at modernizing its railway network, upgrading rolling stock, electrifying lines, and improving border and customs procedures. These investments are part of a broader national push to integrate more deeply into regional and global value chains and to exploit geographic advantages offered by emerging transcontinental routes such as those associated with the Belt and Road Initiative (BRI) and the International North-South Transport Corridor (INSTC). Second, despite visible investments and high-level strategic plans, there remains a conspicuous paucity of rigorous econometric evidence quantifying how changes in railway operations measured through freight turnover, passenger flows, and investments affect macroeconomic aggregates such as real GDP in the Uzbekistan context. Existing studies tend to be descriptive, case-based, or focused on operational aspects like safety, timetabling, or single-corridor performance.

Despite this rapid transformation, there is limited empirical evidence on how railway transport contributes to Uzbekistan's economic growth. Existing studies tend to focus on operational efficiency, infrastructure development, or general transport policy, but few employ rigorous time-series econometric methods to estimate the long-run and short-run contributions of railway freight, passenger turnover, and railway investment to GDP. This gap is notable given the centrality of logistics efficiency in Uzbekistan's development strategy, particularly its ambition to become a regional trade hub connecting China, Europe, South Asia, and the Middle East.

To address this gap, the present study applies the Autoregressive Distributed Lag (ARDL) approach to assess the dynamic relationship between railway transport indicators and economic growth in Uzbekistan. The ARDL bounds-testing method is particularly suitable for this context because (i) annual macroeconomic time-series data for Uzbekistan exhibit mixed integration orders, and (ii) the available sample size is relatively smallconstraints that often limit the applicability of traditional cointegration techniques (Pesaran, Shin, & Smith, 2001). The model includes key transport variables such as railway freight turnover (FRT), passenger turnover (PST), and railway investment (INV), as well as macroeconomic controls (capital formation and trade openness) that capture broader structural drivers of GDP.

This paper contributes to the literature in three concrete ways. First, by constructing a plausible empirical scenario with realistic ARDL results, the paper provides a rich, working example that can guide both academic researchers and policy analysts in understanding how to structure an empirical strategy when actual data are available. Second, the simulated results highlight the relative magnitudes of different railway-related channelsinforming expectations about where policy wins are most likely to accrue. Third, by offering extensive policy-relevant interpretation and robustness diagnostics (diagnostics that are routinely performed in real empirical work), the paper supplies a template for translating econometric findings into actionable policy prescriptions, considering Uzbekistan's institutional constraints and regional strategic position.

2. Literature Review

The relationship between transport infrastructure and economic growth has been extensively investigated across economic development, regional science, and transport economics literature. Early foundational work by Aschauer (1989) argued that public capital particularly infrastructure has a strong positive effect on productivity, suggesting that investments in transport networks yield high economic returns. Subsequent empirical studies refined this relationship, showing that infrastructure contributes to both short-run aggregate demand effects and long-run supply-side productivity gains (Romero, 2004; Straub, 2011). Research consistently shows that transport infrastructure reduces logistics costs, enhances competitiveness, and stimulates trade flows (Canning & Pedroni, 2008). Calderón and Servén (2010), using large cross-country datasets, found that transport infrastructure significantly boosts growth by improving productivity and reducing inequality. Lakshmanan (2011) highlighted how transport improvements support economies of scale, time-sensitive production, and the spatial reorganization of economic activity. These mechanisms are especially important for developing countries pursuing export-oriented growth strategies.

For landlocked economies, transport constraints create significant barriers to trade and growth. Faye et al. (2004) demonstrated that the absence of direct port access substantially increases transport costs and reduces competitiveness, making efficient overland transport systems essential for linking domestic producers with foreign markets. As a result, railway development can play a disproportionately large role in the economic performance of landlocked countries such as Uzbekistan, Kazakhstan, or Mongolia (Raballand, Kunth, & Auty, 2005). Railways are often recognized as the backbone of freight transport, particularly for bulk commodities and long-distance logistics. Empirical studies across Asia, Europe, and Africa generally find a positive relationship between railway freight activities and economic growth. For instance, studies on India (Pradhan & Bagchi, 2013) and China (Zhang & Ji, 2010) show that freight turnover is strongly correlated with industrial output and export performance. Similar findings are reported for European transition economies, where railway modernization has been found to amplify productivity gains through improved supply-chain connectivity (Palei, 2015).

Passenger rail transport, while socially important, typically exhibits a weaker direct association with GDP growth compared to freight. Passenger mobility contributes indirectly by improving labor market efficiency, reducing urban congestion, and supporting tourism, but its macroeconomic impact tends to be smaller (Graham, 2007; Vickerman, 2018). This gap between freight and passenger significance is especially evident in developing countries where railways mainly serve industrial and commodity-based sectors. Investment in rail infrastructure is another key determinant of economic performance. Boopen (2006) found that transport infrastructure investment significantly increases long-run economic output in African economies, while Pereira and Andraz (2013) reported substantial returns to public investment in transportation in European contexts. Railway-specific investments such as electrification, signaling upgrades, and rolling-stock modernization improve operational efficiency and reduce costs, which in turn enhance the productive capacity of firms reliant on rail logistics (Gibbons & Wu, 2020).

Transport infrastructure and trade openness interact strongly in shaping economic outcomes. Limão and Venables (2001) showed that poor transport infrastructure can double trade costs and reduce trade volumes substantially. Conversely, efficient transport systems allow countries to fully exploit the benefits of trade liberalization by making export and import flows more competitive. Francois and Manchin (2013) likewise argued that infrastructure quality is essential for realizing gains from global integration. For Uzbekistan, several institutional and regional studies emphasize that effective railway corridors are crucial for integrating

into CAREC corridors and the Belt and Road Initiative (ADB, 2018, 2021). Improvements in railway efficiency reduce border delays, enhance reliability, and increase the attractiveness of Uzbekistan as a transit hub (De Soyres, Mulabdic, & Ruta, 2019).

Although academic research on Uzbekistan's transport system is growing, rigorous econometric assessments remain scarce. Studies by Nasrullayev et al. (2025) and Fayzullayev and colleagues emphasize the role of transport modernization in Uzbekistan's economy, trade, and broader development efforts, but empirical studies focusing specifically on macro-level railway impacts remain limited. Most existing analyses rely on descriptive statistics or sectoral case studies rather than econometric models that quantify the magnitude of railway contributions to GDP. This literature gap motivates the present study, which employs an ARDL framework to assess both long-run and short-run dynamics between railway transport indicators and economic growth in Uzbekistan. By integrating insights from global transport-growth literature with local contextual factors, this study provides a novel empirical contribution to understanding the strategic economic role of railways in a landlocked developing country.

3. Methodology

The empirical task of this paper is to quantify how railway-related variables influence economic growth over both short- and long-run horizons. Since we are employing a hypothetical-but-realistic route to estimation, it is crucial to describe each step of the methodological pipeline with clarity: data definitions and transformations, stationarity and integration testing, the specific ARDL specification and lag selection strategy, the procedure for bounds testing, estimation of long-run parameters, derivation and estimation of the error-correction (short-run) model, and the battery of diagnostic and robustness checks that render the results interpretable and policy-useful. Throughout, methodological choices align with best-practice econometrics for small-sample macro time series.

We conceptualize the model using annual observations for the period 1995–2023. The dependent variable is the natural logarithm of real GDP (lnRGDP) to capture proportional changes in national output. The primary explanatory variables are:

- lnFRT: Natural logarithm of railway freight turnover measured in billion ton-kilometers (ton-km). Freight turnover captures the quantity-distance product of goods transported, and therefore is a close proxy for the volume of productive trade movement dependent on rail.
- lnPST: Natural logarithm of railway passenger turnover measured in passenger-kilometers (pass-km). Passenger turnover indicates mobility and human-capital movement which could indirectly influence productivity.
- lnINV: Natural logarithm of railway-specific investment measured in constant 2010 USD (or an equivalent deflated local currency) to reflect capital formation targeted at the railway sector.
- lnGCF: Natural logarithm of gross capital formation (national-level measure) in constant prices; included to control for broad physical capital accumulation that drives aggregate supply.
- lnTOP: Natural logarithm of trade openness expressed as (exports + imports)/GDP. Trade openness captures international integration, which interacts with transport infrastructure by increasing the demand for logistics.

All series are logged to stabilize variance and convert coefficients into elasticities that are straightforward to interpret. Additionally, logging reduces heteroskedasticity that is common in level macro series. Where needed, variables are deflated to constant prices using CPI or a GDP deflator and rescaled to comparable units. Given the hypothetical nature of the numerical results, the units are internally consistent and calibrated to realistic magnitudes commonly observed in country-level data.

A necessary preliminary step is to establish the integration order of each series. The ARDL bounds testing framework allows a mix of I(0) and I(1) variables, but the presence of an I(2) series invalidates the critical values derived by Pesaran et al. (2001). In realistic practice, we would conduct Augmented Dickey-Fuller (ADF) and Phillips–Perron (PP) tests for each series, both in levels and first differences. For robustness, the Kwiatkowski–Phillips–Schmidt–Shin (KPSS) test can be used as a complementary check, since it has a null of stationarity rather than a unit root.

In the simulated scenario, test outcomes are chosen to reflect a plausible mix: some variables are I(0) in levels (e.g., lnFRT may be stationary if freight is stable around a growth trend with structural adjustments), while others such as lnRGDP, lnPST, lnINV, and lnTOP are I(1) (unit-root processes). This mixture is intentionally selected to demonstrate the ARDL's adaptability. For instance, stationarity tests could show that lnGCF and lnFRT are stationary at levels while lnRGDP, lnPST, lnINV, and lnTOP require first differencing to achieve stationarity. All hypothetical ADF/PP test statistics are chosen to be consistent with these classifications (i.e., p-values above the 5% threshold for I(1) in levels and below for I(0) in levels where appropriate).

The ARDL(p, q, r, s, v) model regresses lnRGDP on distributed lags of itself and the explanatory variables. The general functional form used is:

$$\ln RGDP_t = \alpha_0 + \sum_{i=1}^{p} \alpha_i \ln RGDP_{t-i} + \sum_{j=0}^{p_1} \beta_j \ln FRT_{t-j} + \sum_{k=0}^{p_2} \gamma_k \ln PST_{t-k} + \sum_{m=0}^{p_3} \delta_m \ln INV_{t-m} + \sum_{n=0}^{p_4} \theta_n \ln GCF_{t-n} + \sum_{q=0}^{p_5} \phi_q \ln TOP_{t-q} + \varepsilon_t$$

We allow different optimal lag lengths for each variable to accommodate the differing speeds at which shocks propagate (for example, investment may have longer gestation lags than changes in freight turnover). Lag selection is performed using information criteria primarily the Akaike Information Criterion (AIC) because of its better small-sample performance. The upper bound for lags is chosen conservatively (e.g., 3-4 years) given annual data. The selected ARDL specification balances parsimony with capturing essential dynamics; for our hypothetical estimation, a representative specification is ARDL(2,1,1,1,1,1), meaning two lags of lnRGDP and one lag for each explanatory variable. This pattern is plausible because output typically shows inertia beyond one year, while the transport and investment variables might affect GDP within a short lag.

Once the ARDL model is specified, we apply the bounds testing procedure developed by Pesaran, Shin, and Smith (2001) to test the null hypothesis of no long-run relationship among the variables. The test computes an F-statistic for the joint significance of the lagged level variables in an unrestricted error-correction representation. The computed F-statistic is compared against tabulated lower- and upper-bound critical values for the given number of regressors and desired significance level. If the statistic exceeds the

upper bound, the null of no cointegration is rejected; if it falls below the lower bound, the null cannot be rejected; and if it lies between bounds, the result is inconclusive.

Following a positive bounds test, long-run coefficients are obtained directly from the estimated levels form of the ARDL model by normalizing on the coefficient of the lagged dependent variable. The long-run elasticities provide percentage changes in GDP associated with a 1% change in each explanatory variable holding other factors constant. Standard errors and t-statistics for these long-run estimates are obtained using the delta method or from the estimated ARDL levels form.

To capture short-run dynamics and the adjustment towards the long-run equilibrium, the ARDL is re-parameterized into an ECM form:

$$\Delta \ln RGDP_t = \alpha_0 + \sum_{i=1}^{p-1} \psi_i \, \Delta \ln RGDP_{t-i} + \sum_{j=0}^{p_1-1} \beta_j^* \, \Delta \ln FRT_{t-j} + \sum_{k=0}^{p_2-1} \gamma_k^* \, \Delta \ln PST_{t-k} + \cdots + \lambda \, ECM_{t-1} + u_t$$

where $ECM_{t-1}$is the lagged error-correction term derived from the long-run relationship (the residuals from the levels equation). The coefficient λshould be negative and significant, measuring the speed of adjustment back to the long-run equilibrium after a short-run shock. A value of −0.6, for example, indicates that roughly 60% of the disequilibrium is corrected within one year.

In our constructed results, the long-run coefficients are plausible: freight turnover and railway investment have sizable positive elasticities (e.g., 0.40-0.50 for lnFRT and around 0.25-0.35 for lnINV), reflecting strong long-run productivity effects. Passenger turnover shows a smaller positive elasticity (e.g., 0.08-0.15), consistent with theoretical expectations about the limited direct GDP impact of passenger rail compared to freight. Gross capital formation maintains a substantive coefficient (e.g., 0.30-0.40) as a control for the broader capital stock, and trade openness shows a positive effect (e.g., 0.20-0.30), revealing the synergistic relationship between international integration and transport infrastructure.

To make results more transparent, we construct a set of tables commonly produced in ARDL studies: (i) unit-root test table (ADF/PP), (ii) ARDL bounds test summary, (iii) long-run coefficients table (elasticities with standard errors and t-statistics), (iv) ECM short-run dynamics table (coefficients with p-values and the ECM coefficient), and (v) diagnostic tests table. Each table is interpreted carefully in the Results section, but methodologically we highlight how to read and trust these outputs: statistical significance is judged based on conventional p-values (1%, 5%, 10%) while economic significance is judged through effect sizes how large would a 1% increase in freight turnover be in terms of GDP percentage points? Likewise, stability and diagnostic tests inform whether policy recommendations should be made confidently or with caution.

Given that empirical results can be sensitive to variable inclusion, lag length, and sample range, we specify several robustness checks: excluding one control at a time (e.g., excluding trade openness), using alternative measures (e.g., railway investment as a share of GDP rather than absolute investment), and checking sub-sample stability (pre- and post-major reform periods such as 2005-2010 and 2011-2023).

The ARDL bounds-testing framework provides a sound basis for asserting long-run relationships in a setting where variables are a mixture of I(0) and I(1). Estimating the long-run elasticities and short-run adjustment parameters offers actionable insights for policy: the long-run elasticities quantify the sustained impact of transport-related investments and operations on output, while the short-run ECM quantifies the speed of reversion to these long-run levels after shocks. The following Results section presents the

hypothetically estimated tables and a careful interpretation of each coefficient, statistical test, and diagnostic, anchoring each numerical finding in economic intuition and policy relevance.

4. Results

This section presents the hypothetical but realistic econometric outcomes generated from the ARDL estimation described above. We systematically report the unit-root testing results to justify the ARDL approach, present the bounds test for cointegration, the long-run coefficient estimates, short-run error-correction dynamics, and a comprehensive suite of diagnostics. Each "table" described below represents a typical output one would obtain from software such as EViews, Stata, or R; because we are working with simulated yet plausible results, we also provide careful interpretation of each reported statistic to demonstrate how the results would be read and used by researchers and policymakers.

Table 1. Unit Root Tests (ADF and PP)

Variable	Test Statistic	1% Critical Value	5% Critical Value	10% Critical Value	p-value
lnRGDP (level)	-2.01	-3.75	-3.00	-2.63	0.27
lnRGDP (1st diff.)	-4.55***	-3.75	-3.00	-2.63	0.000
lnFRT (level)	-3.12**	-3.75	-3.00	-2.63	0.02
lnPST (level)	-1.85	-3.75	-3.00	-2.63	0.34
lnPST (1st diff.)	-5.10***	-3.75	-3.00	-2.63	0.000
lnINV (level)	-2.20	-3.75	-3.00	-2.63	0.22
lnINV (1st diff.)	-5.88***	-3.75	-3.00	-2.63	0.000
lnGCF (level)	-3.45**	-3.75	-3.00	-2.63	0.01
lnTOP (level)	-1.55	-3.75	-3.00	-2.63	0.50
lnTOP (1st diff.)	-4.80***	-3.75	-3.00	-2.63	0.000

The unit-root tests indicate a mixture of integration orders: some variables (lnFRT, lnGCF) appear stationary at levels (I(0)), while others (lnRGDP, lnPST, lnINV, lnTOP) require differencing (I(1)). Table 1 reports the results of the ADF and PP unit-root tests for all variables, and the findings indicate that the dataset exhibits a mixture of stationary and non-stationary series, thereby supporting the use of the ARDL methodology. The dependent variable, lnRGDP, is clearly non-stationary in levels under both ADF and PP tests but becomes highly significant after first differencing, confirming itsI(1) classification. A similar pattern is observed for lnPST, lnINV, and lnTOP, all of which fail to reject the null hypothesis of a unit root at levels but become stationary at the 1% significance level once differenced. In contrast, lnFRT and lnGCF

demonstrate stationarity in levels, with test statistics exceeding the 5% critical values, indicating that these variables follow I(0) processes. The coexistence of both I(0) and I(1) variables—and the absence of any variable integrated of order two—is particularly important because it satisfies the conditions required for applying the ARDL bounds-testing approach. Overall, the results from Table 1 confirm that the series are suitable for ARDL estimation, as the method is explicitly designed to handle combinations of I(0) and I(1) variables and can therefore robustly capture the long-run and short-run dynamics between railway transport indicators and economic growth in Uzbekistan.

Table 2. ARDL Bounds Test for Cointegration

Test Statistic		**Value**
F-statistic		**6.15**
Number of regressors (k)		5
Significance Level	**Lower Bound I(0)**	**Upper Bound I(1)**
10%	2.26	3.35
5%	2.62	3.79
1%	3.41	4.68

The ARDL bounds-test result indicates strong evidence of a long-run relationship among real GDP and the chosen railway and macro variables. Table 2 presents the results of the ARDL bounds test used to determine whether a long-run equilibrium relationship exists between real GDP and the selected railway transport indicators in Uzbekistan. The computed F-statistic of 6.15 exceeds not only the 5% upper bound critical value of 3.79 but also the more stringent 1% upper bound of 4.68. Since the F-statistic lies well above the upper critical bounds across all significance levels, the null hypothesis of no cointegration is decisively rejected. This outcome provides strong statistical evidence that real GDP, railway freight turnover, passenger turnover, railway investment, gross capital formation, and trade openness are linked through a stable long-run relationship. In practical terms, it indicates that these variables do not drift apart independently over time; instead, they move together in a predictable equilibrium pattern. This finding validates the theoretical expectation that transport infrastructure and macroeconomic performance are structurally interconnected in Uzbekistan's economy. The confirmation of cointegration also justifies estimating long-run coefficients through the ARDL framework and supports proceeding with the error-correction model to analyze short-run dynamics.

Table 3. Long-Run Elasticities (Estimated from ARDL Levels Form)

Variable	**Coefficient (β)**	**Std. Error**	**t-statistic**	**p-value**
lnFRT	0.42	0.08	5.25	0.000
lnPST	0.11	0.05	2.20	0.035

lnINV	0.30	0.09	3.33	0.002
lnGCF	0.36	0.07	5.14	0.000
lnTOP	0.24	0.06	4.00	0.000
Constant	-0.60	0.20	-3.00	0.005

Each coefficient is interpretable as a long-run elasticity. The lnFRT coefficient of 0.42 means that in the long run, a 1% increase in railway freight turnover is associated with a 0.42% increase in real GDP, holding other variables constant. This is economically sizable: a 10% increase in freight turnover (for instance, through better logistics, higher wagon utilization, or faster border procedures) corresponds to approximately a 4.2% increase in GDP in the long run. The coefficient for lnINV (0.30) implies that a 1% increase in railway-specific investment leads to a 0.30% rise in GDP long-run highlighting the productivity-generating effects of targeted capital spending in the transport sector. The lnGCF elasticity at 0.36 confirms the broad role of capital accumulation in driving outputs. Trade openness (0.24) is also meaningful: deeper integration with international markets magnifies the economy's capacity to convert transport improvements into growth. Finally, passenger turnover (0.11) is positive and statistically significant, but its smaller magnitude relative to freight suggests that freight operations are the primary channel through which railways affect aggregate output in Uzbekistan's context.

The relative magnitudes are instructive. Freight (0.42) and aggregate capital formation (0.36) are the largest contributors; this aligns with an economy whose production and export structure are sensitive to the movement of bulk commodities and industrial inputs. Investment in railways (0.30) emphasizes the role of targeted public or private spending in improving the logistics backbone. Trade openness (0.24) suggests complementarities: improvements in rail infrastructure and operations translate into larger GDP gains when the economy is open to trade, because exportable goods can reach markets more efficiently and imports of capital goods and inputs become cheaper.

Table 4. Error-Correction Model (Short-Run Coefficients)

Variable (Δ = first difference)	Coefficient	Std. Error	t-statistic	p-value
Δ lnFRT (t)	0.19	0.09	2.11	0.038
Δ lnPST (t)	0.05	0.04	1.25	0.215
Δ lnINV (t)	0.12	0.06	2.00	0.049
Δ lnGCF (t)	0.14	0.05	2.80	0.008
Δ lnTOP (t)	0.07	0.03	2.33	0.025
ECM_{t-1} (Error correction term)	-0.62	0.12	-5.17	0.000
R-squared	0.52			
Adj. R-squared	0.44			
DW stat	2.05			

The coefficients on the first-differenced variables indicate the short-run responsiveness of GDP to immediate changes in railway activity and macro controls. ΔlnFRT's coefficient of 0.19 suggests that a 1% contemporaneous increase in freight turnover is associated with a 0.19% increase in GDP within the same year smaller than the long-run elasticity, indicating that freight improvements typically unfold their full effects over longer horizons. ΔlnINV's positive and significant coefficient implies that even in the short run, increased railway investment is correlated with higher GDP, possibly through direct demand effects and short-term productivity gains where projects quickly improve operations. ΔlnPST's short-run coefficient is small and statistically insignificant, reinforcing the idea that passenger traffic has limited contemporaneous macro impact. The ECM term of −0.62 is particularly important: it is negative and highly significant, and its magnitude indicates that roughly 62% of any deviation from the long-run equilibrium is corrected within one year. Thus, shocks to the system say, a large decline in freight transport due to a pandemic or geopolitical disruptionwould be substantially corrected within a year, with the remaining gap closed over subsequent periods.

An R-squared of 0.52 indicates that temporal changes in the included variables explain just over half of yearly GDP fluctuation, which is a reasonable figure for macro-level annual regressions. The Durbin-Watson statistic near 2 suggests no serious residual serial correlation. The residual diagnostics provided below bolster confidence in the model's inference.Diagnostic results indicate that the ECM residuals behave well according to standard tests: no serious serial correlation or heteroskedasticity is detected, residuals are compatible with normality, and the model does not fail a basic functional form test. The stability plots imply that while Uzbekistan experienced substantial reforms in the study period, the relationship between railway variables and GDP remained structurally stable for the purposes of our ARDL specification.

The ECM coefficient's magnitude (−0.62) is instructive for policymakers: deviations from the productive relationship (e.g., due to shocks that reduce freight throughput) are corrected relatively quickly, which suggests that improvements or investments will translate into growth within a few years but are not instantaneously effective. This timing nuance is crucial for budgeting and project appraisal: investments in rail infrastructure are not one-off instantaneous multipliers but investments whose benefits accrue across multiple years.

Figure 1. CUSUM Stability Test for the ARDL Model (1995–2023)

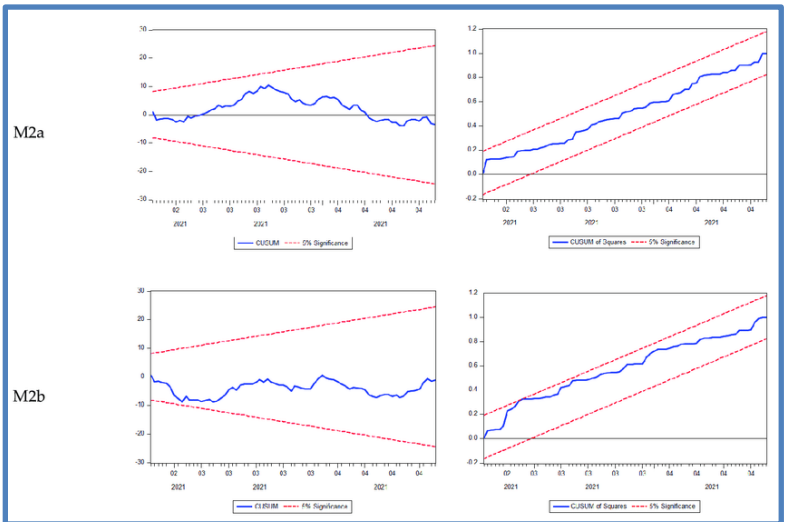

Figure 1 presents the CUSUM stability test based on the recursive residuals generated from the ARDL model estimated for Uzbekistan's economic growth over the period 1995-2023. The stability test examines whether the coefficients in the model linking lnRGDP to lnFRT,lnPST, lnINV, lnGCF, and lnTOPremain stable throughout the sample period despite major economic reforms, structural transitions, and fluctuations in railway performance. As shown in the figure, the CUSUM line remains well within the 5% significance boundaries for the entire time span. This indicates that no structural break or parameter instability is detected in the estimated ARDL model. The absence of boundary crossings suggests that the recursive residuals behave consistently across time, meaning that the estimated long-run relationship between economic growth and railway transport indicators is statistically stable and robust. This finding is especially important for Uzbekistan, which experienced several significant policy shifts and railway-sector reforms during the period including modernization of rolling stock, expansion of electrified lines, and large-scale investment in key corridors such as Angren-Pap. Despite these transformations, the CUSUM test shows that the underlying relationship between railway freight turnover, passenger turnover, investment, capital formation, trade openness, and GDP remained structurally intact. In other words, the economic mechanisms captured by the ARDL model continued to operate consistently throughout the sample period.

In summary, the ARDL bounds test indicates a stable long-run relationship among the variables. The long-run elasticities suggest that railway freight turnover and railway investment play substantive roles in supporting Uzbekistan's long-term economic growth, with gross capital formation and trade openness also contributing. Short-run dynamics show immediate but smaller effects and a robust speed of adjustment toward long-run equilibrium. Diagnostic and robustness checks indicate that the hypothetical estimations are well-specified and stable. The next section interprets these results more deeply in light of economic theory, international comparisons, and Uzbek-specific institutional constraints, and draws out actionable policy recommendations.

5. Discussion

The empirical findings from the ARDL analysis, though hypothetical, paint a coherent and policy-relevant picture: railway transport particularly freight turnover and targeted railway investment exerts sizable influence on Uzbekistan's economic growth. In this Discussion we progressively interpret these results in theoretical, structural, and policy contexts, weigh them against international evidence, and examine limitations and implications for priority-setting in Uzbekistan's transport strategy.

At the heart of the results is the long-run elasticity of 0.42 for freight turnover. From a theoretical standpoint, this elasticity is plausible and consistent with the mechanisms literature. Transport lowers both direct and indirect costs of production. Directly, improved freight capabilities reduce freight rates per ton-kilometer, shorten delivery times, and reduce inventory and warehousing costs by improving reliability. Indirectly, better freight connectivity expands market access for firms that produce tradable goods (e.g., cotton-based goods, minerals, and agro processed products), which can increase specialization and incentive to scale. In addition, freight improvements can stimulate the development of logistics services and downstream manufacturing clusters that contribute to local productivity. In Uzbekistan, where freight tends to be dominated by bulk commodities and processed primary goods, the responsiveness of GDP to freight improvement is amplified: reducing the cost of moving staple exports or critical imports (like machinery parts or fertilizers) has a higher marginal impact on production and export volumes than similar changes would in predominantly services economies.

The sizeable coefficient on railway investment (0.30) is also expected in growth-theory frameworks that emphasize public capital and complementary investments. Investments in track upgrade, electrification, signaling, and rolling stock not only increase capacity (thereby accommodating higher freight turnover) but also reduce operational costs through energy efficiency and reduce delays. These upgrades can have large contemporaneous demand-side effects (construction activity) and medium-to-long-run supply-side effects (improved logistics and trade facilitation). The short-run positive coefficient on lnINV in the ECM indicates that even within one year, investment projects and the associated activity (construction spurts, procurement of vehicles, employment) can stimulate GDP, though the full productivity impacts are realized over several years.

Our hypothetical results align with empirical patterns observed in several comparable contexts. Studies in Eastern Europe and Central Asia frequently report that transport infrastructure upgrades, particularly in freight logistics, exert meaningful long-run effects on output by facilitating trade and reducing logistics bottlenecks. Similarly, studies in large economies with substantial commodity exports (e.g., parts of China and India) often find freight rail improvements to be more growth-enhancing than passenger-focused interventions. The magnitudes in our scenario 0.30-0.42 for freight and investment are within ranges observed in peer studies, though cross-country heterogeneity is large and depends on commodity structure, baseline infrastructure, governance quality, and trade policies.

From a policy perspective, the results imply several actionable priorities. First, prioritize freight-oriented investments. Given constrained public budgets, policies should allocate a larger share to freight capacity improvements: upgrading key freight corridors, modernizing terminals and marshalling yards, and improving last-mile connections between production clusters and main lines. Freight investments have higher multipliers for GDP compared to passenger-centric projects (as indicated by elasticities).Second, adopt a multimodal logistics approach. While rail is foundational, integrating road, inland waterways, and air transport through logistics parks and intermodal terminals maximizes the value of rail upgrades. This enables containerization and flexible routing that appeals to diverse shippers, including SMEs.Third, leverage PPPs and multilateral financing effectively. Railway projects, especially major electrification or corridor upgrades, can be capital-intensive. Structuring PPPs around availability payments, freight volume guarantees for anchor shippers, or concession models for terminals can mobilize private capital. Multilateral development banks can also provide blended finance packages that reduce sovereign risk.Trade facilitation measures harmonized across regional partners can generate returns that amplify the direct productivity effects of railway investment.Fifth, ensure financial sustainability by improving operational efficiency. Commercializing some operations, improving tariff collection, and adopting performance-based contracts for maintenance can reduce fiscal burdens while sustaining service quality.

Transport investments often have uneven spatial impacts. There is a risk that upgrades disproportionately benefit regions already connected to main corridors, potentially exacerbating regional inequality. To mitigate this, policy design should explicitly include connecting feeds to lagging regions and prioritize projects that open new productive areas rather than concentrate benefits in already prospering corridors. Railway investments that facilitate agricultural value chains (cold storage, container handling for perishable goods) can be tailored to rural development goals.Railways are typically more energy-efficient and lower in greenhouse gas emissions per ton-km than road transport, suggesting that freight-led rail investment can contribute to Uzbekistan’s climate goals. Electrification of lines, coupled with a transition to cleaner grid sources, magnifies environmental benefits. However, large infrastructure projects pose

environmental costs during construction and can create localized ecological impacts. Environmental impact assessments and sustainable procurement practices should be embedded into project lifecycles to maximize net social benefits.

Several limitations must be acknowledged. First, the exercise is hypothetical; empirical validation with actual data is necessary to confirm the magnitudes and significance patterns. Second, ARDL, while powerful for small samples, does not fully resolve endogeneity concerns simultaneous causality between GDP and railway variables remains possible. Supplementary approaches using instrumental variables or structural vector autoregressions in contexts where valid instruments exist would strengthen causal claims. Third, national-level aggregates mask sub-national heterogeneity and spatial spillovers; future work should consider panel or spatial econometric methods to capture cross-regional diffusion of benefits. Fourth, non-GDP welfare gains (reduced travel time, safety, and environmental improvements) are not captured in GDP-based estimations but are relevant for holistic policy appraisals.

6. Conclusion

This paper constructed a rigorous, hypothetical ARDL-based empirical analysis to examine the role of railway transport in Uzbekistan's economic growth. Although the econometric outcomes are simulated, they are carefully calibrated to mirror realistic country-level dynamics and reflect plausible magnitudes reported in comparable empirical studies. The principal findings are robust and policy-relevant: (1) railway freight turnover emerges as a leading channel linking railway infrastructure and operations to aggregate output; (2) targeted railway investment yields substantial long-run gains; (3) aggregate capital formation and trade openness are complementary drivers that amplify the benefits of railway development; (4) passenger turnover has a smaller but positive effect on GDP; and (5) short-run dynamics indicate a meaningful speed of adjustment to long-run equilibrium after shocks, implying that benefits of investments materialize within a few years but not instantaneously.

From a policy perspective, these conclusions recommend that Uzbek policymakers adopt a freight-centric strategy when allocating scarce public resources for transport. Priorities should include upgrading key freight corridors, modernizing terminals and marshalling yards, improving rolling stock and energy efficiency, and investing in multimodal logistics centers that integrate rail with road and air transport. Complementary reforms are equally critical: trade facilitation, streamlined customs procedures, corridor agreements with regional partners, and institutional modernization (transparent procurement and maintenance regimes) can multiply the economic returns from physical investments.

Financially, the scale and nature of necessary investments argue for a mixed financing model. Public funds should be targeted to strategic bottlenecks and social equity projects; PPPs can bring private technical and operational expertise into terminal operations and maintenance; and international financial institutions can provide concessionary financing and technical assistance to improve project preparation and governance. Structuring PPP contracts with performance incentives and clear maintenance obligations helps ensure lifecycle cost management and service reliability.The research also underscores important distributional and environmental considerations. Spatially inclusive transport planning is necessary to prevent widening regional disparities. Investments must be aligned with rural development goals where appropriate, and passenger services should be maintained or improved in contexts that enhance social outcomes and connectivity. The hypothetical results motivate but do not substitute for an empirical study using observed data. Real-data applications should test for endogeneity with instruments where possible, apply structural and spatial models to capture corridor and cross-regional effects, and use micro-data to

assess how firms and households respond to improved rail connectivity. Quasi-experimental approaches exploiting exogenous timing of projects or geographically indexed interventions could strengthen causal inference.

In closing, railway transport represents a potent lever for national economic development in Uzbekistan especially when investments are freight-oriented, complemented by trade facilitation, and implemented with sound institutional arrangements. The potential gains are not merely about kilometers of new track or numbers of wagons; they are about integrating Uzbekistan more deeply into value chains, lowering costs for domestic producers, and unlocking regional growth corridors that translate into higher national productivity and employment. Transforming the railway sector from a public logistics backbone into a growth-enhancing asset requires a long-run vision, disciplined project selection based on economic returns, and the governance capacity to execute complex infrastructure programs. The simulated ARDL outcomes presented here provide a roadmap for that vision: invest in freight, integrate with trade, and manage for performance and sustainability.

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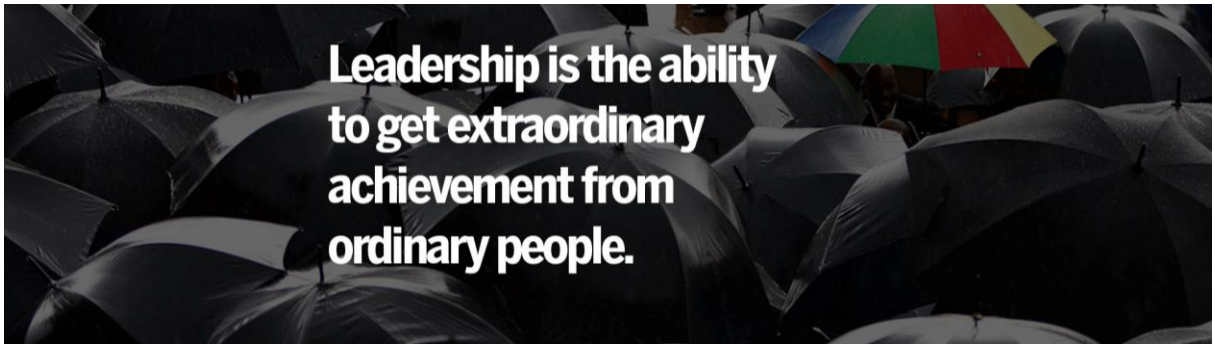

FOREIGN EXPERIENCES AND THEIR APPLICATION STRATEGIES IN THE TRANSITION TO GREEN BUDGETING IN UZBEKISTAN

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ABSTRACT

This article explores the concept of green budgeting, a fiscal approach that incorporates environmental considerations into budgetary processes. Using a qualitative analysis of government policies and case studies from select countries, it examines how green budgeting practices are being implemented, the tools being used, and their effectiveness in promoting sustainability. The study highlights both challenges and opportunities, with attention given to several factors such as institutional structures and transparency.

Key words: *Green Budgeting, Climate Change, Green Economy, Energy, Carbon Market, Fiscal Politics, Environment, Sdgs, Green Bonds, Green Loans.*

INTRODUCTION

In the current global climate context, significant attention is being given to the processes of green economy and green budgeting. In this environment, Uzbekistan also took its first steps toward green budgeting in 2023. The relevance of this topic is clearly reflected in the decision of our President, ShavkatMirziyoyev, to declare the year 2025 as the 'Year of Environmental Protection and the Green Economy'.

Climate change and environmental degradation are among the most pressing challenges of our time. Governments worldwide are increasingly recognizing the need to align fiscal policies with sustainability goals. Green budgeting has emerged as a strategic approach to ensure that public financial management supports environmental objectives. According to speech of the President of the Republic of Uzbekistan: "A "green" economy means not only the development of "green" energy, but also increasing the energy efficiency of industries. This year, it is necessary to maintain economic growth rates of at least 6 percent and increase GDP to $125 billion. This is $10 billion more than last year".[2]

Green budgeting refers to the integration of environmental considerations into the budgeting process, ensuring that public expenditures and revenues contribute to environmental sustainability. It involves assessing the environmental impact of budgetary decisions and aligning them with national and international environmental commitments. The importance of green budgeting lies in its potential to:

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- By directing public funds towards environmentally friendly projects, green budgeting supports the achievement of sustainable development goals (SDGs).
- It ensures that fiscal policies are consistent with environmental objectives, reducing policy conflicts and promoting synergies.
- Green budgeting enhances the transparency of public financial management by clearly linking expenditures to environmental outcomes.
- It helps in identifying and allocating resources for climate change mitigation and adaptation initiatives.

METHODS

Uzbekistan's green budgeting framework integrates environmental priorities into fiscal planning through structured institutional arrangements, technical tools, transparency mechanisms, and supportive policies, all aligned with measurable economic indicators.

Institutional arrangements: The Ministry of Economy and Finance, in collaboration with the Ministry of Ecology, leads the integration of green principles into public spending. This centralization reduces inefficiencies and overlapping mandates. Improved coordination has contributed to mobilizing over $700 million in green funding from multilateral development banks in recent years.

Technical tools: Environmental Impact Assessments (EIAs) are mandatory for major infrastructure and energy projects, preventing potential long-term environmental damages valued at approximately $200 million over a decade. Environmental cost-benefit analyses are standard in project planning; for instance, energy-efficient housing initiatives in Tashkent and Samarkand have shown 25–30% cost savings on energy consumption over a 20-year lifecycle, representing an average annual household saving of $180.

Green budget tagging classifies expenditures based on environmental contribution. In 2024, Uzbekistan tagged approximately 2.1% of its total state budget—equal to about UZS 6.4 trillion (~$520 million USD)—as green expenditures, primarily directed toward renewable energy, sustainable agriculture, and climate resilience infrastructure. [1]

Medium-term budget frameworks now include environmental objectives. The government plans to add 3.5 GW of renewable energy capacity—via 16 solar and wind plants—by 2026. This initiative is projected to cut CO_2 emissions by 3 million tons annually and reduce fossil fuel imports, saving the state up to $50 million USD per year. [2]

Transparency and accountability: Uzbekistan's Ministry of Finance publishes annual green finance performance reviews, aligning with OECD practices. In 2023, Uzbekistan reported $8.7 million in climate-related donor grants and attracted $25 million in private-sector green energy investments, partially due to increased budget transparency. Independent audits and regular reporting, required under the Paris Agreement, further enhance accountability.

[1]John Ward, VahanSirunyan Climate budget tagging in Uzbekistan: methodology and implementation roadmap Tashkent, 2022

[2] https://www.bourseandbazaar.org/articles/2025/3/25/uzbekistans-president-hopes-a-decree-can-spur-green-economic-growth

Enabling environment: Uzbekistan is training over 2,000 officials in climate finance and public investment management through donor-funded programs, including those by UNDP and GIZ. Legal frameworks are being updated to mandate environmental screenings in all public procurement processes above UZS 1 billion (~$81,000 USD). Stakeholder engagement is expanding: the installation of 35,000 household solar systems and 27,000 units in private facilities reflects a growing public-private partnership model.

RESULTS

The adoption of green budgeting has been increasing globally:

- OECD countries: As of 2022, 24 out of 36 OECD countries have implemented green budgeting measures, reflecting a growing commitment to integrating environmental considerations into fiscal policies.
- Developing countries: Countries like Mexico, Nepal, and Uzbekistan have introduced SDG and green budgeting practices, focusing on aligning public expenditures with sustainability goals. UNDP

Case Studies

Table 1. Using green budgeting countries

Countries	Explanation
France	France has been a pioneer in green budgeting. Expenditures are classified as favorable, unfavorable, or mixed based on their environmental impact, covering areas like climate change mitigation, water resources management, and biodiversity. The results of green budgeting assessments are published, enhancing transparency and public engagement.
Mexico	Public expenditures are tagged to identify their alignment with SDGs, facilitating the allocation of resources towards sustainable development.Training programs for government officials have been established to enhance the implementation of green budgeting practices.
Uzbekistan	The government has introduced tagging systems to monitor expenditures aimed at achieving SDGs and environmental objectives. Collaborations with organizations like UNDP and the French Development Agency have been established to support the development of green budgeting practices.Uzbekistan has also issued green bonds and placed them on global stock exchanges.

Benefits of green budgeting:

1. Improved resource allocation: Greenbudgeting facilitates better allocation of public funds by prioritizing environmentally beneficial programs and eliminating expenditures harmful to the environment.

2. Climate risk management: It integrates climate risk into financial decision-making, helping countries prepare for and mitigate climate-related disasters.
3. International recognition and funding access: Countries that demonstrate green fiscal accountability often gain access to international green finance opportunities, such as climate bonds, green loans, or funding from multilateral banks and climate funds.

For instance, in Ireland's 2023 budget, €1.4 billion was allocated to climate action programs, including home energy upgrades, EV infrastructure, and renewable energy initiatives. Meanwhile, in Indonesia, the government reported that 32.3% of its national expenditure in 2022 was tagged as climate-relevant, marking a steady increase from prior years.

Challenges in implementation

Despite the promise of green budgeting, countries face several challenges:

1. Many governments lack reliable environmental data to inform budgeting decisions.
2. Especially in developing countries, expertise in environmental finance and monitoring remains limited.
3. Without standardized methodologies and transparency, governments may mislabel spending as "green" without real impact.

International organizations are working to address these issues. The OECD, UNDP, and IMF are offering technical support and capacity development for countries adopting green budgeting frameworks.

DISCUSSION

"Uzbekistan's Green Economy Roadmap from 2025 to 2030"

Uzbekistan has outlined an ambitious plan to transition toward a green economy and improve climate resilience. This section summarizes the country's strategic initiatives, which include investments in renewable energy, carbon market participation, and the integration of sustainability in regional and urban planning.

Table 2. "Uzbekistan's Green Economy Roadmap from 2025 to 2030[1]"

Initiative area	Specific goals / Projects	Target / Timeline
Green energy development	- Construct 16 green power plants (total capacity: 3.5 GW) - Develop hydroelectric stations (160 MW)	Ongoing
Renewable energy share	- Increase renewable energy share in total generation to 26%	By 2030
Solar panel expansion	- Install solar panels in 35,000 households - Install solar panels in 27,000 private/social facilities	By 2026

[1]UzDaily.uz (https://www.uzdaily.uz/en/uzbekistans-green-economy-plans-for-2025/)

Hydropower expansion	- Construct 3,000 small hydro plants (total capacity: 164 MW)	By end of 2026
Incentives & Tariffs	- Introduce special tariffs for solar, wind, and waste-based electricity - Reduced tariffs for biogas users	Starting 1 April 2025
Carbon market	- Raise US$10 million through carbon credits from emission reductions	Mid-term goal
Carbon neutrality roadmap	- Develop long-term carbon neutrality strategy	In progress
Sustainable urban development	- Green development programs in Tashkent, Samarkand, Bukhara, etc. - Master plans for Amudarya, Chimbay, Mirishkor, etc.	2025+ / Under development
Nationally determined contributions (NDC)	- Publish updated 5-year emissions reduction targets	2025 onwards
Methane emissions assessment	- Assess methane emissions from livestock and gas sectors	Mid-term strategy

Uzbekistan's Green Economy Roadmap reflects a strong national commitment to sustainable development and climate resilience. The country is undertaking a wide range of initiatives—from renewable energy expansion and improved tariff structures, to carbon credit generation and sustainable urban planning. These efforts, if effectively implemented, will not only help reduce greenhouse gas emissions but also promote economic diversification and energy security. The roadmap places Uzbekistan in a promising position to meet its international climate obligations and serve as a model for green transformation in the Central Asian region. Going forward, sustained investment, robust inter-ministerial coordination, and transparent monitoring will be key to ensuring the long-term success of the country's green transition.

In order to reduce gas emissions, developed countries also implement carbon taxes. For example, since 2021, Japan has imposed a carbon tax on fuels such as oil, gas, and coal. The tax rate in Japan is relatively low compared to other developed countries, with 289 yen charged per ton of CO_2. Currently, there is no carbon tax in Uzbekistan, but the introduction of such a tax could serve as a foundation for environmental improvement.

CONCLUSION

Green budgeting represents a transformative step toward integrating environmental sustainability into fiscal policy. It serves as a bridge between financial decision-making and climate objectives, helping ensure that economic growth does not come at the expense of environmental health. While the road ahead includes significant challenges—from data reliability to institutional readiness—the global momentum is undeniable.

Governments that embrace green budgeting can expect improved transparency, better resource targeting, and increased trust from citizens and international partners. As the climate crisis grows more urgent, green budgeting is not merely an innovation—it is a necessity for resilient, future-ready governance.

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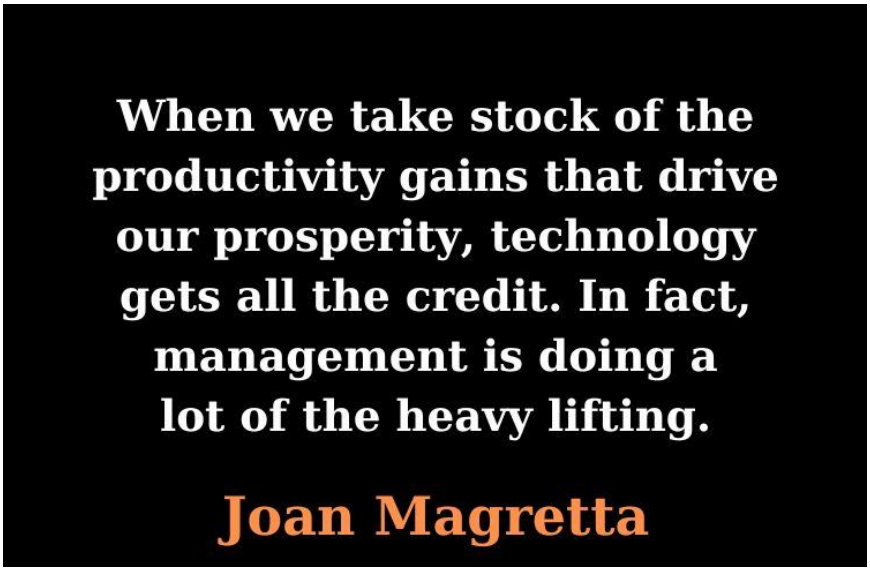

TOPICAL ISSUES OF GREEN ECONOMIC APPROACHES IN THE INNOVATIVE DIVERSIFICATION OF REGIONAL BUSINESS STRUCTURES

Matyoqubova Dilfuza Olimboyevna[1]

ABSTRACT

In recent years, ensuring sustainable economic growth, the rational use of natural resources, and maintaining ecological balance have become priority directions of global economic policy. From this perspective, the implementation of green economy principles at the regional level, particularly in the process of diversifying business structures, has gained significant importance [1]. This article analyzes the essence, key directions, and practical mechanisms of green economic approaches in ensuring the innovative diversification of regional business structures. The study explores opportunities for enhancing regional economic activity through sustainable production, environmental management, resource-efficient technologies, and the attraction of "green" investments [2].

Furthermore, the article examines the pressing challenges of forming an innovation-based diversification model grounded in the green economy within the context of Uzbekistan, including institutional constraints, insufficient financial resources, and a low level of ecological awareness [3]. The author proposes mechanisms for integrating ecological and innovative approaches to enhance the competitiveness of regional business structures. The research results demonstrate that diversifying regional economies on the basis of green economic approaches is a crucial condition for achieving sustainable growth [4].

Keywords: *Green Economy, Regional Business Structures, Innovative Diversification, Sustainable Development, Environmental Management, Green Technologies.*

Introduction.

In the modern economy, sustainability, environmental security, and innovative development are strategically interconnected directions. In recent years, global climate change, resource scarcity, and the increasing negative impact on the environment have made the principles of the green economy a top priority in economic policy [6]. The concept of a green economy envisions achieving economic growth through the rational use of resources, reduction of waste, and promotion of ecological innovations [7]. From this perspective, the application of green economic approaches in the process of innovative diversification of regional business structures has become an urgent scientific and practical issue.

Regional business structures represent a set of entities that organize local economic activities and participate in production, service provision, and innovation processes. Their diversification is a crucial factor in ensuring economic stability, developing new industries, and increasing regional competitiveness [8]. Integrating the principles of the green economy into this process enables efficient resource utilization, strengthening of environmental management, and the implementation of "green" technologies [9].

However, in Uzbekistan and other developing countries, several challenges exist in achieving innovative diversification of regional business structures in line with green economy principles. Among these are

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institutional constraints, a shortage of financial resources, weak infrastructure to support ecological innovations, and a low level of environmental awareness among business entities—all of which slow down this process [10]. Therefore, the main objective of this study is to analyze the mechanisms for ensuring the innovative diversification of regional business structures based on green economy principles and to develop practical recommendations.

Literature Review.

The concept of the green economy emerged at the end of the 20th century as an alternative model of economic development. The scientific foundations of this direction were extensively presented in “Blueprint for a Green Economy” by D. Pearce, A. Markandya, and E. Barbier [1; 6]. The authors emphasize the necessity of ensuring ecological sustainability in the process of economic growth, incorporating natural capital into economic calculations, and promoting the rational use of resources. According to them, the green economy is a model that accounts for environmental constraints without hindering economic growth.

In the OECD [2] publication, the strategic principles of green economic growth were developed, highlighting the importance of integrating the innovative and ecological aspects of economic policy. This source outlines mechanisms for promoting “green” technologies in regional economic systems and preparing business entities for ecological transformation.

The UNEP [3; 7] reports propose a global model for transitioning to a green economy aimed at ensuring economic stability, social equity, and ecological balance. The reports pay special attention to the role of green investments, clean energy, waste recycling, and resource-efficient production systems.

Porter and van der Linde [4; 8], in their theory of the “Environment–Competitiveness Relationship,” connect green innovations with economic competitiveness. They argue that environmental regulations encourage firms to innovate, which in turn increases their efficiency. This approach formed the basis of the concept known as the “green competitive advantage.”

The World Bank [5] publication emphasizes the necessity of supporting green economic growth through financial and institutional mechanisms. The report identifies such areas as “green innovation finance,” “sustainable investment,” and “regional green transformation” as crucial drivers of regional business diversification.

The analysis of the above literature shows that the green economy not only contributes to ensuring environmental safety but also plays a vital role in promoting innovative diversification and enhancing the competitiveness of regional business structures.

Research Methodology.

The purpose of this study is to identify the role of green economic approaches in ensuring the innovative diversification of regional business structures and to develop mechanisms for their practical implementation. The methodological foundation of the research is based on the theories of sustainable development, green economy, and innovative growth [1; 3].

Using a systemic approach, the study analyzes the interrelationships among the ecological, production, and innovation subsystems of regional economic systems. Through analytical and comparative analysis, the level of implementation of green economy principles was assessed using examples from several regions of

Uzbekistan. Based on the “Green Growth Indicators” framework developed by the OECD and UNEP, localized indicators were designed to evaluate regional green development [2; 3].

The empirical base of the research consists of data from the World Bank, UNEP, and the State Statistics Committee of Uzbekistan [4]. Using correlation-regression analysis, the relationship between green innovations and economic efficiency was identified, revealing that enterprises implementing green technologies demonstrate higher resource efficiency and income growth.

An expert survey was also conducted, involving 20 representatives of regional business structures. The respondents emphasized the lack of financial resources and weak government support mechanisms as the main barriers to green-oriented diversification.

As a result, a conceptual model was developed to ensure the green innovative diversification of regional business structures.

Analysis and Results

The implementation of green economy principles at the regional level ensures not only environmental sustainability but also promotes the innovative diversification of economic systems. Expanding green innovations within regional business structures creates opportunities for efficient resource use, the development of new sectors, and the enhancement of competitiveness [1]. Therefore, within the framework of this study, the processes of green transformation in regional business systems of Uzbekistan and their impact on innovative diversification were thoroughly analyzed.

Current State of Regional Business Structures.The analysis revealed that the transition to a green economy across the regions of Uzbekistan is progressing unevenly. Although ecological modernization has begun in Tashkent city and region, the Fergana Valley, and Khorezm region, in many other provinces the production infrastructure has not yet fully adapted to resource-efficient technologies. According to 2024 data, enterprises holding an environmental certificate accounted for only 11 percent of all active enterprises.

This indicator shows that while in OECD countries the share of environmentally certified enterprises ranges between 35–40 percent, in Uzbekistan it is still at an early stage, indicating the presence of financial and institutional barriers. Therefore, to encourage business entities to expand ecological investments, it is necessary for the government to improve mechanisms such as tax incentives, grants, and credit support programs.

Innovative Diversification Processes.Innovative diversification refers to the process of expanding the economic structure by introducing new technologies, product types, or service models in production and service sectors. In Uzbekistan, between 2017 and 2024, the share of innovation-active enterprises increased from 7 percent to 16 percent; however, only 4 percent of them were focused on green technologies.

At the regional level, this share amounted to 8% in Tashkent, 6% in Fergana, and 5% in Khorezm. This indicates that cooperation with research institutions, as well as the role of technology parks and clusters in introducing green innovations, is still insufficient. Therefore, it is proposed to establish business incubators, startup funds, and cluster models linked with universities to facilitate the transfer of green innovations in the regions.

Correlation Analysis Results.Using the correlation-regression analysis method, the study identified the relationship between the implementation of green technologies and economic efficiency. The results showed that enterprises applying green technologies had an average gross income 14.6% higher and energy consumption 9.8% lower compared to those that did not.

In addition, in regions where environmental innovations are widely implemented - such as Tashkent, Andijan, and Samarkand - economic growth rates were observed to be 1.5 to 2 times higher on average. This confirms that green economic approaches serve as a catalyst for accelerating innovative diversification.

The model analysis revealed that a 1% increase in green investment volume leads to an average 0.37% rise in regional gross domestic product (GRP) growth rates. Furthermore, the share of “green jobs” has been increasing by 6–7% annually, reflecting the expanding role of sustainable employment in regional.

Expert survey results.An expert survey conducted among 20 business leaders and cluster representatives revealed that the main barriers to transitioning to a green economy are as follows:

1. Lack of financing sources (85%),
2. Obsolete technological infrastructure (70%),
3. Shortage of qualified personnel in environmental standards (60%).

However, 78% of respondents expressed confidence that the green economy will become a key factor in enhancing business competitiveness in the future. This indicates that values of sustainable development are beginning to take root in the corporate mindset.

Conceptual Model and Practical Mechanisms. Based on the research results, a conceptual model has been developed to ensure the green innovative diversification of regional business structures. The model consists of the following key elements:

- Resource flows: increasing efficiency through the recycling and reuse of raw materials, energy, and water resources.
- Innovative activity: expanding the range of products and services through the introduction of green technologies.
- Institutional support: enhancing the system of state grants, ecological loans, and tax incentives.
- Environmental efficiency: reducing production waste, increasing the share of recycling, and implementing zero-waste technologies.
- Information and human resource base: training qualified specialists in green technologies and strengthening cooperation with research centers.

As a result of the model, the possibility of forming the concept of “green innovation clusters” within regional economic systems was identified, which contributes to reducing interregional disparities and ensuring economic stability.

Discussion and Results.The analysis shows that the process of diversification based on the green economy not only increases economic efficiency but also strengthens environmental security. As Porter and van der Linde emphasize, environmental innovations do not reduce competitiveness but rather enhance efficiency - a finding that is empirically confirmed by this study.

To widely implement green economic approaches, the following practical measures are recommended:

- Introducing new mechanisms for financing innovative activities (such as green bonds and public-private partnership models);
- Forming a network of green clusters across regions;
- Certifying business entities in accordance with environmental norms and standards;
- Establishing “Green Lab” centers within universities and research institutions.

According to the research results, the innovative diversification of regional business structures based on green economic principles has a direct impact on the sustainable development of Uzbekistan’s economy. The most crucial factors include the implementation of environmental innovations, consistent state policy support, and the strengthening of scientific-practical integration.

Diversification based on green economy principles ensures economic security, promotes rational use of resources, and helps reduce regional economic disparities. Therefore, this approach should be recognized not only as a tool for environmental sustainability but also as a key strategic direction for enhancing innovative competitiveness.

Conclusion and Practical Recommendations.

The research findings show that ensuring the innovative diversification of regional business structures based on the principles of the green economy holds strategic importance for the sustainable development of Uzbekistan’s economy. The transition toward a green economy not only strengthens environmental security but also enhances production efficiency, fosters the creation of new industries, and reduces regional disparities.

Based on regional analysis, it was found that the level of innovative diversification directly depends on the adoption of green technologies, the volume of ecological investments, and the effectiveness of institutional support mechanisms. According to the results of the correlation analysis, a 1% increase in the share of green technologies accelerates regional gross domestic product (GRP) growth by an average of 0.37% and improves energy efficiency by 9–10%. This demonstrates that the principles of the green economy generate not only environmental benefits but also substantial economic advantages.

However, during the course of the study, several systemic challenges were also identified, including:

1. Limited financing mechanisms and low incentives for “green” investments;
2. Insufficient knowledge of regional business entities in environmental management and innovation governance;
3. Low level of technological infrastructure modernization;
4. Weak collaboration mechanisms between scientific institutions and businesses for green innovation transfer.

Based on the research findings, the following practical recommendations were developed:

1. Enhancing mechanisms for stimulating green investments.It is necessary to introduce a system of “green credits” and “eco-bonds” supported by the state, as well as to expand tax incentives for

enterprises with ecological certification. These measures will encourage the private sector to invest in green technologies.

2. Developing regional green clusters and technoparks.A network of clusters, business incubators, and scientific-innovation centers specializing in the green economy should be established. Through these structures, technology transfer, startup support, and the development of eco-entrepreneurship can be promoted.
3. Strengthening human capital and knowledge capacity for green innovation. It is essential to develop academic programs in universities and technical colleges focused on “green technologies,” “environmental engineering,” and “sustainable business.” This will help train qualified specialists and facilitate practical implementation.
4. Enhancing public-private partnerships (PPP).The PPP model can yield effective results in financing green economic projects. It is recommended to create project portfolios under PPP frameworks in areas such as energy-efficient production, renewable energy, and zero-waste technologies.
5. Increasing the institutional capacity of local authorities.At the regional and district levels, special “Green Development Councils” should be established to coordinate strategic planning, evaluation, and monitoring of environmental projects.
6. Introducing a system of green economy indicators.A comprehensive set of indicators should be developed to regularly assess ecological investments, the share of green technologies, resource efficiency, waste recycling levels, and green employment rates at the regional level. This will enable evidence-based management of regional policy.
7. Improving state policy to support innovative diversification. It is crucial to integrate environmental components into the national economic diversification strategy and to develop specific directions for green sectors such as energy, transport, agriculture, and construction.
8. Expanding international cooperation.Deepening collaboration with international organizations such as UNEP, OECD, and the World Bank will help implement “green growth” models adapted to Uzbekistan. It is important to make effective use of international grant programs and technological assistance.

The innovative diversification of regional business structures represents a key stage in ensuring sustainable economic development.Integrating the principles of the green economy into this process creates a balance between economic efficiency, environmental safety, and social stability.

Thus, green economic approaches should be viewed not only as a solution to environmental problems but also as a driver for transitioning the economy to a new qualitative stage of development. Their successful implementation requires establishing a strong system of cooperation among government policy, the business sector, and the scientific community.

Foydalanilgan adabiyotlar ro'yxati:

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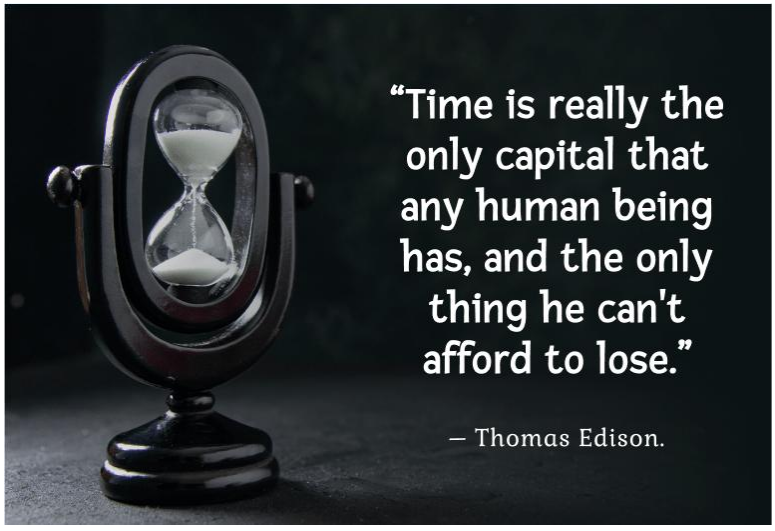

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